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Load Carriage: An integrated risk management approach.

Robin M. Orr
Bond University, rorr@bond.edu.au

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Load Carriage:
An integrated risk management approach
**Original Framework**

1. Establish the Context
   - The internal context
   - The external context
   - The risk management context
   - Develop criteria & define the structure

2. Identify Risks
   - What can happen?
   - When and where? How and why?

3. Analyse Risks
   - Identify existing controls
   - Determine consequence & likelihood
   - Determine level of risk

4. Risk Evaluation
   - Compare against criteria
   - Set priorities

5. Treat Risks
   - Identify and assess options
   - Prepare and implement treatment plans
   - Analyse and evaluate residual risk

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**Framework modified for this research program**

1. Establish the Context
   - Scientific context (Literature Review)
   - Historical context (Historical Review)
   - Australian Army context (Study A)

2. Identify Risks
   - Define Risk
   - Risks associated with load carriage (Study B)
   - The Role of physical training (Study C)
   - Policy and Doctrine (Study D)

3. Analyse Risk & 4. Risk Evaluation
   - Analysis and Evaluation of risks associated with soldier load carriage

5. Treat Risk
   - Risk treatments and recommendations
The Historical Context
OPERATIONAL LOAD CARRIAGE (Marching Order)

Mean Marching Order Loads (M&F)

<table>
<thead>
<tr>
<th>Corps</th>
<th>Mean Load (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Armoured Corps*</td>
<td>61.2</td>
</tr>
<tr>
<td>Infantry Corps*</td>
<td>60.9</td>
</tr>
<tr>
<td>Engineering Corps*</td>
<td>59.4</td>
</tr>
<tr>
<td>Artillery Corps*</td>
<td>58.1</td>
</tr>
<tr>
<td>Signals Corps</td>
<td>54.4</td>
</tr>
<tr>
<td>Other Corps</td>
<td>42.4</td>
</tr>
</tbody>
</table>
OPERATIONAL LOAD CARRIAGE (Marching Order)

Mean Marching Order Loads (M only)

- Armoured Corps*: 61.2 kg
- Infantry Corps*: 60.9 kg
- Engineering Corps*: 59.4 kg
- Artillery Corps*: 58.1 kg
- Signals Corps: 57.5 kg
- Other Corps: 48.8 kg

The Australian Soldier Context
OPERATIONAL LOAD CARRIAGE – Gender Differences

**ABSOLUTE LOADS**

FEMALE: $M = 26.4 \text{ kg}$

MALE: $M = 39.0 \text{ kg}$

$p = .045$

**RELATIVE LOADS**

FEMALE: $M = 43\%$

MALE: $M = 47\%$

$p = .55$
## OPERATIONAL LOAD CARRIAGE – BW Differences

### ABSOLUTE LOADS

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light 20%</td>
<td>$M = 34.7 \text{ kg}$</td>
<td></td>
</tr>
<tr>
<td>Heavy 20%</td>
<td>$M = 35.7 \text{ kg}$</td>
<td></td>
</tr>
</tbody>
</table>

$p = .902$

### RELATIVE LOADS

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light 20%</td>
<td>$M = 49%$</td>
<td></td>
</tr>
<tr>
<td>Heavy 20%</td>
<td>$M = 36%$</td>
<td></td>
</tr>
</tbody>
</table>

$p = .0509$
The Current Context v History

- Approximate relative load carried by Roman Legionnaires = 56% and Australian Soldiers in East Timor = 56%
Impacts of Load Carriage – From the Literature

- \( \uparrow \) in load weight = \( \uparrow \) in the energy cost of standing, walking (forwards and backwards, up and down stairs) and running

(Beekley, Alt, Buckley, Duffey, & Crowder, 2007; Bhambhani, Buckley, & Maikala, 1997; Bhambhani & Maikala, 2000; Bilzon, Allsopp, & Tipton, 2001; Blacker, Fallowfield, Bilzon, & Willems, 2009; Charteris, Scott, & Nottrodt, 1989; Chung, Lee, Lee, & Choi, 2005; Datta, Chatterjee, & Roy, 1975; Engels, Smith, & Wirth, 1995; Goslin & Rorke, 1986; Lyons, Allsopp, & Bilzon, 2005; Patton, Kaszuba, Mello, & Reynolds, 1991; Pederson, Stokke, & Mamen, 2007; Pimental, Shapiro, & Pandolf, 1982; Polcyn, Bensel, Harman, & Obusek, 2000; Robertson et al., 1982; Samanta & Chatterjee, 1981; Vaz, Karaolis, Draper, & Shetty, 2005).
Impacts of Load Carriage – From the Literature

- ↑ in speed of load carriage = ↑ in the energy cost of carrying given load (more than weight)? ↑ 0.5km/h= ↑10kg

Impacts of Load Carriage – From the Literature

• ↑ in gradient of load carriage = ↑ in the energy cost of carrying given load (more than weight)? ↑ 1% = ↑ 10kg

(Crowder, Beekley, Sturdivant, Johnson, & Lumpkin, 2007; Givoni & Goldman, 1971; Goldman & Jampietro, 1962; Legg, Ramsey, & Knowles, 1992; Lyons, et al., 2005; Pimental & Pandolf, 1979; Scott & Ramabhai, 2000; Vaz, et al., 2005).
‘When you get shot at, you move as fast as you can…but it wasn’t very fast. You are just tired. So tired.

Justin Kalentis, US Army, wounded in Afghanistan, discussing the loads they were carrying quoted in *The Seattle Times* (14 Feb 11)
Risks Associated with LC

• Injuries

Comparison of Reported Load Carriage Injuries Captured By Survey (1999-2010) and By OSCHAR (2009-2010)
Risks Associated with LC

- Injuries

<table>
<thead>
<tr>
<th></th>
<th>Training</th>
<th>1st 12 months in Unit</th>
<th>Post 12 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-Reported Injuries</td>
<td>56</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>18</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>29</td>
</tr>
<tr>
<td>TOTAL</td>
<td>56</td>
<td>38</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>194</td>
</tr>
</tbody>
</table>

- First reported load carriage injury
- Second reported load carriage injury to the same person
- Third or fourth reported load carriage injury to the same person
- Shows groups which contributed to successive injuries
• Decrements in performance:
  - ↓ Mobility
    • Assyrian Spearmen (Orr, 2010)
    • Impacted on battle tactics in major conflicts (Lothian, 1921)
    • Impeded mission success – Chasing Militia in East Timor (Breen 2000)
• Decrements in performance:
  – ↓ Lethality
Risks Associated with LC

• Decrement in performance:
  – ↓ Lethality
  • ↓ Grenade throw distance and accuracy (Harper et al., 1997: Knapik et al., 1990:1991)
• Decrements in performance:
  – ↓ Lethality
  • Ave soldier grenade throw distance = 40m

Risks Associated with LC

A. Lethal Radius - 6 metres
B. Casualty Radius - 15 metres
C. Danger Radius - 30 metres
Risks Associated with LC

- Reduced performance
  - Reduced mobility
  - Reduced lethality
Risks Associated with LC

- Reduced performance

![Graph showing impacts of load carriage on various operational tasks such as Mobility, Marksmanship, Grenade Throw, Administration, and Attention to Task.](image)
Risks Associated with LC
Challenge
Challenge

How to mitigate the effects of load carriage on the soldier?

Alter the environment?

Reduce the speed?

Reduce the duration?

Reduce the load?
Challenge

How to mitigate the effects of load carriage on the soldier?

Elimination?

Substitution?

Engineering?

Administration?

Reduce the load?
Risk Treatments

Short Term Targets

- Initial load carriage directive to all units
- RISK TREATMENT OPTION 1: Improved Load Carriage Conditioning Practices
  - 1.1 Improved Load carriage conditioning
- RISK TREATMENT OPTION 2: Improved Load Carriage Doctrine and Policy Controls
  - 2.1 Load carriage doctrine development
- RISK TREATMENT OPTION 3: Continued Investment in Soldier Load Reduction Measures and Practices
  - 3.1 Logistic practices review

Long Term Targets

- 1.2 Improved unit load carriage preparation
- 1.3 Formal training in load carriage conditioning for PTI
- 2.2 Unit load carriage policy development and update
- 3.2 Continued support to organisations invested in improving ARA load carriage practices

Ongoing review
Load Carriage:
An integrated risk management approach

Dr Rob Orr
rorr@bond.edu.au or Robin.orr@defence.gov.au
References


References


Evidence supporting increases in load weight found to increase the energy cost of standing, walking (forwards and backwards, up and down stairs) and running:

Evidence supporting increases in load weight found to increase the energy cost of standing, walking (forwards and backwards, up and down stairs) and running:

Evidence supporting increases in speed increasing the energy cost of carrying a given load:


References

Evidence supporting increases in energy expenditure while carrying loads up an incline:

- Pimental, N., & Pandolf, K. B. (1979). Energy expenditure while standing or walking slowly uphill or downhill with loads. Ergonomics, 22(8), 963-973.