

An Analysis of Back Pain & Muscle Activity during Load Carriage in Army ROTC Cadets

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Background

- **Load carriage:** an external load carried by professionals as part of the demands associated with their occupation¹
- Load Carriage is a frequently reported cause of injury (~34%)¹
 - The spine accounts for ~30% of load carriage injuries¹
- EMG can be used to identify individuals who have LBP²
 - Those with LBP demonstrate increased activity of the Erector Spinae during gait³
- Greater loads → greater muscle activation of LE over short distances⁴⁻⁷

Purpose

- Assess how muscle activity of the lower extremity and core change when a load is added
- Determine changes in muscle activity over time during gait with and without a load
- Examine a possible relationship between muscle activation and back pain

Methods

- Participants: 30 Army ROTC cadets
 - Analysis = 27 (age 20.96 ± 1.78)
- 5 km road march +/- 35 lb. load @ 3 mph
 - Load conditions randomized & counterbalanced
- Back pain & disability questionnaire
- Surface EMG of:
 - Rectus femoris, Biceps femoris, Gluteus medius, Gluteus maximus, Rectus abdominis, & Erector spinae



Results

Table 1. Average muscle activation by load and pain conditions

| Time | No Load | | | | | | Load Carriage | | | | | |
|------|---------|-------|-------|-------|-------|-------|---------------|-------|-------|-------|-------|-------|
| | RF | RA | GM | GMx | ES | BF | RF | RA | GM | GMx | ES | BF |
| Q1 | 0.318 | 0.182 | 0.213 | 0.177 | 0.200 | 0.615 | 0.813 | 0.518 | 0.892 | 0.956 | 0.566 | 0.709 |
| Q2 | 0.265 | 0.193 | 0.197 | 0.154 | 0.199 | 0.519 | 0.231 | 0.150 | 0.241 | 0.199 | 0.072 | 0.381 |
| Q3 | 0.226 | 0.108 | 0.175 | 0.131 | 0.166 | 0.432 | 0.178 | 0.067 | 0.202 | 0.176 | 0.071 | 0.298 |
| Q4 | 0.195 | 0.095 | 0.149 | 0.123 | 0.170 | 0.384 | 0.159 | 0.047 | 0.208 | 0.174 | 0.068 | 0.257 |

Table 2. Repeated measures ANOVA for each muscle examined

| | RF | RA | GM | GMx | ES | BF |
|------|-------------|-------------|-------------|-------------|-------------|-------------|
| Load | p=.015 ↑ | p=.236 ↑ | p<.001 ↑ | p=.007 ↑ | p=.886 ↑ | p=.345 ↓ |
| Time | p<.001 ↓ | p=.001 ↓ | p<.001 ↓ | P<.001 ↓ | p<.001 ↓ | p<.001 ↓ |

Table 3. Average Muscle Activation by Load & Pain Conditions

| Load | Pain | RF | RA | GM | GMx | ES | BF |
|------|------|-------|-------|-------|-------|-------|-------|
| Yes | Yes | 0.270 | 0.123 | 0.272 | 0.749 | 0.081 | 0.466 |
| Yes | No | 0.195 | 0.057 | 0.204 | 0.237 | 0.062 | 0.263 |
| No | Yes | 0.272 | 0.175 | 0.190 | 0.157 | 0.283 | 0.525 |
| No | No | 0.231 | 0.113 | 0.176 | 0.136 | 0.087 | 0.453 |

Conclusions

- Added load → increased muscle mean muscle activity
- Mean muscle activity decreases over time
- Pain is associated with increased mean muscle activity

Future Research

- Analyze muscle activity bilaterally & assess pain throughout load carriage session
- Assess muscle activity over longer distance and at varying speeds

Acknowledgements

We would like to thank the Mid-America Athletic Trainers' Association for funding this study. We would also like to thank the Army ROTC Cadets for their participation in this study.

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Acknowledgements

Funded: Mid-America Athletic Trainers' Association

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