

# SYSTEMIC INFLAMMATORY RESPONSES TO ACUTE SPINAL LOADING

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## INTRODUCTION

- Traditionally, ergonomic attempts to reduce work-related low back disorders (LBDs) have been aimed at altering the mechanical loading of the spine, focusing on the magnitude of the load as well as the frequency of repetition.
- Up to 85% of LBD cases cannot be directly linked to specific patho-anatomical diagnoses (fractures, disc herniation, failure of spinal tissues (muscles, ligaments, tendons)), implying that other non-mechanical causes must contribute significantly to LBDs [1,2].
- Acute increases in pro-inflammatory cytokines (similar to those found in chronic pain and LBD patients) have also been identified as unresolved within 20 hours following cumulative loading (in-vitro and in-vivo studies) [3,4,5].
  - This has the potential to reduce tissue tolerance in the spinal column with repeated exposure to inflammation without adequate resolution time [6,7,8].

## PURPOSE

- Identify acute changes in inflammatory markers (IL-6, IL-8) in response to acute lifting tasks while controlling for external work.

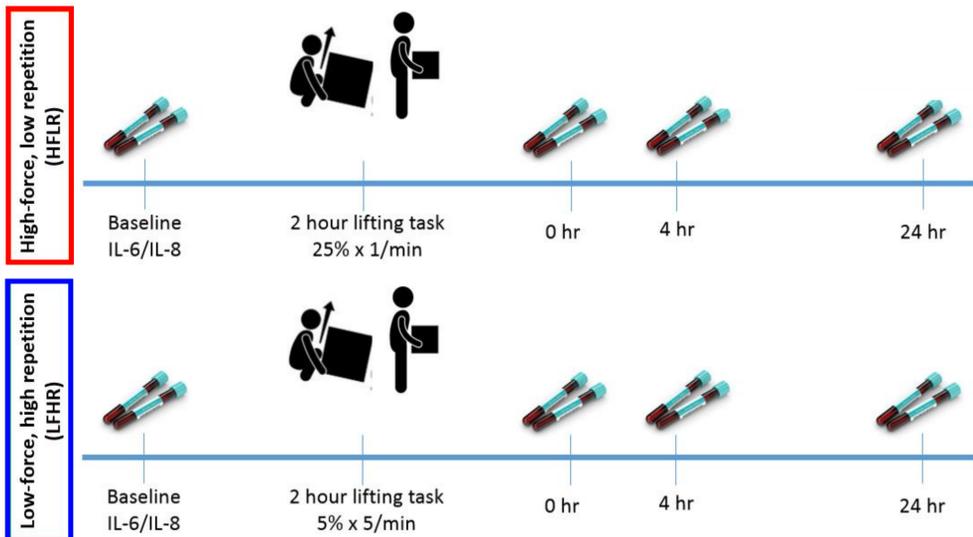
## METHODS

### Experimental Sessions:

- Two sessions completed by each participant:
  1. High-force, low repetition (HFLR)
  2. Low-force, high repetition (LFHR)
- Baseline blood draw (7:30 am)
- Two hour lifting protocol (HFLR or LFHR)
- Blood draws following lifting (0, 4 and 24 hours).
- One week between sessions.

### Participants:

- 6 Males and 6 Females
- Age: 24.9 years ± 4.8
- Weight: 68.7 kg ± 7.4
- Height: 174.25 cm ± 8.3
- No current low back disorders/pain or history within the past 12 months.



**Figure 1:** Methodological process for testing sessions. HFLR condition at 25% of the participant's maximal back strength, one lifting cycle per minute, and LFHR condition at 5% of the participant's maximal back strength, 5 lift cycles per minute.

- Whole-body kinematics were recorded at 60 Hz by a 10-camera motion capture system (Vantage V5, Vicon, UK).
- Ground reaction force data collected from two force plates (FP-4060, Bertec, USA; 2040 Hz), synchronized with kinematic data through a 64-channel analogue-to-digital converter (Lock+, Vicon, UK).

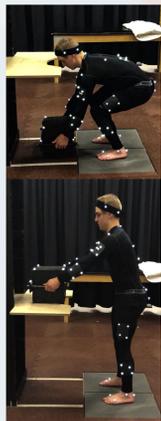
## ANALYSIS & STATISTICS

### Mechanical

- Paired-sample t-tests between conditions.
- Peak spinal moment (peak of each lift and mean over a 10 minute period).
- Cumulative spinal moment (integrated area under the curve for each lift in 10 minute block, multiplied by number of lifts in a two hour period).

### Inflammation

- IL-6 and IL-8 assessed utilizing 96-well, enzyme-linked immunosorbent assay kit (ELISA; R&D Systems, MN, USA).
- 2-way repeated-measures ANOVA.
- Within factor of **Load condition** (HFLR & LFHR) and **Time** (Baseline, 0, 4 and 24 hours post-test).



**Figure 2:** Lifting task

## REFERENCES

[1] Deyo, R.A., & Weinstein, J.N., 2001. N. Engl. J. Med. 344 (5), 363–370. [2] Elrich, G.E., 2003. Low Back Pain. Bull. World Health Organ. 81 (9), 671–676. [3] Wang, J. et al, 2011. J. Biol. Chem. 286 (46), 39738–39749. [4] Burke, J.G. et al, 2002. J Bone Jt. Surg Br 84-B, 196–201. [5] Zeilhofer, H.U., 2005. Cell. Mol. Life Sci. 62, 2027–2035. [6] Splittstoesser, R.E. et al, 2012. Work. 41, 6016–6023. [7] King, K., et al, 2009. Clin. Biomech. 24, 792–798. [8] Barr, A.E. et al, 2004. J. Electromyogr. Kinesiol. 14, 77–85.

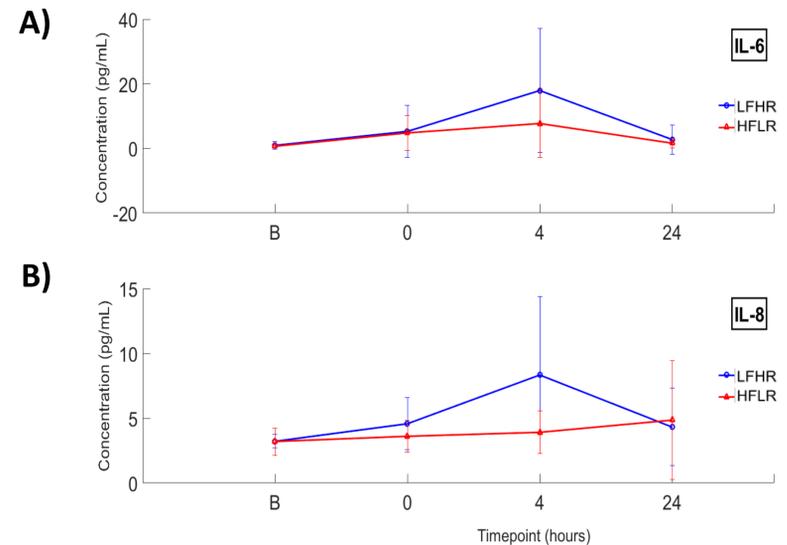
## RESULTS

**IL-6:**  
(Figure 3a)

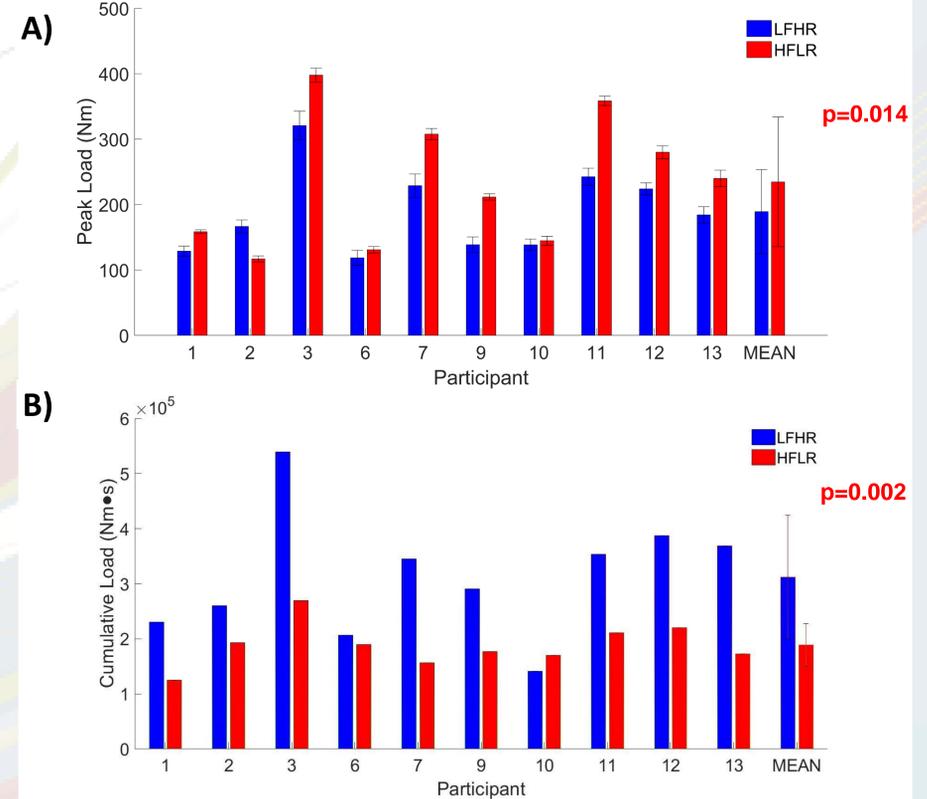
**Weight:** ( $p = 0.145$ )  
**Time:** ( $p = 0.009$ )\*  
**Weight x Time:** ( $p = 0.048$ )\*

**IL-8:**  
(Figure 3b)

**Weight:** ( $p = 0.16$ )  
**Time:** ( $p = 0.030$ )\*  
**Weight x Time:** ( $p = 0.029$ )\*



**Figure 3:** Mean concentrations of IL-6 (A) and IL-8 (B) in each of the HFLR and LFHR tasks as a function of time



**Figure 4:** A) Average peak spinal load for each participant across the first 10 minutes of the lifting task. B) Cumulative spinal loads were calculated using the integrated area under the curve for each lift in the first 10 minutes. The average cumulative spinal load was then extrapolated across the amount of lifts performed over the two hour lifting period.

## DISCUSSION & CONCLUSIONS

- Plasma concentrations of IL-8 and IL-6 significantly increase over time during the LFHR session, while remaining relatively stable in the HFLR session.
- While peak loads were greater in the HFLR condition (234 vs 189 Nm), the cumulative load in the LFHR condition was greater (312, 205 vs 188,545 Nm\*s), despite external work being equivalent.
- This study provides great insight into the impact of different lifting tasks on acute inflammatory patterns and their potential to influence injury risk in an occupational setting.