

Tactical Load Carriage: Impacts and Conditioning

Orr, Rob Marc; Pope, Rodney R

Licence:
CC BY-NC-ND

[Link to output in Bond University research repository.](#)

Recommended citation(APA):

Orr, R. M., & Pope, R. R. (2017). *Tactical Load Carriage: Impacts and Conditioning*. The Sports Science Summit, London, United Kingdom.

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

For more information, or if you believe that this document breaches copyright, please contact the Bond University research repository coordinator.



**SPORTS
SCIENCE**

24th - 26th JANUARY

2017



**BOND
UNIVERSITY**

TACTICAL RESEARCH UNIT

Dr Rob Orr & Dr Rod Pope

Tactical Research Unit,
Bond University

*Tactical Load Carriage:
Impacts and Conditioning*



CONTENT:

- Load carriage context
- Risks associated with load carriage
- Risk variables
- Load carriage conditioning



MILITARY CONTEXT



http://img266.imageshack.us/img266/9808/digger_ssmg28.jpg



http://4.bp.blogspot.com/_BZQXUhgZR3A/S9Tzq_w6uOI/AAAAAAAAABE/HGGoRbjiaoU/s1600/vietnam-peter-b.jpg



http://upload.wikimedia.org/wikipedia/commons/5/5a/Australian_soldier_Afghanistan_Aug_2008.jpg



FIREFIGHTER CONTEXT

1770



http://upload.wikimedia.org/wikipedia/commons/thumb/6/66/Old_firefighters.jpg/220px-Old_firefighters.jpg

1879



http://upload.wikimedia.org/wikipedia/commons/4/43/Vintage_firefighters.jpg

2012



<http://www.stacksplace.com/EMS/ffadd1.jpg>



LAW ENFORCEMENT CONTEXT

1890s



[http://2.bp.blogspot.com/-xHtSiLRFIMQ/UfewLRnEgAI/AAAAAAAIpc/54yapn_iBtE/s1600/Curious+Black+&+White+Photographs+of+The+Police+Officers+from+1890-1930+\(28\).jpg](http://2.bp.blogspot.com/-xHtSiLRFIMQ/UfewLRnEgAI/AAAAAAAIpc/54yapn_iBtE/s1600/Curious+Black+&+White+Photographs+of+The+Police+Officers+from+1890-1930+(28).jpg)

1970s



[http://3.bp.blogspot.com/-HO26ffMhqS4/UihkEhycrol/AAAAAAAMR4/qGsg2ryfWKA/s640/Pictures+of+Life+of+the+New+York+Police+Department+in+the+1970's+\(7\).jpg](http://3.bp.blogspot.com/-HO26ffMhqS4/UihkEhycrol/AAAAAAAMR4/qGsg2ryfWKA/s640/Pictures+of+Life+of+the+New+York+Police+Department+in+the+1970's+(7).jpg)

2010



<http://images.smh.com.au/2012/12/04/3861588/artist-police-uniforms-620x349.jpg>

<http://images.smh.com.au/2009/03/09/410908/policebelt.jpg>



http://www.gunblast.com/images/WBell_PoliceHolsterHistory/Police-Holster-History-012.jpg





SEARCH AND RESCUE (SAR) CONTEXT



http://bloximages.newyork1.vip.townnews.com/estesparknews.com/content/tncms/assets/v3/editorial/d/c7/dc7f6316-1ea7-11e5-a8eb-bb1f7936f02c/5591bc1ee90b6_image.jpg



<http://www.medicinac.si/wp-content/uploads/2013/10/img51351803309img5092e1ada9b3c.jpg>



<http://www.sandia.gov/news-center/news-releases/2004/images/SAR-map.gif>



RECREATIONAL / OCCUPATIONAL CONTEXT





RISKS ASSOCIATED WITH LOAD CARRIAGE

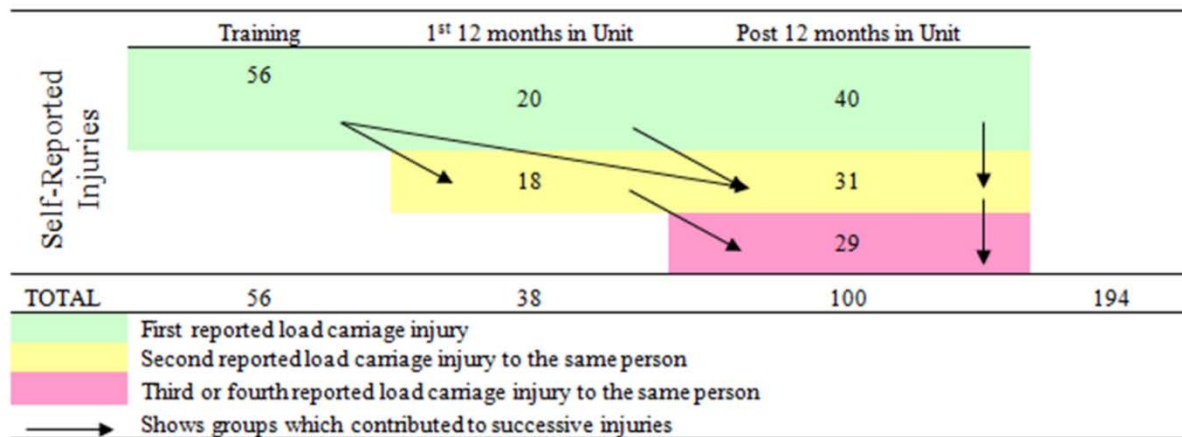
- Injuries: Associated with a variety of injuries (from skin blistering to muscle, ligament, tendon, bone and nervous system injuries)





RISKS ASSOCIATED WITH LOAD CARRIAGE

- Once injured – more likely to be reinjured



Orr, R., Pope, R., Coyle, J. & Johnston, V. (2016). Self-reported load carriage injuries in Australian Regular Army soldiers, *International Journal of Injury Control and Safety Promotion*, pp. 1-9 <http://dx.doi.org/10.1080/17457300.2015.1132731>



RISKS ASSOCIATED WITH LOAD CARRIAGE

- Decrements in performance:
 - ↓ Mobility
 - Increased risk of trip and fall
 - Decreased ability to negotiate escape routes



http://mountainenterprise.com/dfs/images/story/fs_4764.jpg

<http://us-news.us/wp-content/uploads/2015/09/wpid-635780139405791932-Flash-Flood-114.jpg>



RISKS ASSOCIATED WITH LOAD CARRIAGE

- Decrements in performance:
 - ↓ Lethality
 - Marksmanship





RISKS ASSOCIATED WITH LOAD CARRIAGE

- Decrements in performance:
 - ↓ Attention to task: response to stimuli





RISKS VARIABLES

- \uparrow in load weight = \uparrow in the energy cost of standing, walking (forwards and backwards, up and down stairs) and running
- \uparrow in speed of load carriage = \uparrow in the energy cost of carrying given load (more than weight)?
 $\uparrow 0.5\text{km/h} = \uparrow 10\text{kg}$



1 Joint Public Affairs Unit - Achieves



http://i.dailymail.co.uk/i/pix/2009/06/09/article-0-0547F168000005DC-683_634x619.jpg



RISKS VARIABLES

- \uparrow in gradient of load carriage = \uparrow in the energy cost of carrying given load (more than weight)?
 $\uparrow 1\% = \uparrow 10\text{kg}$



1 Joint Public Affairs Unit - Achieves



http://mountainenterprise.com/fds/images/story/fs_4764.jpg



RISKS VARIABLES

- Different terrains types will elicit different energy cost requirements
(*road-light brush-heavy brush-sand*)



<http://crowboroughlife.com/wp-content/uploads/2015/02/Search-and-Rescue.jpg>





LOAD CARRIAGE CONDITIONING

- Concept is not new (*Flavius Vegetius Renatus - Epitoma rei militaris*)





LOAD CARRIAGE CONDITIONING

Research by Orr et al. (2010) and Knapik et al., (2012) recommend:

- F.I.T.T Formula (Frequency, Intensity, Time & Type)
 - F. 7-10 days per load carriage session
 - I. To loads required at the speeds and over the terrains required
 - T. Duration of load carriage operations
 - T. Load carriage preferable, but combined resistance and cardio may be of some benefit



LOAD CARRIAGE CONDITIONING

- Specificity



<http://www.grough.co.uk/lib/img/editorial/KirkbystephenCautley-Spout-2.jpg>



<http://blog.nhstateparks.org/wp-content/uploads/2012/04/Search-Rescue-litter-passing-over-rough-terrain.jpg>



Take Home Messages

- Load carriage reduces performance and can cause injuries = decreased operational success
- Load carriage is about more than the load weight, terrain type and grade, speed of movement and load position must be taken into account
- To minimise the risk of injury and increase the potential for operational success personnel need to be conditioning to carry load and effectively reconditioned following an injury



REFERENCES

- Carlton, S. & Orr, R. (2014). The impact of occupational load carriage on carrier mobility: A critical review of the literature, *International Journal of Occupational Safety and Ergonomics*, 20(1), pp.3-11.
- Carlton, S.D., Carbone, P.D., Stierli, M & Orr, R. (2014). The Impact of Occupational Load Carriage on the Mobility of the Tactical Police Officer. J. *Aust. Strength Cond.*, 22(1), pp. 32-37.
- Conolly M, Elder C. & Dawes J. (2015). Needs Analysis for Mountain Search and Rescue. *Strength & Conditioning Journal*, 37(4):35-42
- Datta S & Ramanathan NL. (1971). Ergonomic comparison of Seven Modes of Carrying Loads on the Horizontal Plane. *Ergonomics*, 14(2):269-78
- Drain, J., Orr, R. M., Billing, D., & Rudzki, S. J. (2010). *Human Dimensions of Heavy Load Carriage*. Paper presented at the Land Warfare Conference, Queensland, Australia.
- Harper, W. H., Knapik, J. J., & de Pontbriand, R. (1997). *Equipment compatibility and performance of men and women during heavy load carriage*. Paper presented at the Proceedings of the Human Factors and Ergonomics Society 41st Annual Meeting.
- Johnson, R. F., Knapik, J. J., & Merullo, D. J. (1995). Symptoms during load carrying: effects of mass and load distribution during a 20-km road march. *Perceptual Mot Skills*, 81(1), 331-338.
- Knapik, J. J., Ang, P., Meiselman, H., Johnson, W., Kirk, J., Bense, C. K., et al. (1997). Soldier performance and strenuous road marching: influence of load mass and load distribution. *Mil Med*, 162(1), 62-67.



- Knapik JJ, Harper W, Crowell HP, et al. (2000). *Standard and alternative methods of stretcher carriage: performance, human factors, and cardiorespiratory responses*. *Ergonomics*, 43(5):639-52.
- Knapik, J. J., Bahrke, M., Staab, J., Reynolds, K. L., Vogel, J. A., & O'Connor, J. (1990). *Frequency of Loaded Road March Training and Performance on a Loaded Road March*. T13-90. *Military Performance Division*. US Army Research Institute of Environmental Medicine, Natick, 52.
- Knapik, J. J., Harman, E. A., Steelman, R. A., & Graham, B. S. (2012). *A Systematic Review of the Effects of Physical Training on Load Carriage Performance*. *The Journal of Strength & Conditioning Research*, 26(2), 585.
- Knapik, J. J., Reynolds, K. L., & Harman, E. (2004). *Soldier load carriage: historical, physiological, biomechanical, and medical aspects*. *Mil Med*, 169(1), 45-56.
- Lothian, N. V. (1921). *The load carried by the soldier*. *J R Army Med Corps*, 38, 9-24, 241-263, 342 - 351, 448-458.
- Mahoney, C. R., Hirsch, E., Hasselquist, L., Leshner, L. L., & Lieberman, H. R. (2007). *The effects of movement and physical exertion on soldier vigilance*. *Aviat Space Environ Med*, 78(5 Suppl), B51-57.
- Neumann DA, Cook TM, Sholty RL, et al. (1992). *An electromyographical analysis of hip abductor muscle activity when subjects are carrying load in one or both hands*. *Physical Therapy*, 72(3):207-17
- Orr, R., Pope, R., Coyle, J. & Johnston, V. (2016). *Self-reported load carriage injuries in Australian Regular Army soldiers*, *International Journal of Injury Control and Safety Promotion*, pp. 1-9





- **Orr, R. & Pope, R. (2015). *Load Carriage: An Integrated Risk Management Approach*, *Journal of Strength and Conditioning Research*, 29(115): S119–S128.**
- **Orr, R., Pope, R., Johnston, V. & Coyle, J. (2015). *Operational Loads Carried by Australian Soldiers on Military Operations*. *Journal of Health, Safety and the Environment*, 31(1), 451-457.**
- **Orr, R., Pope, R., Johnston, V. & Coyle, J. (2014). *Reported Load Carriage Injuries: An Australian Army Soldier Profile*, *Journal of Occupational Rehabilitation*, 25:316–322**
- **Orr, R., Pope, R., Johnston, V., & Coyle, J. (2012). *Load carriage: Reductions in soldier task performance and the risks posed*. Paper presented at the Land Warfare Centre Conference, Melbourne.**
- **Orr, R. M. (2007). *The Royal Military College of Duntroon. Physical Conditioning Optimisation Review*. Department of Defence. Canberra: AUST.**
- **Orr, R. M. (2010). *The History of the Soldier's Load*. *Australian Army Journal*, VII(2), 67-88.**
- **Orr, R. M., Pope, R., Johnston, V., & Coyle, J. (2010). *Load Carriage: Minimising soldier injuries through physical conditioning - A narrative review*. *Journal of Military and Veterans' Health*, 18(3), 31-38.**
- **Park, K., Hur, P., Rosengren, K. S., Horn, G. P., & Hsiao-Wecksler, E. T. (2010). *Effect of load carriage on gait due to firefighting air bottle configuration*. *Ergonomics*, 53(7), 882-891.**



- Park, K., Hur, P., Rosengren, K. S., Horn, G. P., & Hsiao-Wecksler, E. T. (2008). *Changes In Kinetic And Kinematic Gait Parameters Due To Firefighting Air Bottle Configuration*. Paper presented at the NACOB, Ann Arbor, Michigan, U.S.A.
- Renatus, F. V. (1996). *Vegetius: Epitome of Military Science* (N. P. Milner, Trans. 2nd ed.). Liverpool: Liverpool University Press
- Rice, V. J., Sharp, M., Tharion, W. J., & Williamson, T. (1999). *Effects of a Shoulder Harness on Litter Carriage Performance and Post-Carry Fatigue of Men and Women*. Military Performance Division. US Army Research Institute of Environmental Medicine, Natick, 76.
- Ruby, B. C., Leadbetter III, G. W., Armstrong, D., & Gaskill, S. E. (2003). *Wildland firefighter load carriage: effects on transit time and physiological responses during simulated escape to safety zone*. *International Journal of Wildland Fires*, (12), 111-116.
- Soule RG. & Goldman RF. (1969). *Energy cost of loads carried on the head, hands, or feet*. *J Appl Physiol*, 27(5):687-90
- Zhang XA & Ye M, Wang CT. (2010). *Effect of unilateral load carriage on postures and gait symmetry in ground reaction force during walking*. *Computer Methods in Biomechanics and Biomedical Engineering* 2010;13(3):339-44



<https://bond.edu.au/tru>