Injuries suffered by an Australian State Police Force
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Australian Tactical Loads and their Operational Impacts

Dr Rob Orr (PhD, PHTY, BFET, TSAC-F, ADFPTS)
HISTORICAL CONTEXT – MILITARY

Background

• From the early Assyrian spearman of antiquity (circa 800 B.C.), soldiers have been required to carry external loads consisting of weaponry, equipment and food

  (Orr, 2010; Knapick et al., 2012:2004)

• Downstream effects of these loads have been shown to impact on the tactics of warfare, cause injury and reduce fighting force size

  (Lee, 2007; Breen, 2002;Lothian , 1921)
HISTORICAL CONTEXT – MILITARY

![Chart showing historical context of military load weights](https://bond.edu.au/tru)

(Orr, 2010: Orr et al., 2015)
CURRENT CONTEXT – AUSTRALIAN ARMY

On Operations (2001-2010)

• PO loads
  • M=28.4 ± 10.0 kg
    • heaviest mean load in 2008 (M=36.9±10.8 kg)

• MO loads
  • M=56.7 ± 15.3 kg
    • heaviest mean load in 2009 (M=65.1 ±16.3 kg)

• OVERALL loads
  • 47.7±21.0 kg, (mean range over 10 years = 40.7 kg to 50.9 kg),
  
(Orr et al., 2015)
CURRENT CONTEXT – AUSTRALIAN ARMY

• Approximate relative load carried by Roman Legionnaires = 56%
• Australian Soldiers in East Timor = 56%
• US Soldiers in Afghanistan = 57%
ABSOLUTE VS RELATIVE LOADS

- Currently female soldiers carry lighter absolute loads than male soldiers but only slightly heavier relative loads

<table>
<thead>
<tr>
<th></th>
<th>ABSOLUTE LOADS*</th>
<th>RELATIVE LOADS</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEMALE: $M = 26.4$ kg</td>
<td></td>
<td>FEMALE: $M = 43%$</td>
</tr>
<tr>
<td>MALE: $M = 39.0$ kg</td>
<td></td>
<td>MALE: $M = 47%$</td>
</tr>
<tr>
<td>$p=.045$</td>
<td></td>
<td>$p=.55$</td>
</tr>
</tbody>
</table>

ABSOLUTE VS RELATIVE LOADS

• Currently lighter soldiers carry the same absolute loads as heavier soldiers but heavier relative loads

<table>
<thead>
<tr>
<th>ABSOLUTE LOADS</th>
<th>RELATIVE LOADS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light 20%: $M = 34.7$ kg</td>
<td>Light 20%: $M = 49%$</td>
</tr>
<tr>
<td>Heavy 20%: $M = 35.7$ kg</td>
<td>Heavy 20%: $M = 36%$</td>
</tr>
<tr>
<td>$p = .902$</td>
<td>$p = .0509$</td>
</tr>
</tbody>
</table>

HISTORICAL CONTEXT – LEO

http://2.bp.blogspot.com/-xH5UL RFM0g/lfwLPl5EgAI/AAAAAAAAIpc/54yapn blatant_bell.jpg


HISTORICAL CONTEXT – LEO

• Police are becoming Christmas trees
HISTORICAL CONTEXT - LEO

• Increasing levels of threat
## Historical Context – Australian LEO

<table>
<thead>
<tr>
<th>ILAV type (A-C) &amp; Normal station wear (N)</th>
<th>ILAV Weight (kg)</th>
<th>Duty load Complete (kg)</th>
<th>Total load including officer weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4.12 ± 0.65*</td>
<td>11.53 ± 0.77‡</td>
<td>88.03 ± 20.49</td>
</tr>
<tr>
<td>B</td>
<td>3.54 ± 0.70*</td>
<td>11.01 ± 1.01‡</td>
<td>87.51 ± 20.60</td>
</tr>
<tr>
<td>C</td>
<td>3.24 ± 0.48*</td>
<td>10.77 ± 1.16‡</td>
<td>87.27 ± 20.66</td>
</tr>
<tr>
<td>N</td>
<td>NA</td>
<td>8.69 ± 0.68</td>
<td>85.19 ± 20.24</td>
</tr>
</tbody>
</table>

* Significantly different (p<0.05) between vests:
‡ Significantly different (p<0.001) from normal station wear

(Orr et al., 2016)
### CURRENT CONTEXT – AUSTRALIAN LEO

(Orr et al., 2016)

<table>
<thead>
<tr>
<th>ILAV type</th>
<th>FEMALE</th>
<th>MALE</th>
<th>FEMALE</th>
<th>MALE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ILAV + Duty Loads (kg)</td>
<td>ILAV + Duty Loads (kg)</td>
<td>%BW</td>
<td>%BW</td>
</tr>
<tr>
<td>B</td>
<td>10.80</td>
<td>11.18</td>
<td>16.43</td>
<td>13.91</td>
</tr>
<tr>
<td>C</td>
<td>10.24</td>
<td>11.22</td>
<td>15.60</td>
<td>13.95</td>
</tr>
<tr>
<td>N</td>
<td>8.68</td>
<td>8.70</td>
<td>13.20</td>
<td>10.92</td>
</tr>
</tbody>
</table>

*\( p=0.225 \)

*\( p=0.009 \)
ABSOLUTE VS RELATIVE LOADS

• The LEO study found female officers carried the same absolute loads compared to the male officers

• However when expressed as a percentage of their body weight female officers carried significantly more relative load than male officers

(Orr et al., 2016)
CURRENT CONTEXT – AUSTRALIAN LEO (TOU)

<table>
<thead>
<tr>
<th></th>
<th>Mean ± SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absolute load carried (kg)</td>
<td>22.8 ± 1.8</td>
<td>20.6-25.6</td>
</tr>
<tr>
<td>Relative load carried (%BW)</td>
<td>25.9 ± 4.0</td>
<td>21.2-28.8</td>
</tr>
</tbody>
</table>

(Carbone et al., 2014; Carlton et al., 2014)
SEX DIFFERENCES IN LC INJURIES


• Mean ARA population over 2 years = 24,876 personnel
  • Female n= 2441 (10%): Male n= 22435 (90%)
• 401 reported injuries associated with load carriage
  • Female n=40 (10%): male n= 361 (90%)
  • RR = 1.02 (95% CI 0.74 to 1.41)
• SPI
  • Female n=6 (15%): male n= 23 (6%)
  • RR of SPI = 2.40 (95% CI 0.98 to 5.88)
IMPACTS ON PERFORMANCE - MARKSMANSHIP

• Decrements in performance:

https://bond.edu.au/tru
Reduced performance
- Survey of 218 soldiers on operations

IMPACTS ON PERFORMANCE - MARKSMANSHIP

(Orr et al., 2013)
IMPACTS ON PERFORMANCE - MARKSMANSHIP

• Distance to centre of target
  • DCOT
• Horizontal shot spread
  • X-Dispersion
• Vertical shot spread
  • Y-Dispersion

Carbone et al., 2014

https://bond.edu.au/tru
IMPACTS ON PERFORMANCE - MARKSMANSHIP

- Mobility Task

Carbone et al., 2014

https://bond.edu.au/tru
IMPACTS ON PERFORMANCE - MARKSMANSHIP

• Marksmanship

Carbone et al., 2014
IMPACTS ON PERFORMANCE - MARKSMANSHIP

• No significant difference when TL

Orr et al., Unpublished
IMPACTS ON PERFORMANCE - MARKSMANSHIP

• Visual Analogue Scale (VAS)

Orr et al., Unpublished

https://bond.edu.au/tru
IMPACTS ON PERFORMANCE - MARKSMANSHIP

• Perceived significant improvement in marksmanship when TL
  • Primary – VAS +3.00 ± 2.53 (p = 0.016)
  • Secondary – VAS +2.83 ± 2.93, (p = 0.039)

• Correlations between perceptions of load carriage impacts on performance and actual marksmanship scores
  • Primary: Short move: r = -0.347, (p = 0.500) and mobility task: r = -0.401 (p = 0.431)
  • Secondary: Short move: r=-0.631 (p = 0.179) and mobility task: r = -0.306, (p = 0.555)

Orr et al., Unpublished
IMPACTS ON PERFORMANCE - MARKSMANSHIP

• GD police (n=11)
  • Average marksmanship scores (p=.118)
  • ILAV B – smallest SD,
    • ILAV A: a negative impact, -2.1 (95% CI -5.5 to +1.3)
    • ILAV B: a positive impact, +2.7 (95% CI +0.4 to +5.0)
    • ILAV C: a negative impact, -1.7 (95% CI -4.4 to +0.9)
    • Normal station wear: a positive impact, +1.4 (95% CI -2.2 to +5.0)

Schram et al., unpublished
IMPACTS ON PERFORMANCE - MOBILITY

• Decrements in performance:
  • ↓ Mobility
    • Impeded mission success (Breen 2000)
IMPACTS ON PERFORMANCE - MOBILITY

• Victim Drag (10m)
• Police Vehicle Exit and Sprint

<table>
<thead>
<tr>
<th>Condition</th>
<th>Victim Drag</th>
<th>Vehicle Exit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time (s)</td>
<td>Time (s)</td>
</tr>
<tr>
<td>ILAV A</td>
<td>5.74±0.28</td>
<td>3.49±0.94</td>
</tr>
<tr>
<td>ILAV B</td>
<td>5.47±0.23</td>
<td>3.41±0.87</td>
</tr>
<tr>
<td>ILAV C</td>
<td>5.50±0.38</td>
<td>3.40±1.06</td>
</tr>
<tr>
<td>N</td>
<td>5.56±0.43</td>
<td>3.41±0.85</td>
</tr>
</tbody>
</table>

Schram et al., unpublished
### IMPACTS ON PERFORMANCE - MOBILITY

Carlton et al., 2014

<table>
<thead>
<tr>
<th>Test</th>
<th>Unloaded</th>
<th>Loaded</th>
</tr>
</thead>
<tbody>
<tr>
<td>10m sprint (sec)</td>
<td>2.40 ± 0.22</td>
<td>2.46 ± 0.15</td>
</tr>
<tr>
<td>10m dummy drag (sec)</td>
<td>6.89 ± 0.44</td>
<td>7.79 ± 0.75*</td>
</tr>
<tr>
<td>Total time (sec)</td>
<td>9.29 ± 0.53</td>
<td>10.25 ± 0.77*</td>
</tr>
</tbody>
</table>

* Indicates statically significant differences between unloaded and loaded, p<0.01.
ENCAPSULATION

• Loads for both LEO and Army are increasing
• Female soldiers carry lighter absolute but similar relative loads
• Female LEO carry similar absolute but heavier relative loads
• There are differences in injuries sustained based on sex
• There are different impacts of load on marksmanship (primary / secondary weapon)
• Soldiers think load reduces marksmanship, LEO varies but appear accurate
• Load impacts on mobility – but the load may need to reach a threshold
Australian Tactical Loads and their Operational Impacts

References avail on request from tru@bond.edu.au

4th International Congress on Soldiers’ Physical Performance
28 November - 1 December 2017
Melbourne Australia