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Load carriage: Female officers carry their share

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Load Carriage: Female Officers Carry Their Share

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

- Police are becoming Christmas trees

![Image of police officers in uniform]

http://img.dailymail.co.uk/i/pix/2008/04_03/TabGunGirlLEWIS_468x715.jpg

HISTORICAL CONTEXT - POLICING

- Increasing levels of threat

NSW TOU Mean Load of 22kg
Excluding specialised equipment

Photograph taken by author
### AUSTRALIAN CONTEXT

<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
## AUSTRALIAN CONTEXT

<table>
<thead>
<tr>
<th>ILAV type</th>
<th>FEMALE</th>
<th>MALE</th>
<th>FEMALE</th>
<th>MALE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ILAV + Duty Loads (kg)</td>
<td>ILAV + Duty Loads (kg)</td>
<td>%BW</td>
<td>%BW</td>
<td></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
## US CONTEXT


<table>
<thead>
<tr>
<th></th>
<th>COMBINED (n=246)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>30.82±5.84</td>
</tr>
<tr>
<td>Years sworn (yrs)</td>
<td>3.62±3.46</td>
</tr>
<tr>
<td>Body Wt (Kg)</td>
<td>85.69±15.08</td>
</tr>
<tr>
<td>Load Wt (Kg)</td>
<td>10.72±1.73</td>
</tr>
<tr>
<td>Relative load (%)</td>
<td>11.83±2.38</td>
</tr>
</tbody>
</table>
## US CONTEXT

<table>
<thead>
<tr>
<th></th>
<th>FEMALE (n=43)</th>
<th>MALE (n=203)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>30.60±4.56</td>
<td>30.86±6.09</td>
</tr>
<tr>
<td>Years sworn (yrs)</td>
<td>4.03±2.92</td>
<td>3.54±3.56</td>
</tr>
<tr>
<td>Body Wt (Kg)</td>
<td>68.78±10.96*</td>
<td>89.27±13.31</td>
</tr>
<tr>
<td>Load Wt (Kg)</td>
<td>9.99±1.66*</td>
<td>10.87±1.71</td>
</tr>
<tr>
<td>Relative load (%)</td>
<td>13.36±2.46*</td>
<td>11.50±2.24</td>
</tr>
</tbody>
</table>

* Significantly different from male sheriffs, p<.001

ABSOLUTE VS RELATIVE LOADS

• Both LEO studies found female officers carried either the same (AUST) or lighter (US) 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
CURRENTLY FEMALE SOLDIERS CARRY LIGHTER ABSOLUTE LOADS THAN MALE SOLDIERS BUT ONLY SLIGHTLY HEAVIER RELATIVE LOADS


**ABSOLUTE LOADS**

<table>
<thead>
<tr>
<th>Gender</th>
<th>Absolute Load (kg)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>26.4</td>
<td>0.045</td>
</tr>
<tr>
<td>Male</td>
<td>39.0</td>
<td></td>
</tr>
</tbody>
</table>

**RELATIVE LOADS**

<table>
<thead>
<tr>
<th>Gender</th>
<th>Relative Load (%)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>43%</td>
<td>0.55</td>
</tr>
<tr>
<td>Male</td>
<td>47%</td>
<td></td>
</tr>
</tbody>
</table>
ABSOLUTE VS RELATIVE LOADS

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

**ABSOLUTE LOADS**

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

**RELATIVE LOADS**

|        | Light 20%: $M = 49\%$   | Heavy 20%: $M = 36\%$   |

ABSOLUTE VS RELATIVE LOADS

• Both Lyons, et al. (2005) and Ricciardi, et al. (2007) observed a reduced aerobic capacity and load carriage task performance ability (p=.01) in participants with increased levels of body fat.

• Even when participants were wearing a relatively light load (10 kg body armour), the amount of body fat of males (17%) and females (26%) was found to negatively correlate ($r=-0.88$; $p<.001$) with physical task performance (Ricciardi, et al., 2007).
INJURIES IN POLICING

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)
SEX DIFFERENCES IN GENERAL INJURY RX

<table>
<thead>
<tr>
<th>Primary Injury</th>
<th>N</th>
<th>% of Injuries</th>
<th>Total Treatments Attended</th>
<th>Mean ±SD Treatments/Patient</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Neck</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>4</td>
<td>13.3</td>
<td>13</td>
<td>3.25 ± 0.5</td>
</tr>
<tr>
<td>Female</td>
<td>2</td>
<td>16.7</td>
<td>5</td>
<td>2.5 ± 0.71</td>
</tr>
<tr>
<td>Total</td>
<td>6</td>
<td>14.3</td>
<td>18</td>
<td>3.0 ± 0.63</td>
</tr>
<tr>
<td><strong>Lumbar Spine</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>13</td>
<td>43.3</td>
<td>85</td>
<td>6.54 ± 3.73</td>
</tr>
<tr>
<td>Female</td>
<td>4</td>
<td>33.3</td>
<td>34</td>
<td>8.5 ± 3.7</td>
</tr>
<tr>
<td>Total</td>
<td>17</td>
<td>40.5</td>
<td>119</td>
<td>7.0 ± 3.71</td>
</tr>
<tr>
<td><strong>Shoulder</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>5</td>
<td>16.7</td>
<td>40</td>
<td>8.0 ± 5.43</td>
</tr>
<tr>
<td>Female</td>
<td>2</td>
<td>16.7</td>
<td>29</td>
<td>14.5 ± 6.36</td>
</tr>
<tr>
<td>Total</td>
<td>7</td>
<td>16.7</td>
<td>69</td>
<td>9.86 ± 6.04</td>
</tr>
</tbody>
</table>
SEX DIFFERENCES IN LC INJURIES

• The most common site of injury for both sexes was the back (F: 27%; M: 22%).


• Female Soldiers:
  • the foot (20%),
  • ‘neck and shoulder’ and knee (12%) and
  • ankle (10%).

• Male Soldiers:
  • the ankle (17%),
  • knee (11%),
  • ‘neck and shoulder’ (10%) and
  • foot (9%).
### INJURIES DUE TO LOAD CARRIAGE

<table>
<thead>
<tr>
<th>Mechanism of Load Carriage Injuries</th>
<th>Number of reported injuries (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muscular stress</td>
<td>251</td>
</tr>
<tr>
<td>Fall</td>
<td>85</td>
</tr>
<tr>
<td>Exposure to environmental heat</td>
<td>28</td>
</tr>
<tr>
<td>Rubbing and chafing</td>
<td>21</td>
</tr>
<tr>
<td>Stepping kneeling or sitting on objects</td>
<td>9</td>
</tr>
<tr>
<td>Unspecified mechanisms of injury</td>
<td>3</td>
</tr>
<tr>
<td>Contact with moving or stationary object</td>
<td>4</td>
</tr>
<tr>
<td>Other and multiple mechanisms of injury</td>
<td>2</td>
</tr>
<tr>
<td>Being trapped between stationary and moving object</td>
<td>1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>404</strong></td>
</tr>
</tbody>
</table>

INJURIES DUE TO LOAD CARRIAGE


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
IMPACTS ON PERFORMANCE

• ↑ in load weight = ↑ in the energy cost of standing, walking (forwards and backwards, up and down stairs) and running
IMPACTS ON PERFORMANCE

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

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

- Different terrains types will elicit different energy cost requirements

(road-light brush-heavy brush-sand)
IMPACTS ON PERFORMANCE

- Differences in load placement will elicit differences in energy cost.
  - Weight on the feet more costly than the back
  - Thigh more costly that back (0.5kg increases cost by 3.5%)
  - Waist less costly than back (use of waist belts on packs)
  - Shoulder more costly than back
IMPACTS ON PERFORMANCE

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

• Decrements in performance:
  • 0 Change Marksmanship (Orr et al., 2014).
IMPACTS ON PERFORMANCE  

- **Grip Strength and Marksmanship**

  43.22 ± 8.04 kg (25-67)

  34.67 ± 5.94 kg (28-51)

(rs[169]=-.419, p<0.001)
IMPACTS ON PERFORMANCE

• Alertness: Attention to task: Response to stimuli
  (Johnson et al., 1995: May et al., 2009: Mahoney et al., 2007)
RISK MITIGATION

• Change the job
• Change the equipment
• Change their fitness
  • Increase aerobic fitness and upper body strength
  • Minimise fat mass and increase lean mass
→ Other downstream benefits
CVD STRESS

• Police officers are twice as likely to develop cardiovascular disease when compared to the general population (Ramey, et al., 2014)

• Poor lifestyle choices
  • e.g. nutritional intake
CVD STRESS

- Police officers are less fit than recruits for same age?

CVD STRESS


• a 40-year-old male officer who breached his predicted maximum HR during three separate calls within one day,

• two officers’ HR ranging from 188 to 209 b.p.m. on four separate occasions, and

• four officers (one call out) ‘driving urgently’ to a ‘domestic incident’, who all recorded concerning HR, ranging from 185 to 198 b.p.m
RISK MITIGATION

- The Female Athlete Triad
RISK MITIGATION

• In a study by Rauh et al., (2006) female soldiers who reported being amenorrheic were found to have an almost threefold increase in lower-extremity stress fracture risk (amenorrhoea prevalence rate of around 45% has been found for female military recruits (Cline, 1998)).
RISK MITIGATION

- Low energy intake
  - Increased energy cost of load carriage
  - Body image and limiting dietary intake
  - Shift work (Hinton, et al., 2017)

- Even if caloric intake is high through poor meal choices there are concerns:
  - Female soldiers may not be meeting their recommended daily iron intake requirements (Booth, 2002)
RISK MITIGATION

• Poor nutrition + Amenorrhea = negative impact on bone health

• Poor nutrition
  = increased fatigue when working → poorer movement mechanics → increased load on passive system (bones).
  = poorer recovery from previous day’s efforts.
RISK MITIGATION

• PFM Dysfunction
  • 25-31% of female soldiers have reported PFMD (Davis et al., 1999)
    • Lead them to drink less fluids
    • Contributes to spine stability
  • Post partum PFM retraining vital
SUMMARY

• Female officers will be required to carry loads that, in general, will be relatively heavier than that of male officers

• Female officers need to be conditioned to carry these loads

• A holistic supported implementation plan is needed to mitigate the impact of occupational load carriage in LEO
To all serving LEO (past and present)
Thank you for your service

https://bond.edu.au/tru
Load Carriage: Female Officers Carry Their Share

References available on request:

Dr Rob Orr

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