# “Birds do it, Bees do it”*: Standing and Sitting We All do it.

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*Cole Porter, 1928

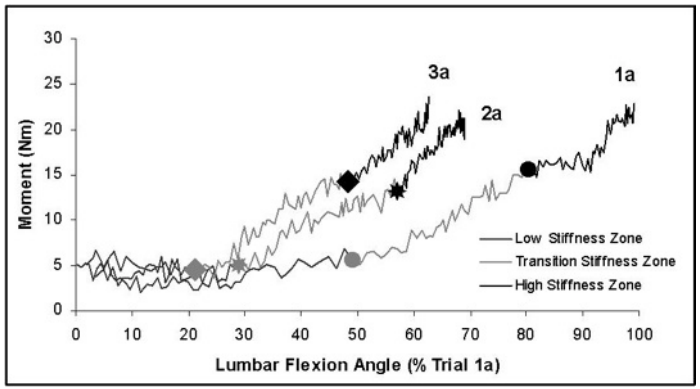
Canada Research Chairs
Chaires de recherche du Canada
Canada

# Fatigue

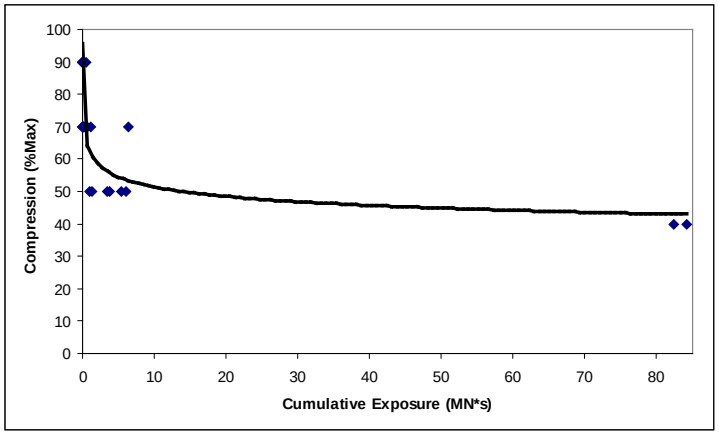
- Muscular
- Neural
- Central
- Peripheral
- Mental
- Etc.

# Fatigue

- Structural or Material




Beach, Parkinson, Stothart & Callaghan (2005) The Spine Journal




Parkinson & Callaghan (2008) TIES

- Performance
  - Injuries & Performance

# Standing and LBP



**Ergonomics**
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713701117

## Studying the relationship between low back pain and working postures among those who stand and those who sit most of the working day

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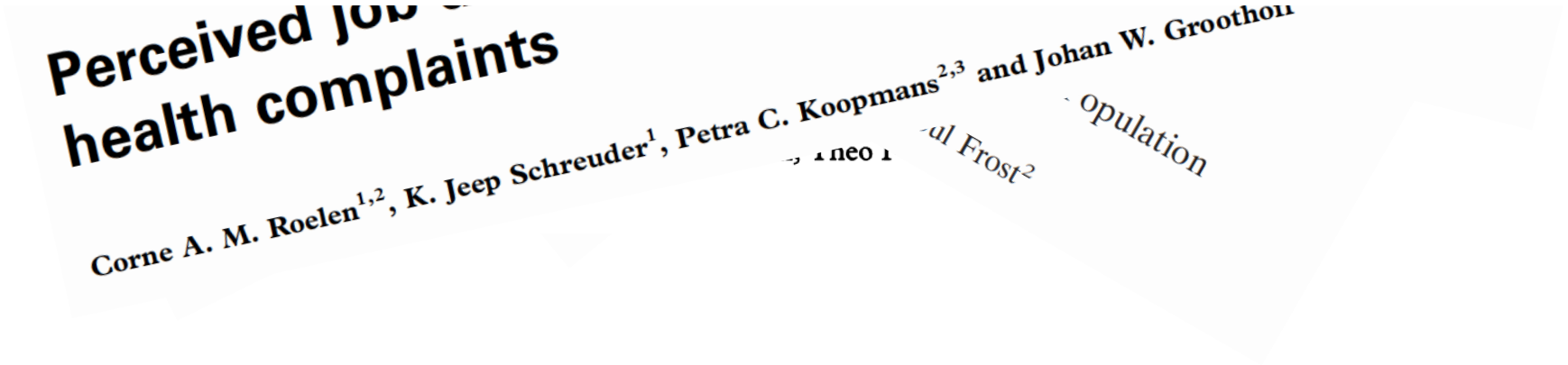


# Sitting and Standing = LBP?

- Mixed results
- When "quality" of standing is factored into the evaluation:
  - > 30 minutes OR 2.1 (Andersen et al., 2007)
  - > 2 hours Females OR 2.9 Males OR 1.6 (MacFarlane et al., 1997)
  - Constrained standing Prevalence 30% vs 17% (Tissot et al., 2009)
- When "quality" of seated exposures are factored
  - Leisure + Work combined increased LBP reporting (Nourbakhsh et al., 2001)
  - Constrained seated driving postures 6x increase in lost time (Porter & Gyi, 2002)

# Ergonomic Guidelines

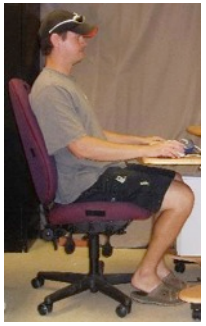
OHSCO's Musculoskeletal Disorders Prevention Series

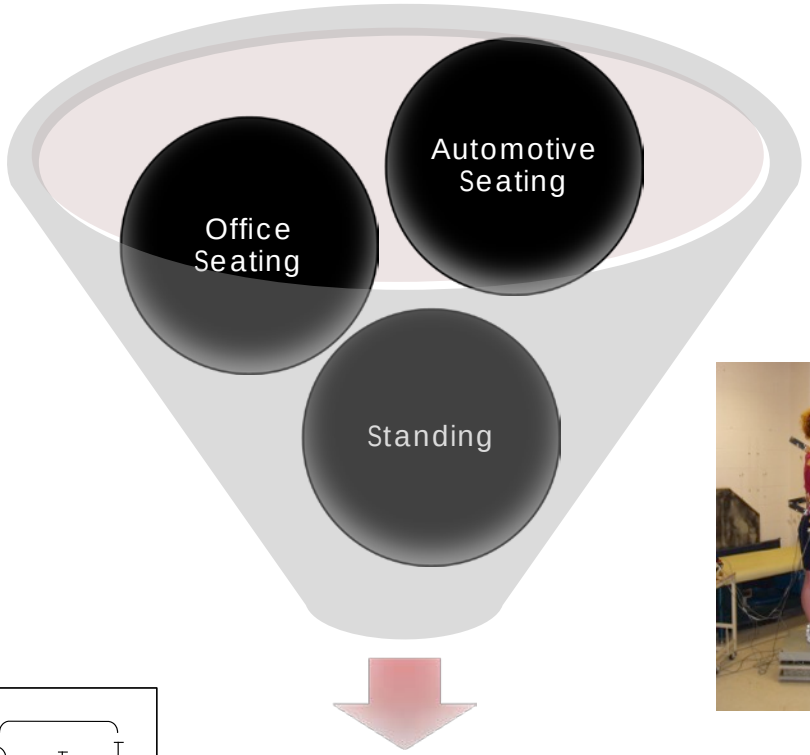
Parts 3A&B: MSD Prevention Toolbox

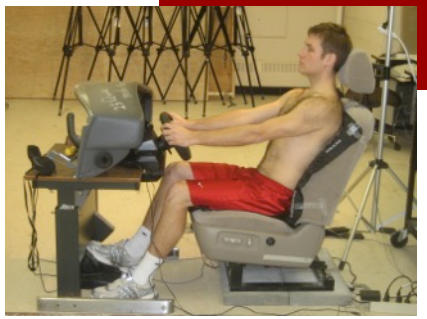
| | | |
|---|---|---|
| Fixed Posture | • sitting for long periods without standing (office work, driving, etc.) | ☐ |
| | • standing still on a hard surface for a long period of time | ☐ |

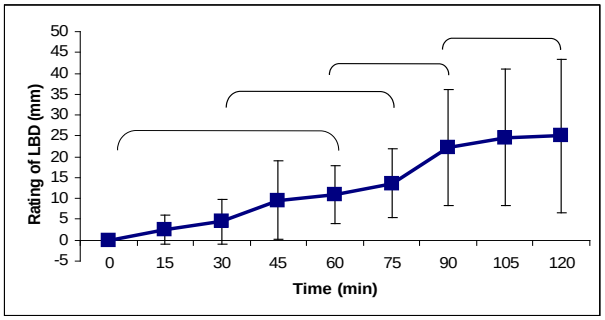
| STATIC WHOLE BODY POSTURES | | CHECK (☑) HERE IF REQUIRED AT THIS JOB/ TASK | NOTES |
|---|---|---|---|
| **PROLONGED SITTING** | • Worker sits for more than six hours total per day | ☐ | |
| **PROLONGED STANDING** | • Worker stands on a hard surface for more than four hours total per day (standing in one location without taking more than two steps in any direction) | ☐ | |

# Exposure Situations

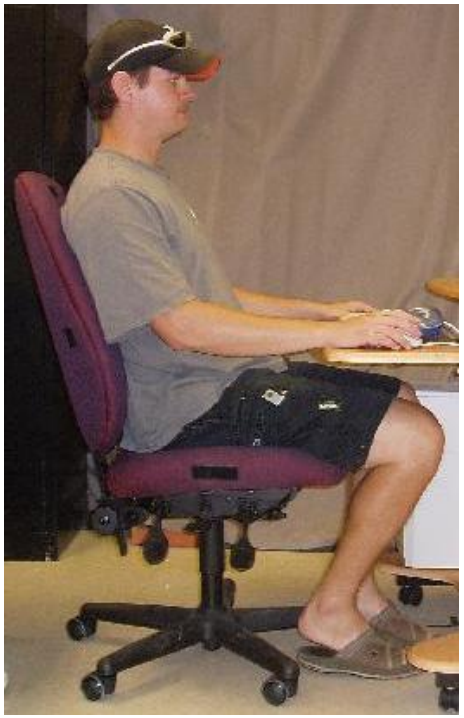


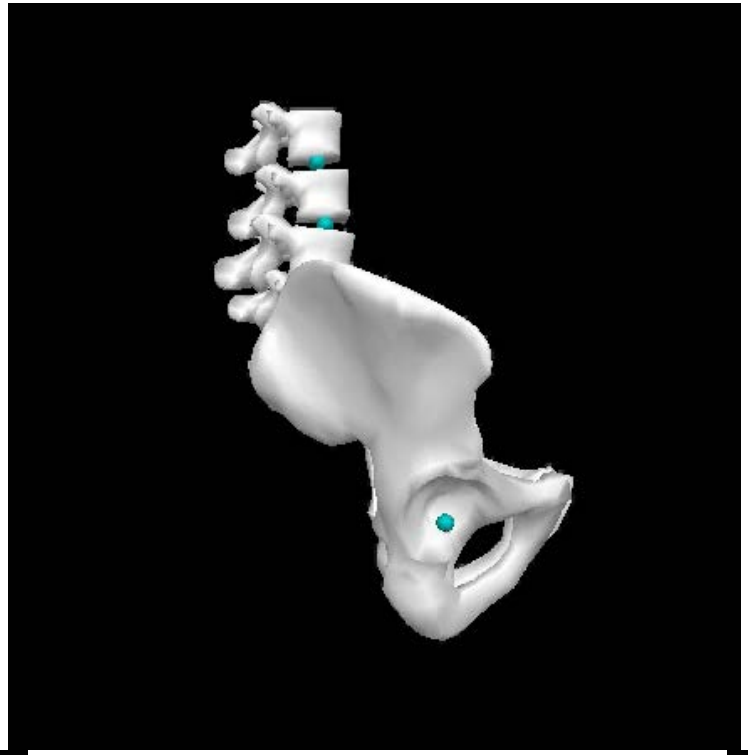


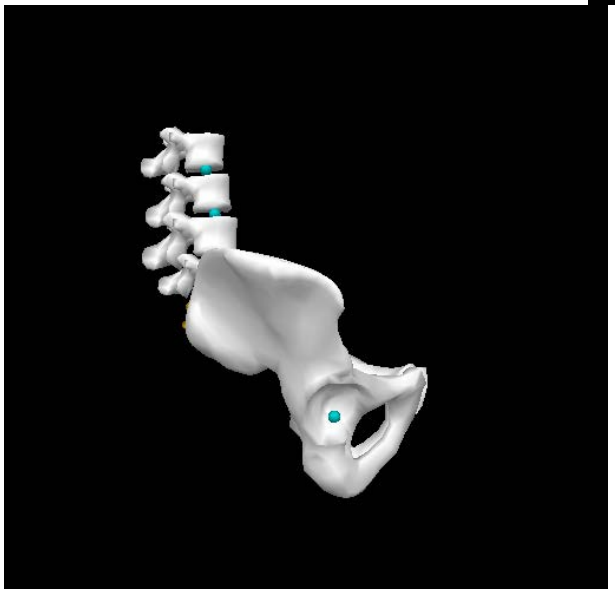



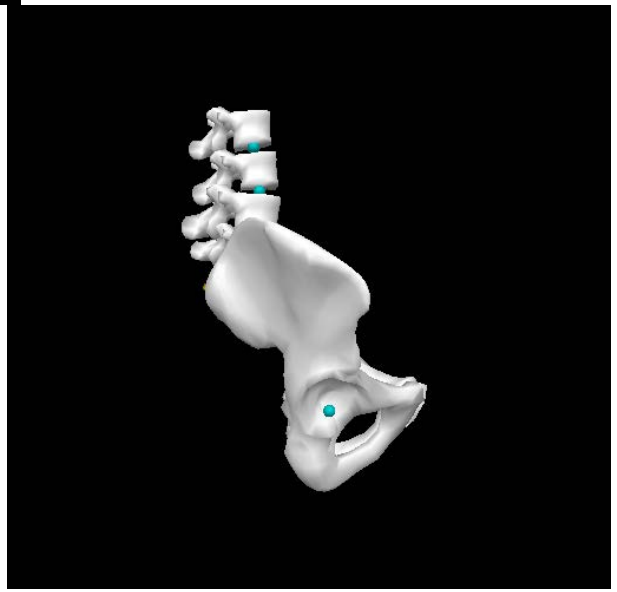



Induced Subjective Discomfort

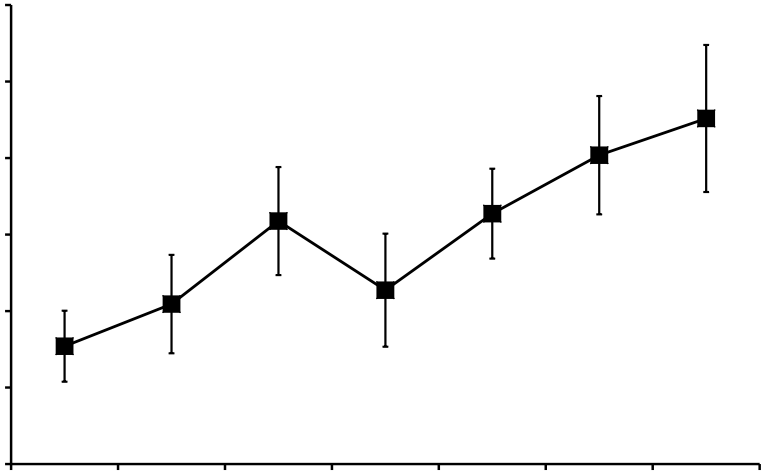






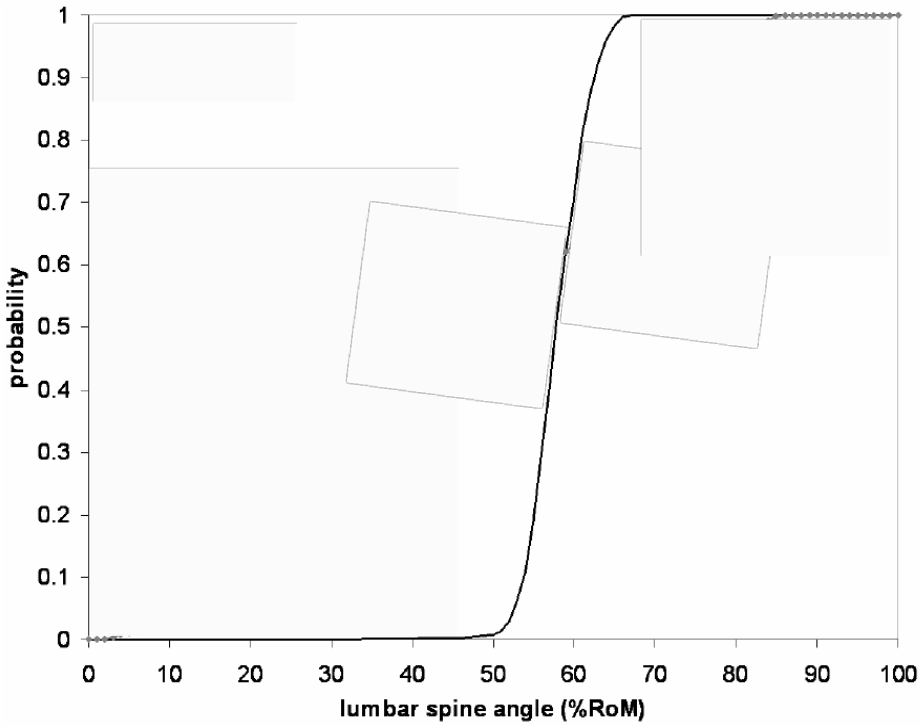


# Standing Time Varying Responses



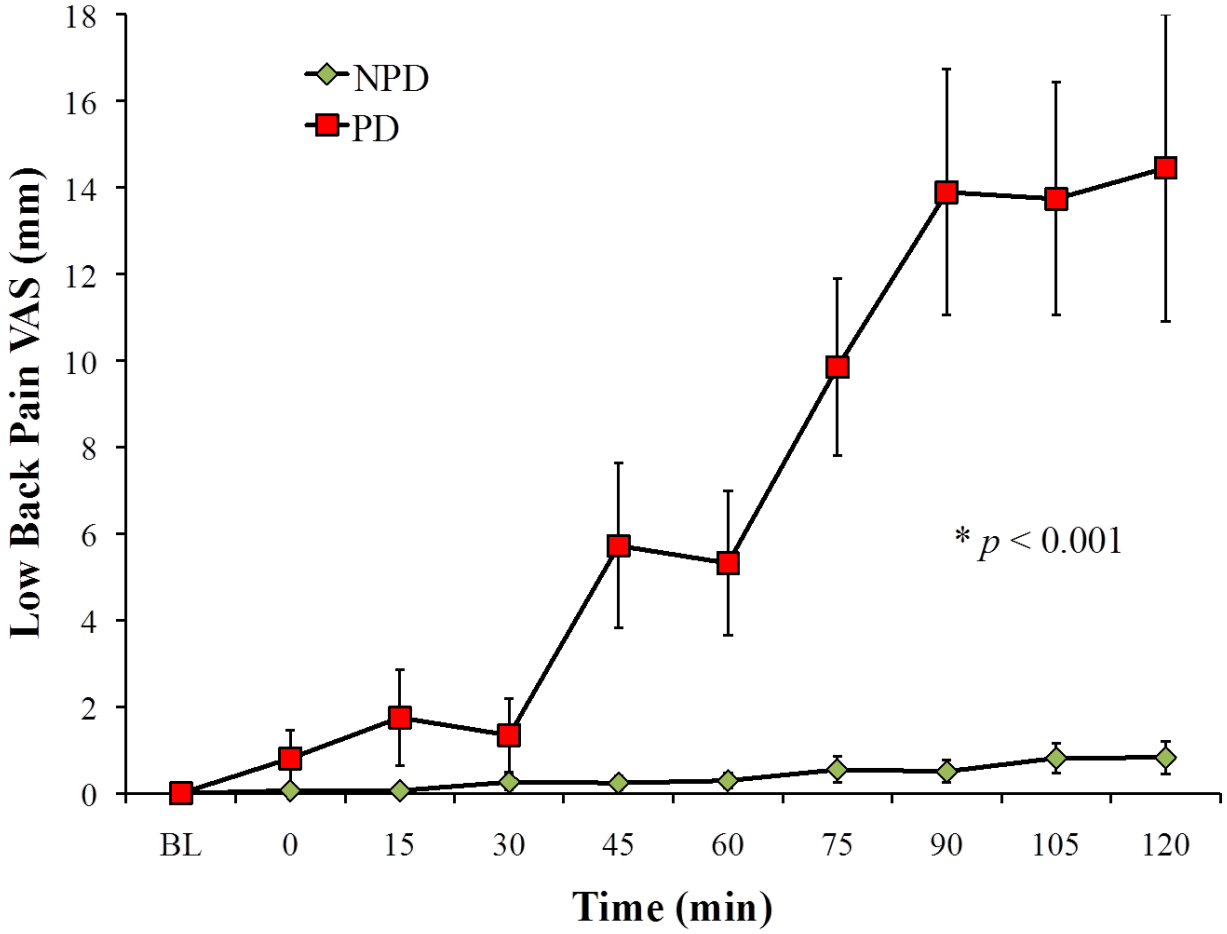
*Nelson-Wong & Callaghan J EMG & Kin 20 (2010)*

*Gallagher, Wong, Callaghan Gait and Posture (2012)*



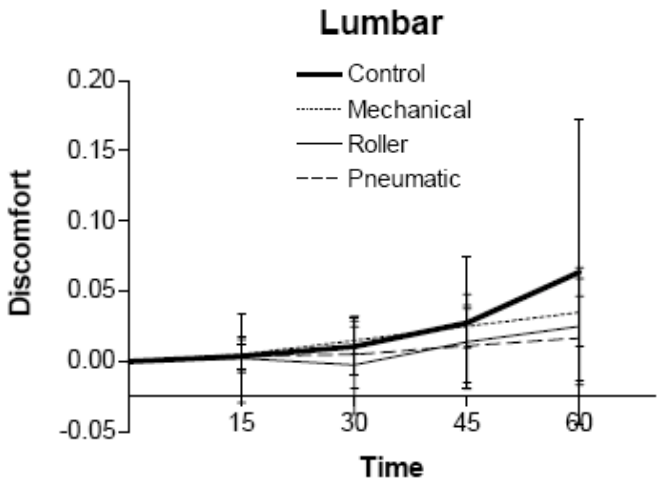

*Dunk & Callaghan/ Work/ 35 (2010)*

# One Hour!

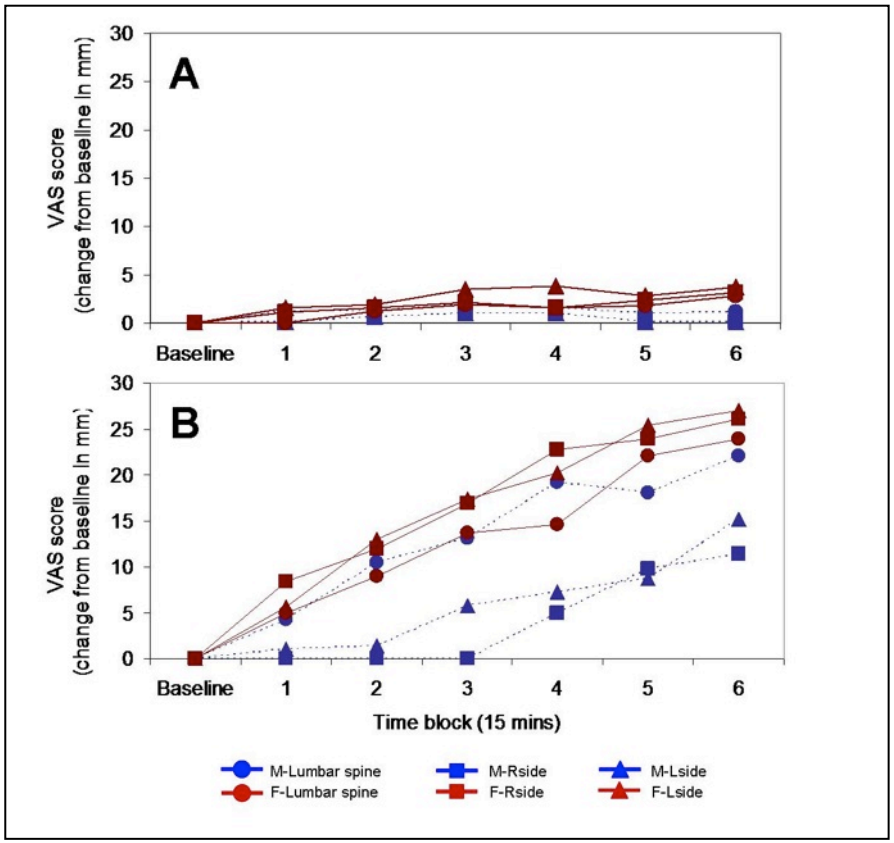

NPD
PD
Low Back Pain VAS (mm)
18
16
14
12
10
8
6
4
2
0
BL
0
15
30
45
60
75
90
105
120
Time (min)
* $p < 0.001$


Tang

# Discomfort for Prolonged Exposure

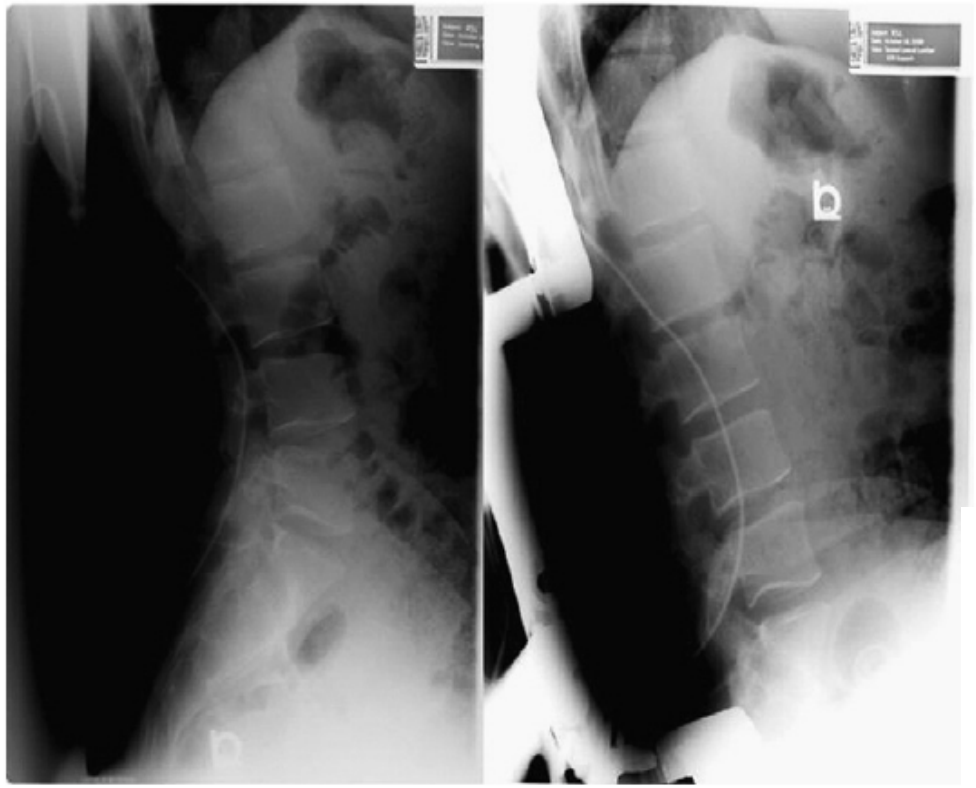



*Durkin, Harvey, Hughson, Callaghan/ Ergonomics/ 49 (2006)*

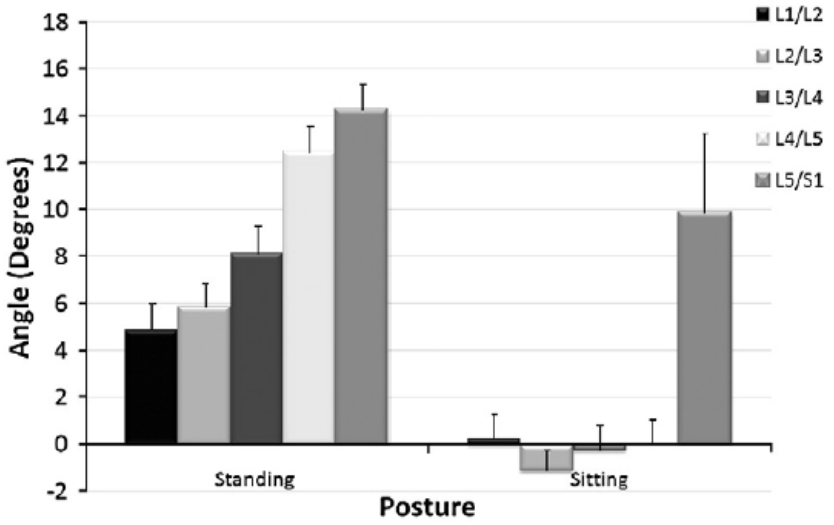


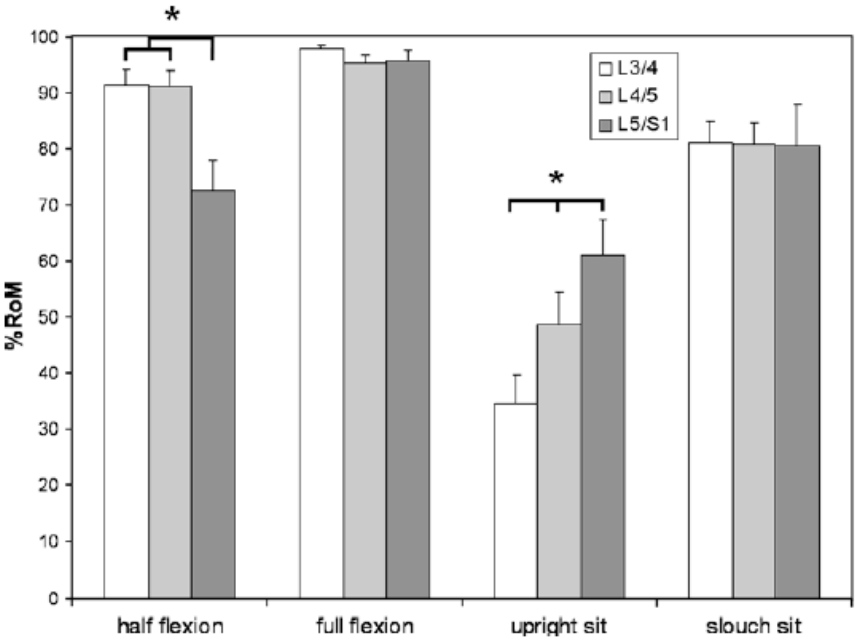

*Dunk & Callaghan/ Work/ 35 (2010)*

# Standing vs Sitting Postures



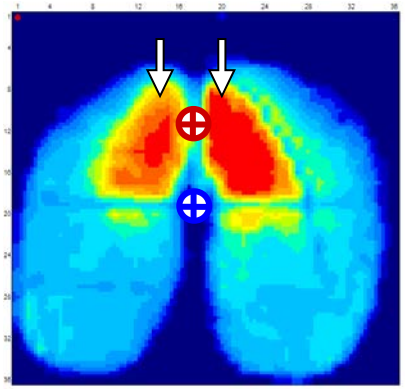
*De Carvalho, Soave, Ross, Callaghan/ J Manip Physio Ther/ 33 (2010)*

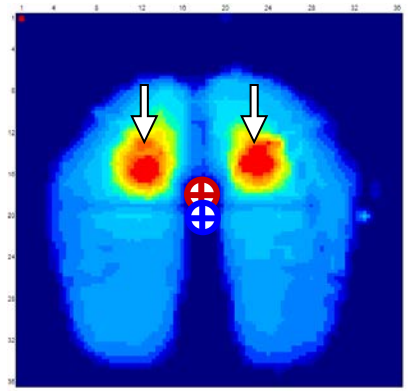


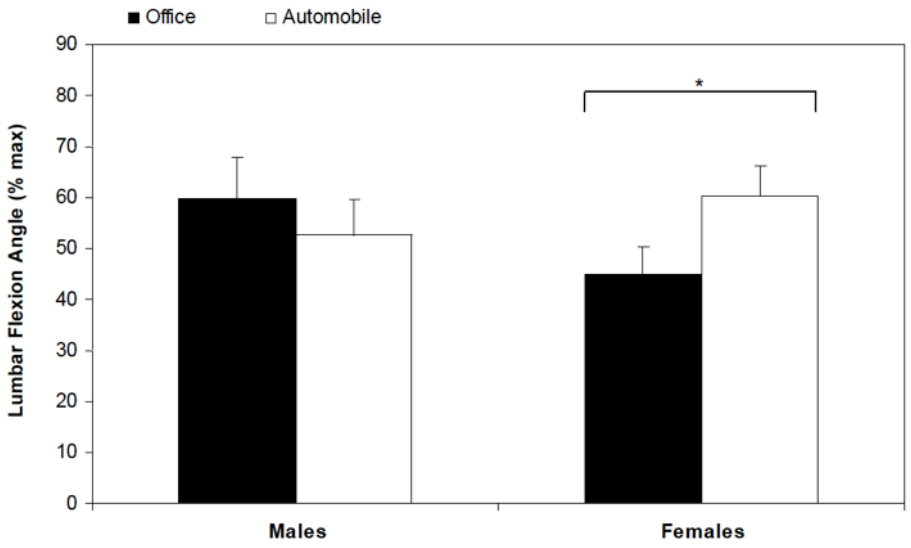



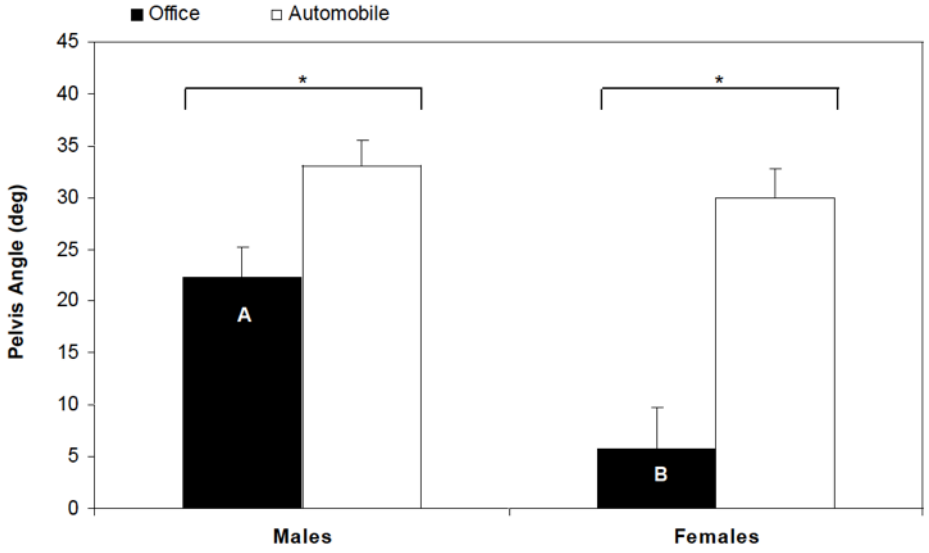

*Dunk, Kedgley, Jenkyn, Callaghan/ Clinical Biomechanics/ 24 (2009)*

# Automobile vs Office Sitting



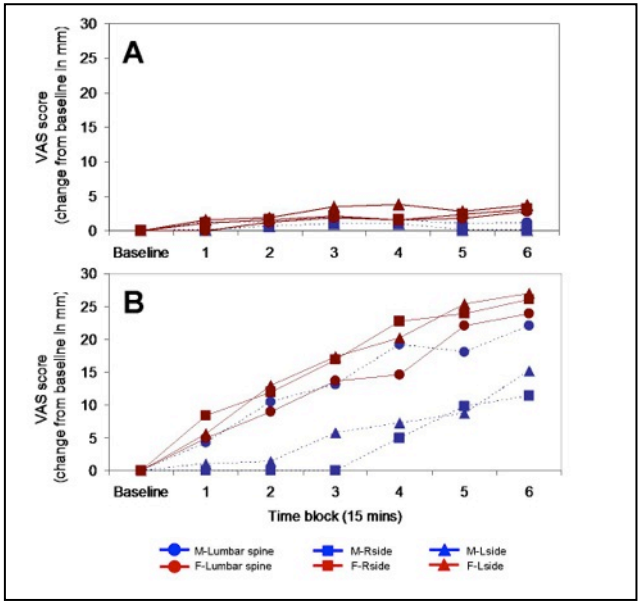


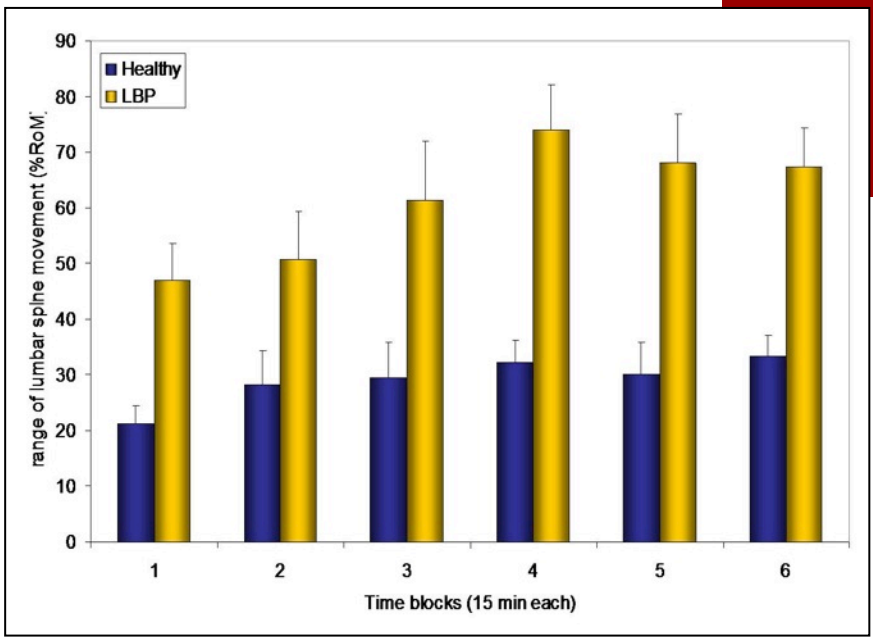


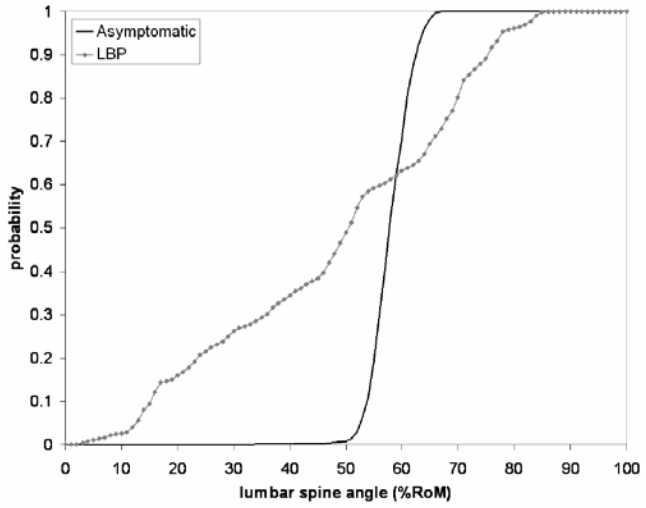




*Beach, McDonald, Coke, Callaghan/ Open Ergonomics/ 1 (2008)*

# LBP Sufferers and Sitting



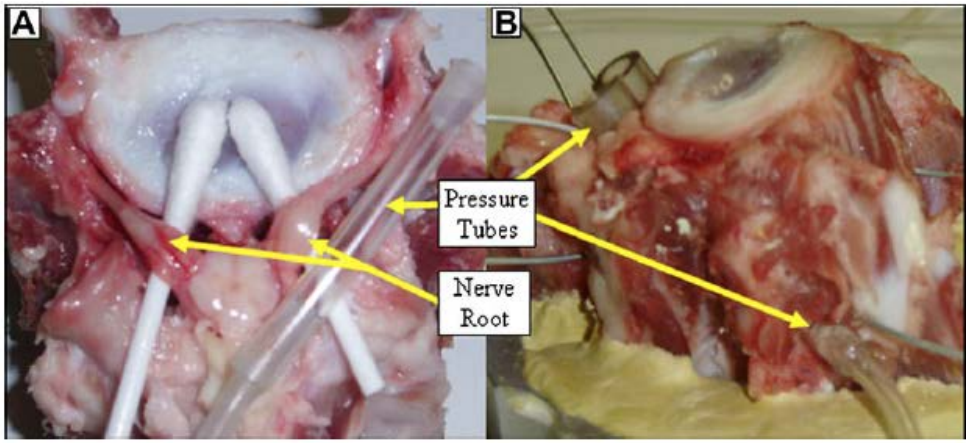



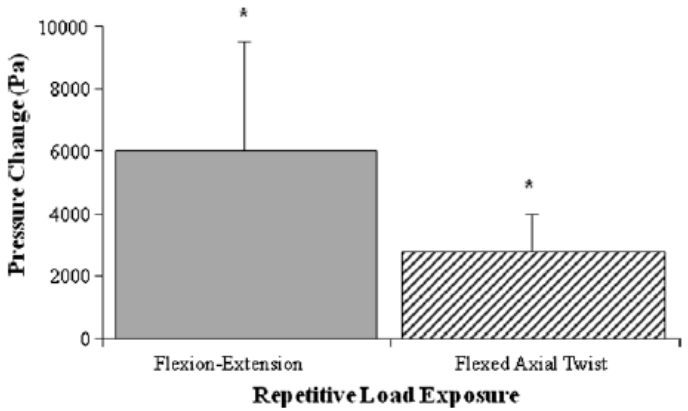



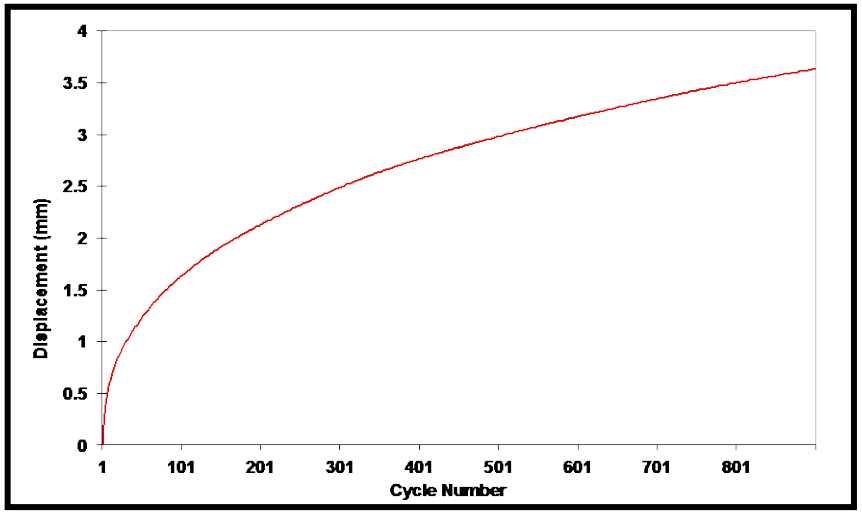

**Range of lumbar spine movement over 90 minutes of sitting. LBP sufferers had greater range of movement ($P$ = 0.0002)**

*Dunk & Callaghan/ Work/ 35 (2010)*

# Disc and Impingement Pressures :Linking Time varying Mechanical Responses and Injury to Pain




**Drake & Callaghan (2009)** ***Clin Biomech***

**Drake & Callaghan (2008)** ***Spine***

# Causal
# Adaptive
# Aggravating/Exacerbating

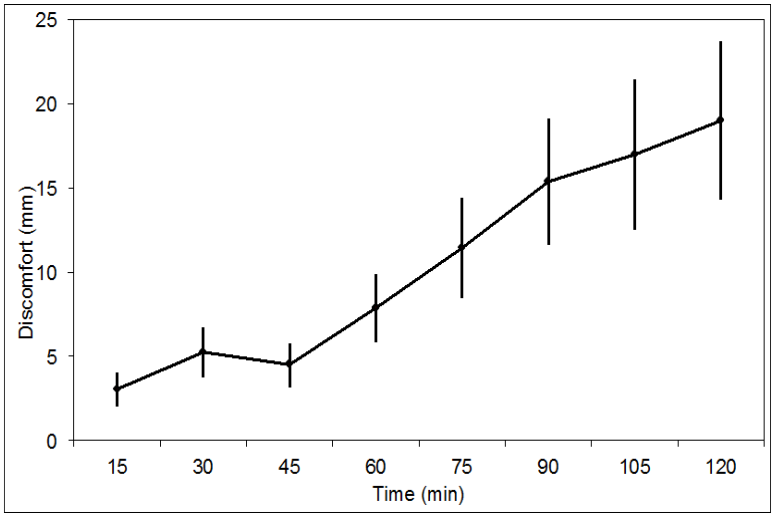
- Muscle activation patterns are altered in people with low back pain
  - Agonist-Antagonist co-activation (van Dieen, 2003; Dankaerts, 2006)

- Muscle co-activation is an adaptation to low back pain
  - Protection of compromised passive structures 'Instability' (van Dieen, 2003)
  - 'Maladaptive' movement patterns – some patients adapt in a way that aggravates condition (O'Sullivan, 2005)

# Time Varying Standing Responses

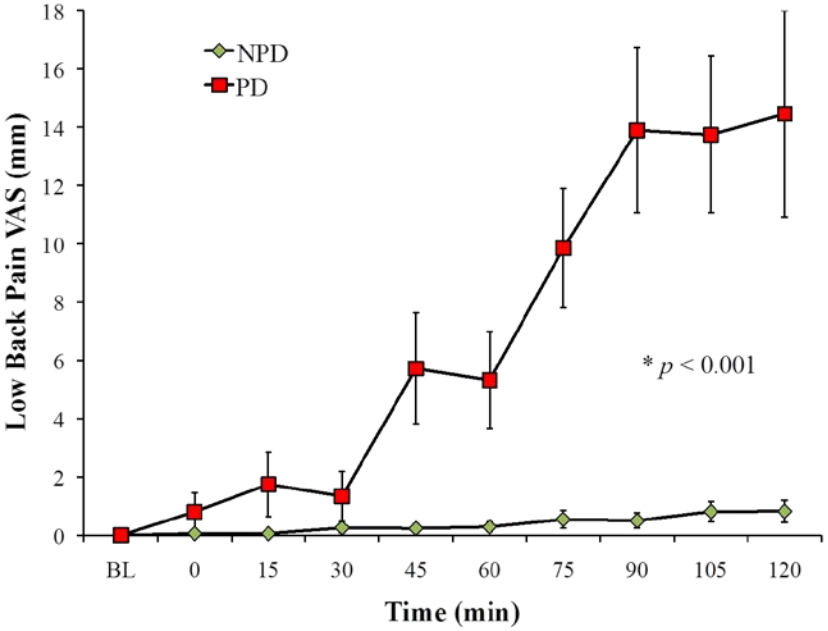
## Were variables affected by Time and Group?

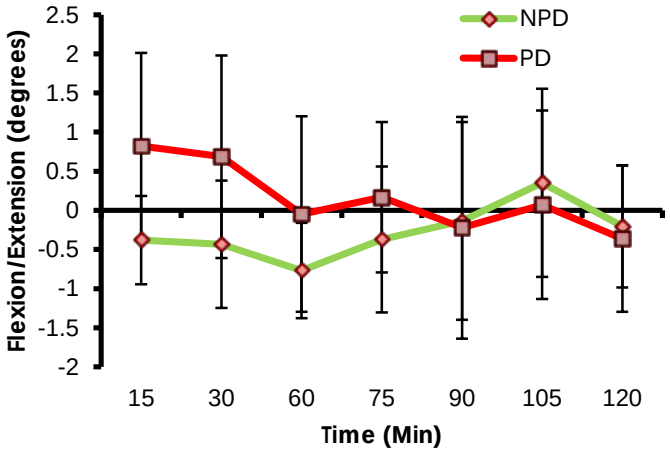
- LBD ↑ $p < 0.0001$
- Flexion ↑ $p = 0.0156$
- Anterior joint shear ↑ $p < 0.0001$



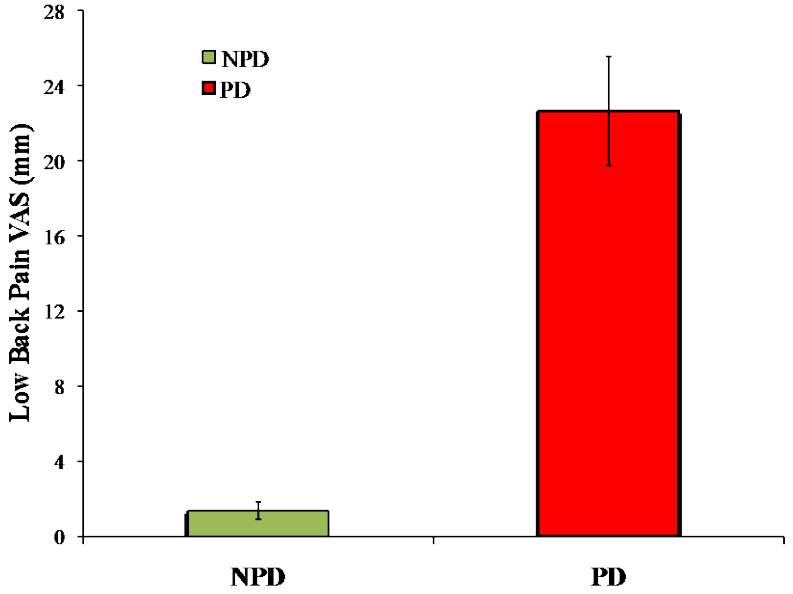

*D.E. Gregory, J.P. Callaghan / Gait & Posture 28 (2008) 86–92*

# Where Now:?
# Clear Separation into Discomfort and non-Discomfort Groups



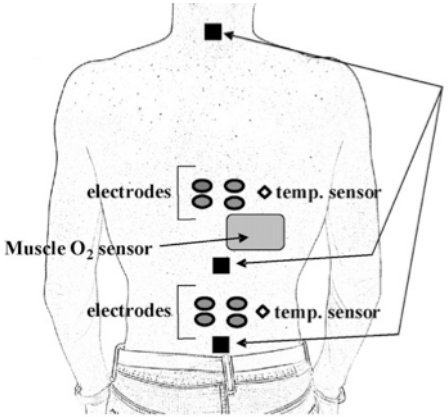

- 40% developed LBP (17/43)

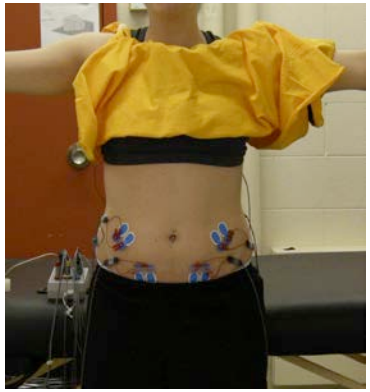



Nelson-Wong & Callaghan *Journal of Electromyography and Kinesiology* 20(6): 1125-1133, 2010.

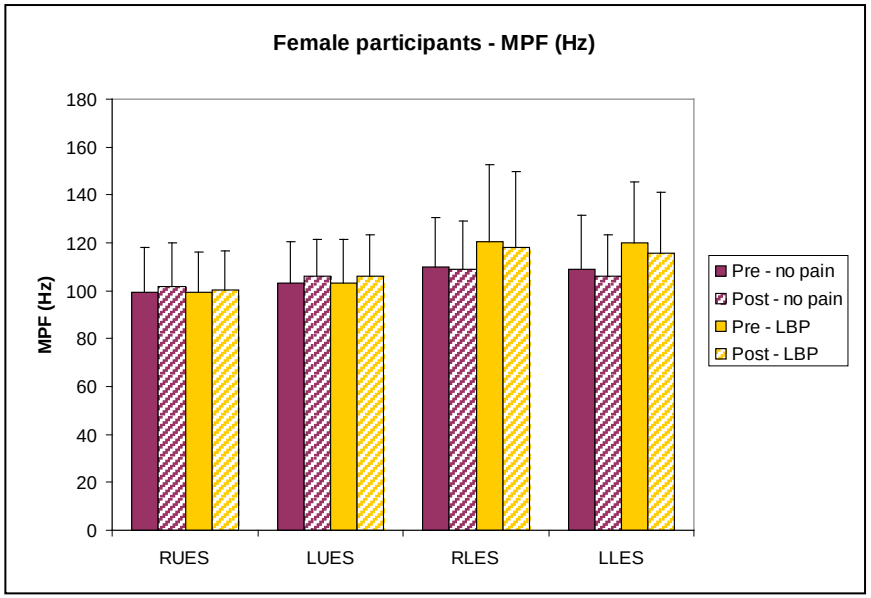
# Instrumentation

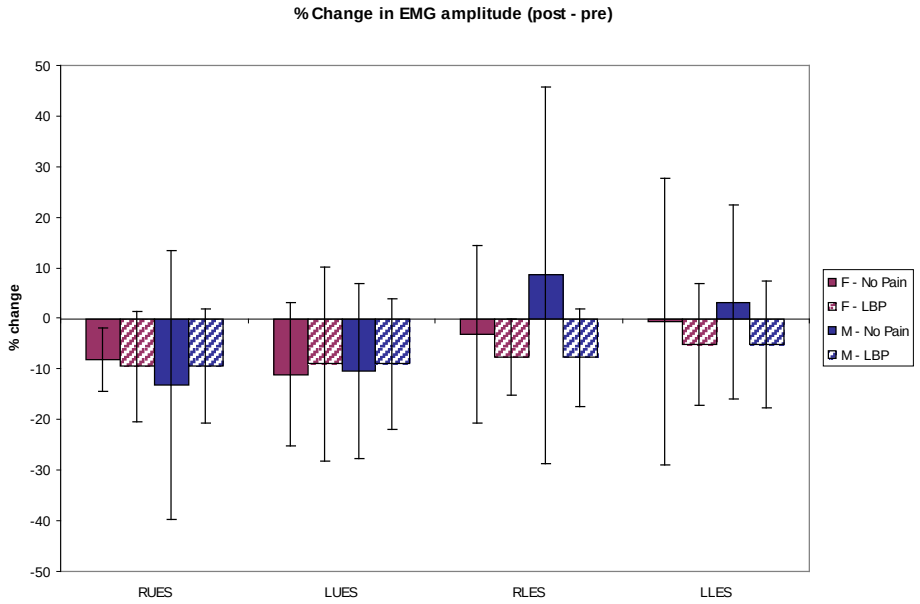
- Total n > 200 subjects
- Trunk Muscle Activation
- Kinematics, Whole Body
  - & Lumbar Spine
- Muscle Oxygenation
- Skin Temperature
- Forceplate, Hand Forces
- Pressure Mapping



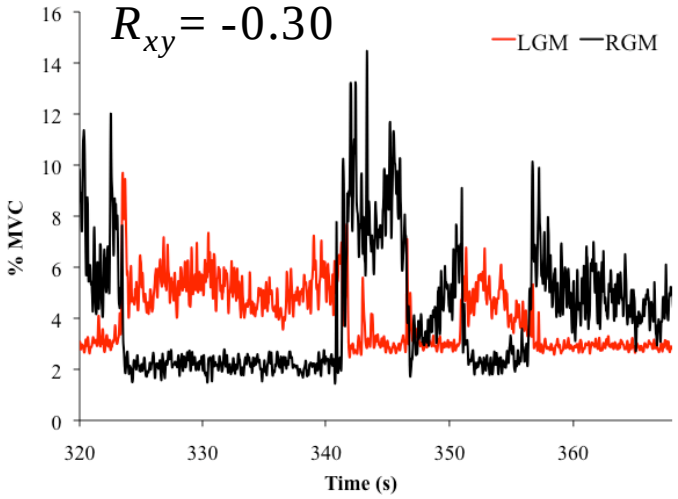



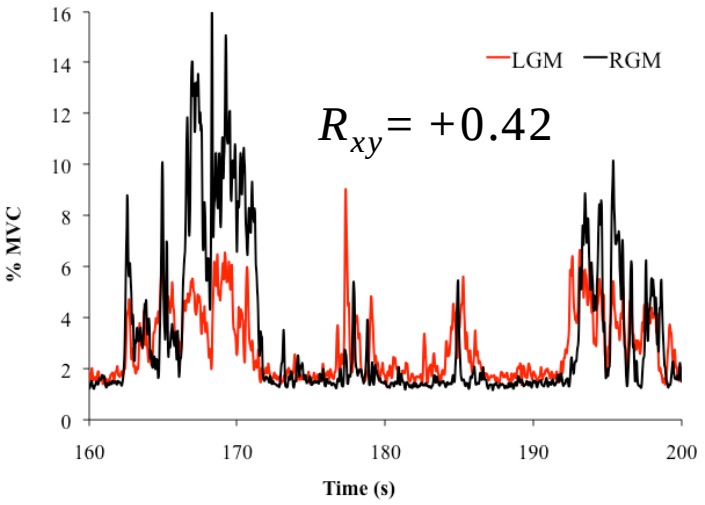
# EMG Changes – Frequency & Amplitude Based

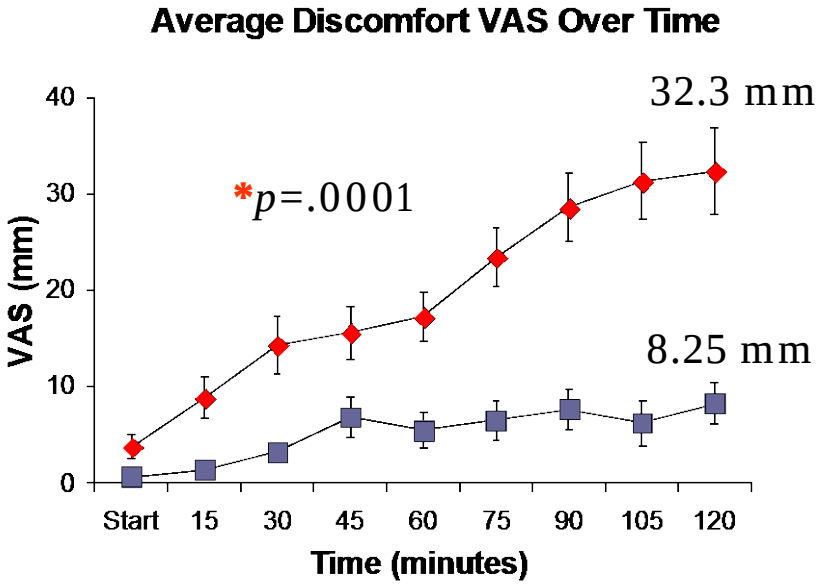


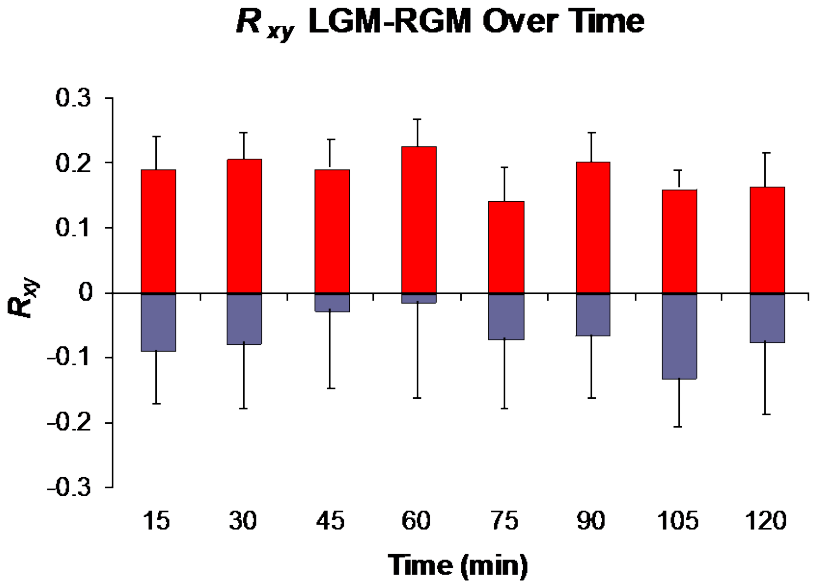



# Where now?



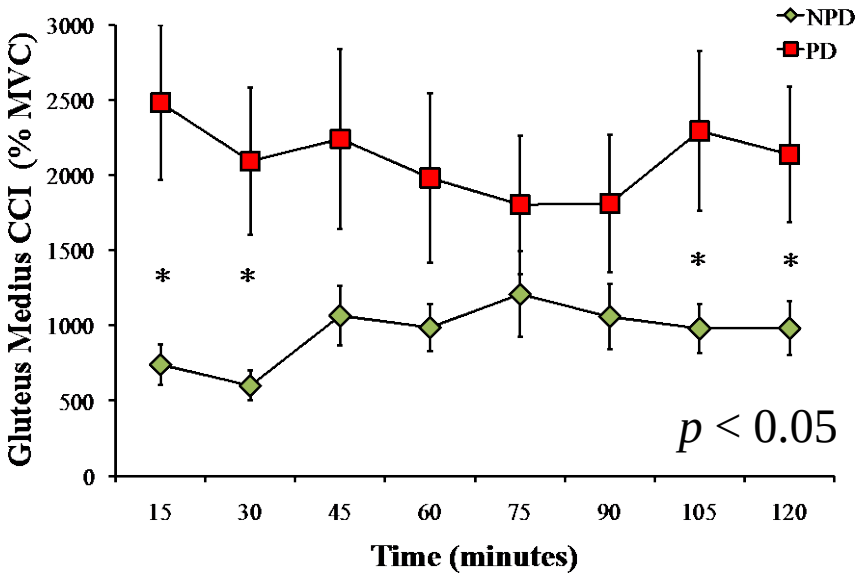



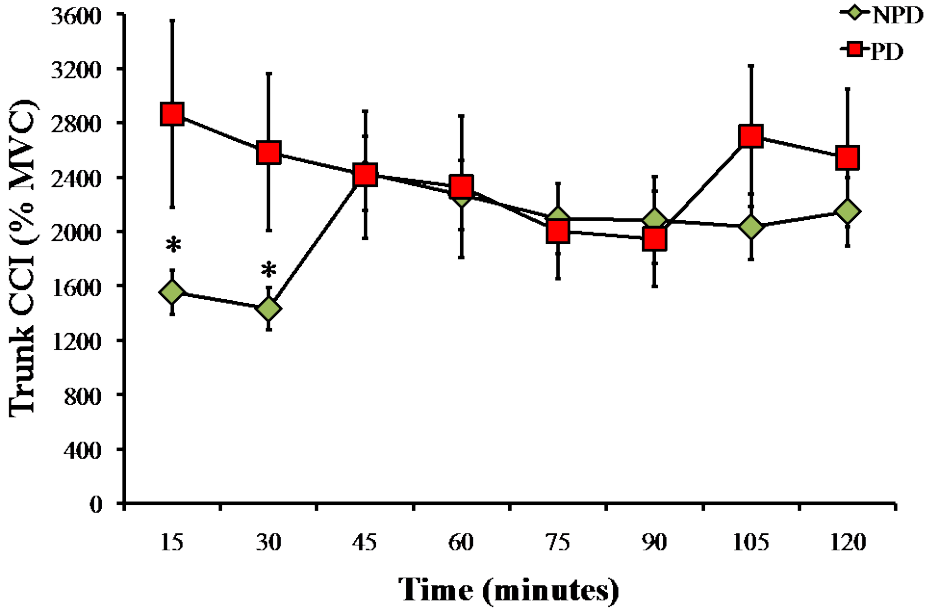



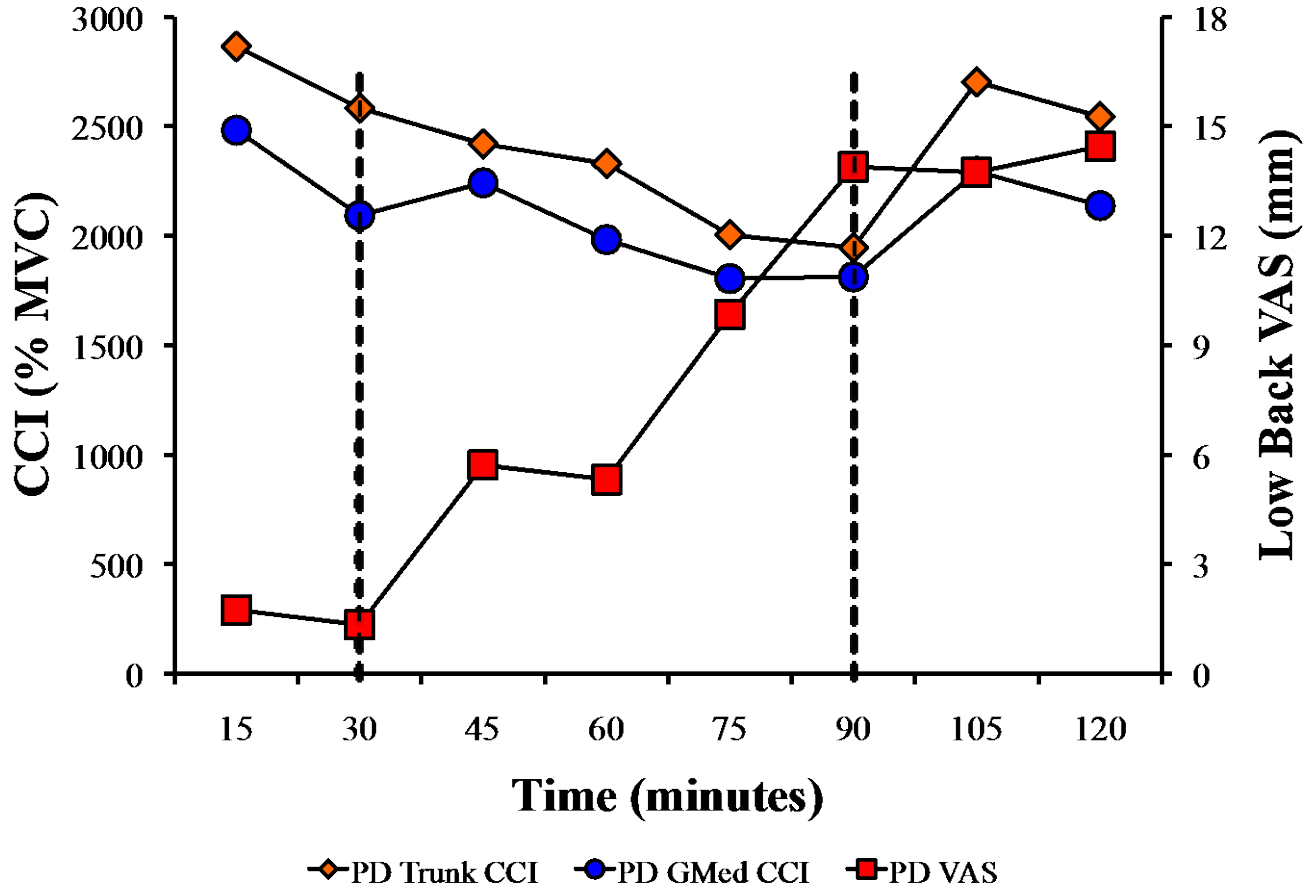

*E. Nelson-Wong et al. / Clinical Biomechanics 23 (2008) 545–553*

# PD had Higher Muscle Co-Contraction than NPD



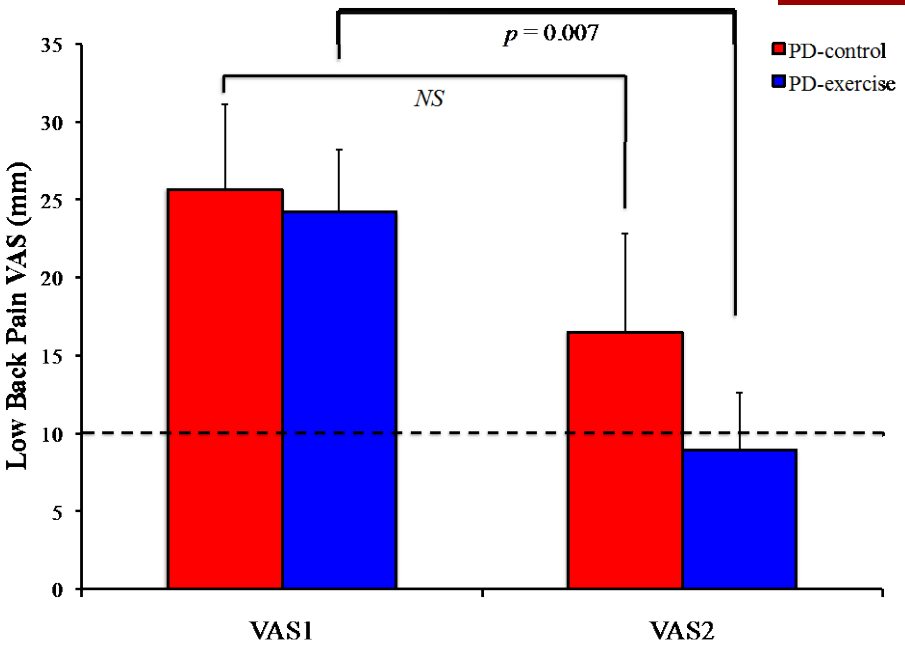



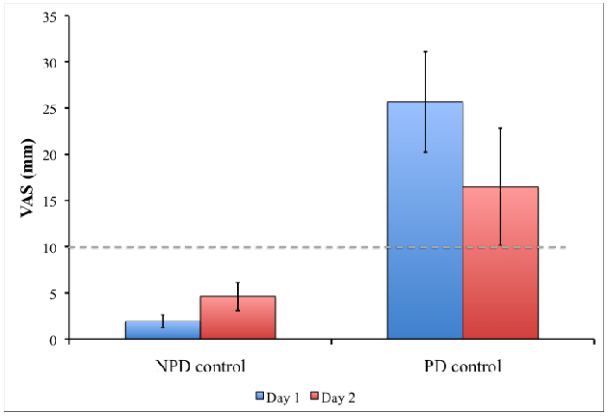
# Muscle Co-activation Occurs Prior to LBP Development



# Interventions/ Solution

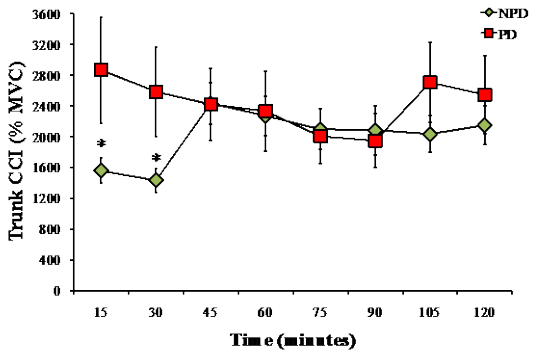
# Response to Exercise Intervention

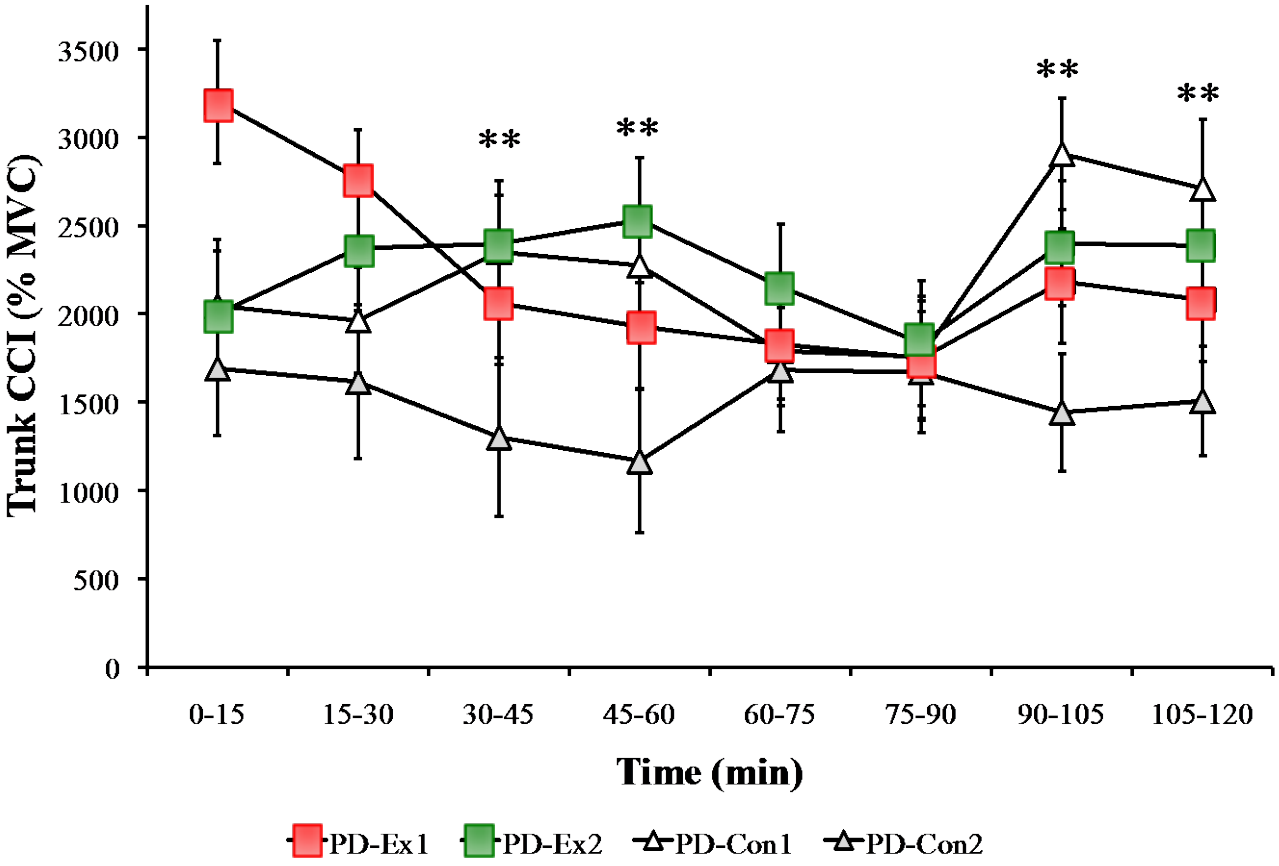



**25% of PD Control sought Clinical Care for LBP in 1 year**

# Changes in Trunk CCI

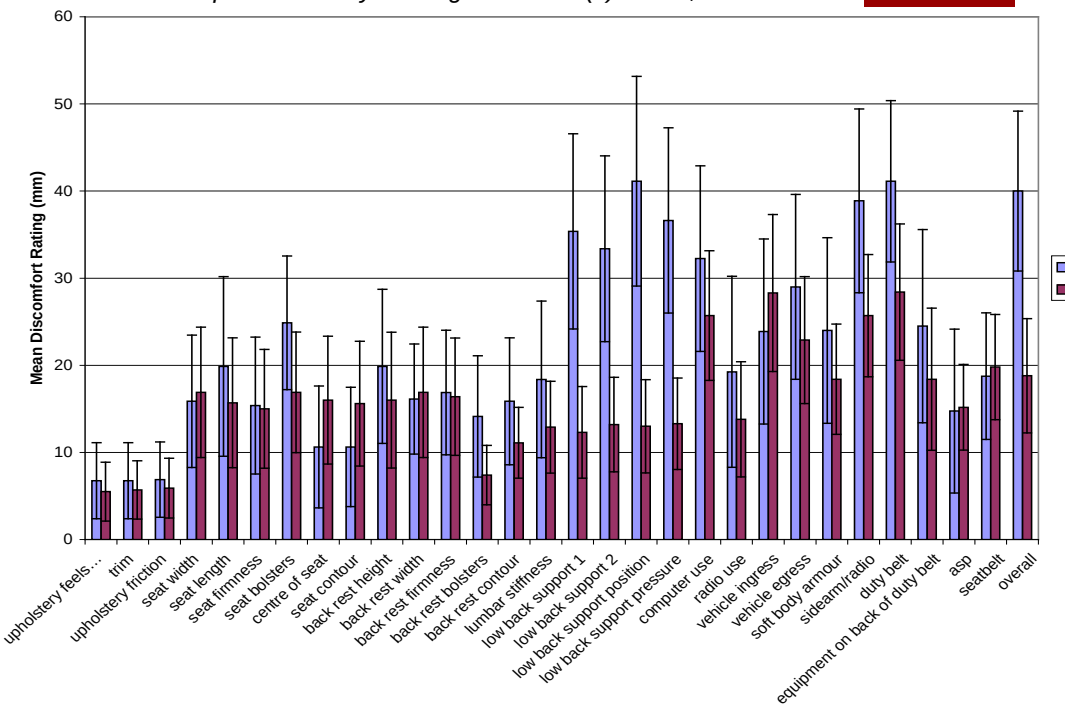


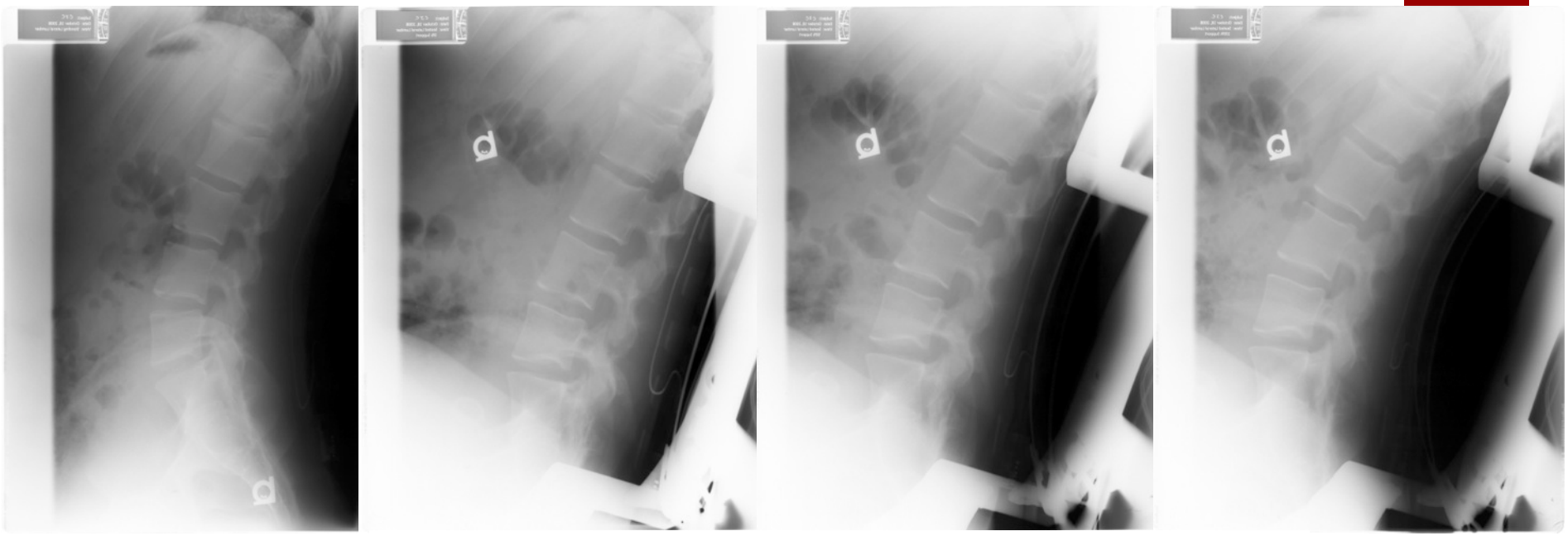
*Donnelly, Callaghan, Durkin, JOSE (2009) vol. 15 (3)*

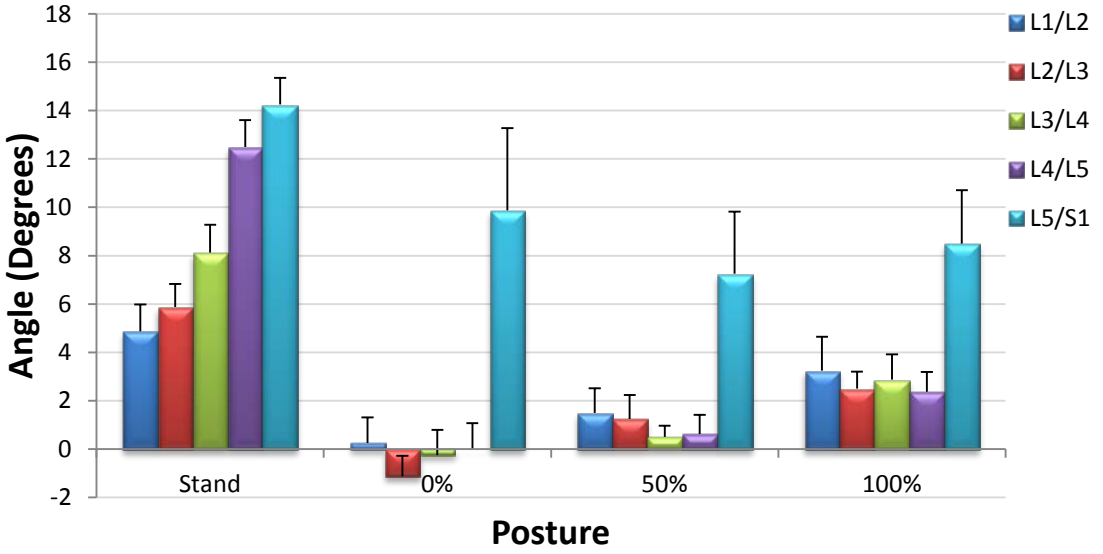
*Durkin, Hughson, Callaghan, Ergonomics (2006) vol. 49 (1)*

*McKinnon, Callaghan, Dickerson The International Journal of Occupational Safety and Ergonomics 17(1): 61-68, 2011.*



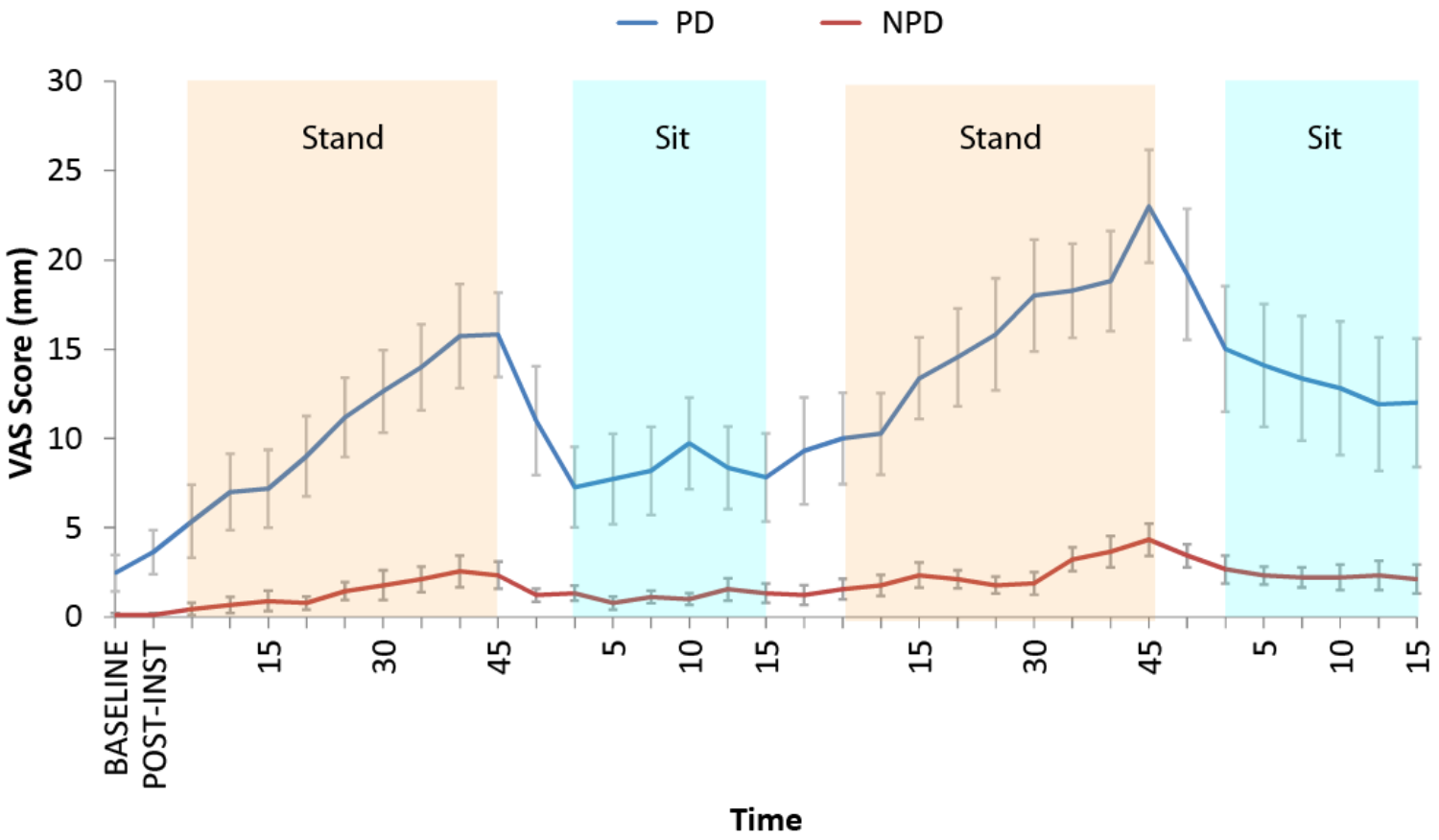

# Lumbar Supports





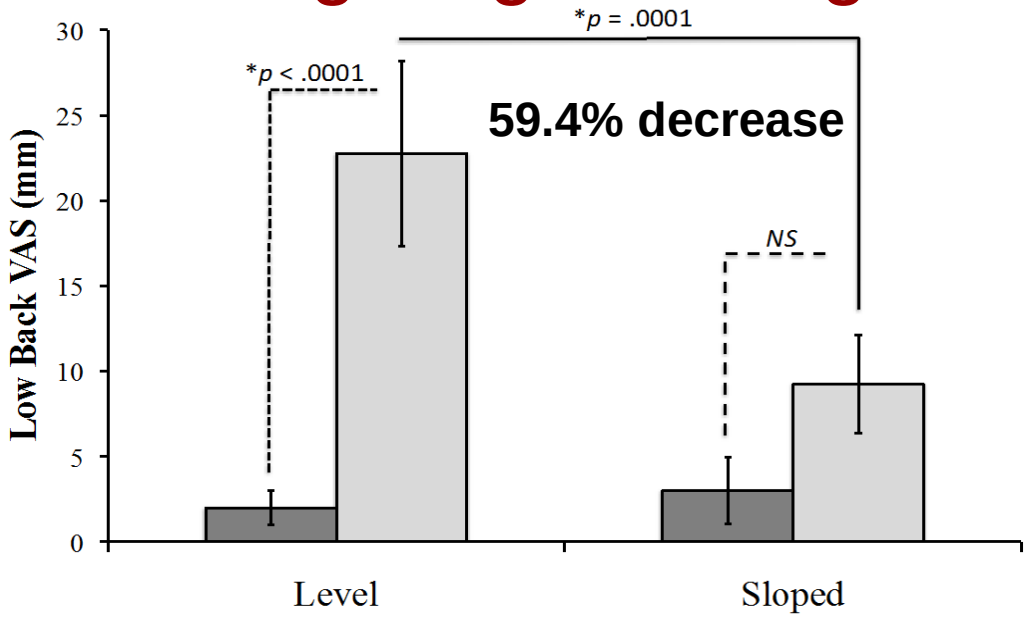

De Carvalho and Callaghan. *The International Journal of Industrial Ergonomics* 2011.

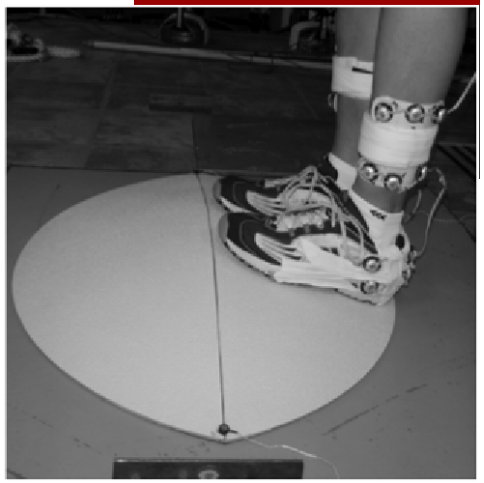
# Standing & Sitting as Rotation Partners




Gallagher & Callaghan, 2012 – In progress

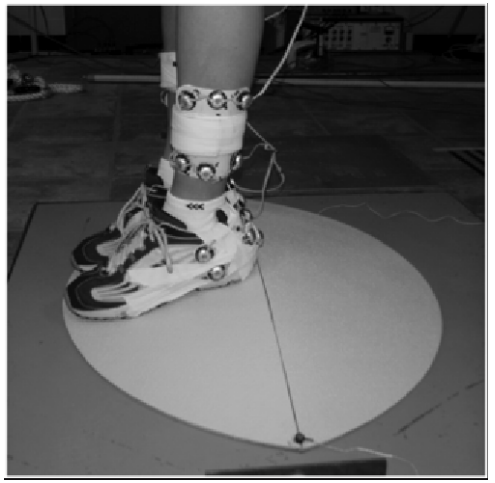
# Standing Engineering Solution

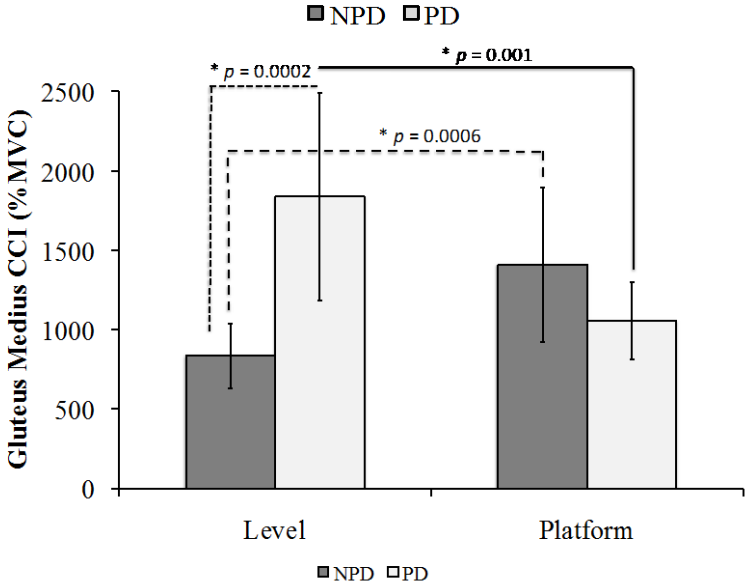


incline

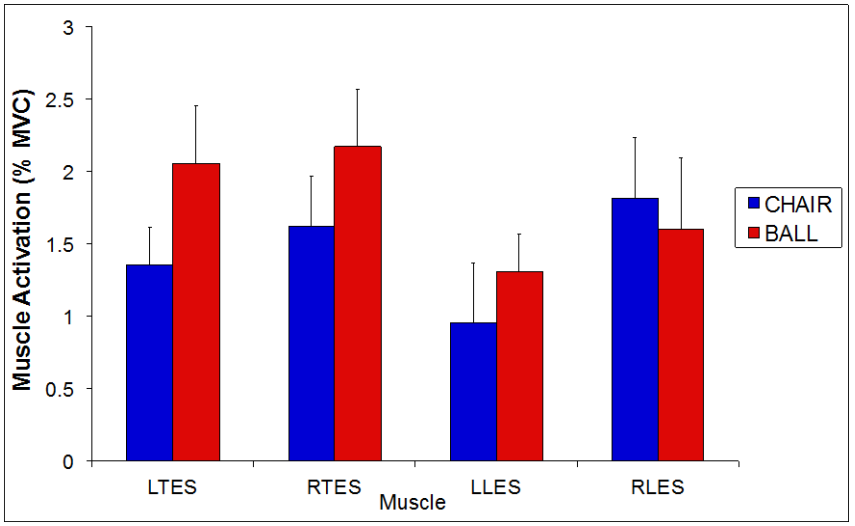
decline

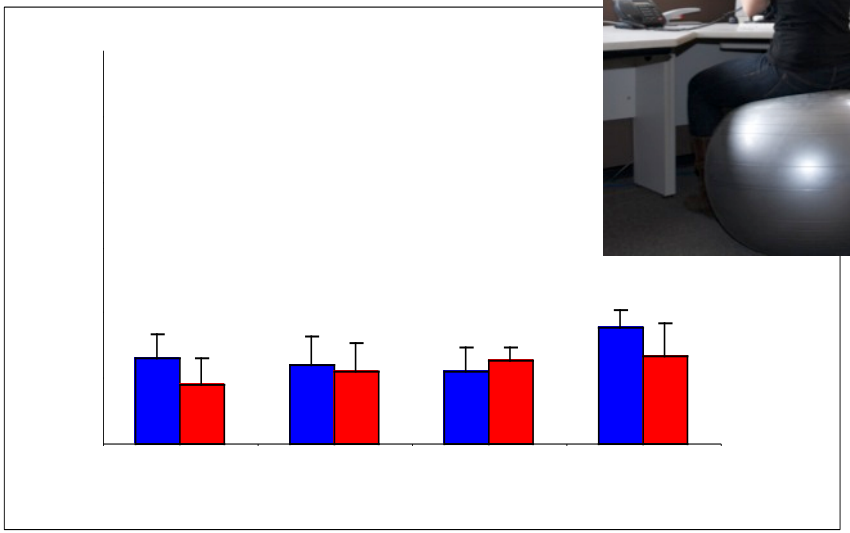


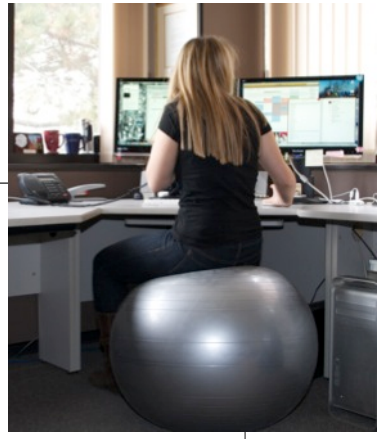



Nelson-Wong & Callaghan, *Applied Ergonomics,* 2010

# Stability Balls



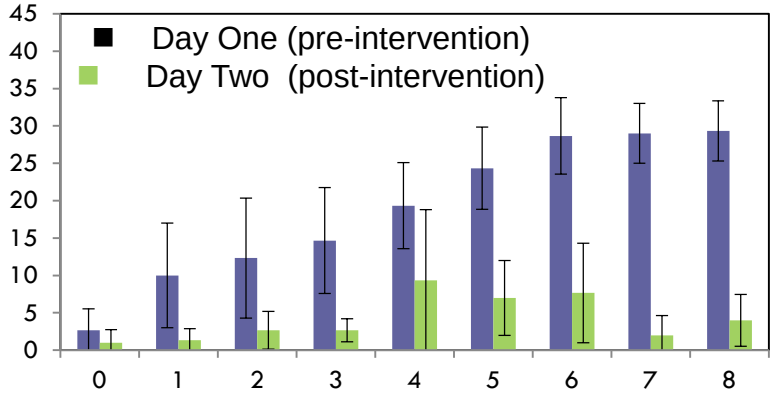





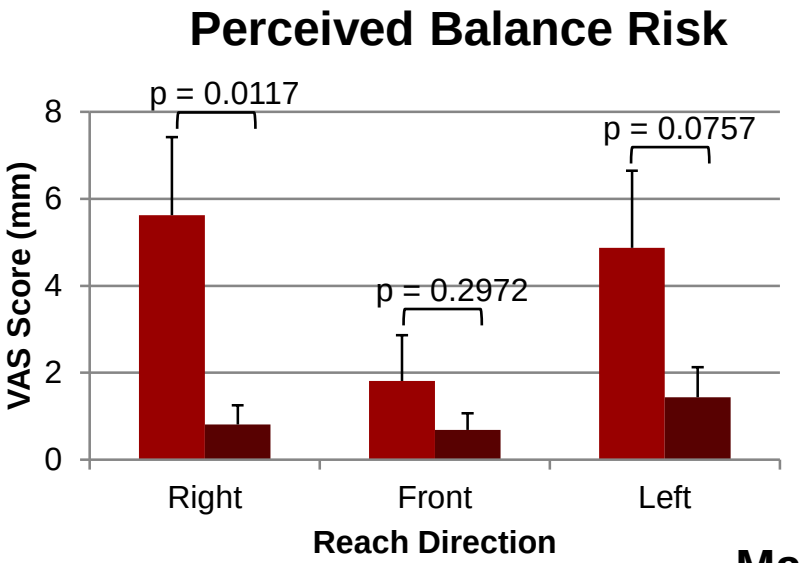
| | Ball | Chair |
|---|---|---|
| Lumbar Flexion | 43.4 %max RoM | 43.0 %max RoM |
| Range of Flexion | 13.9% | 14.0% |
| Pelvic Tilt | 18.3° | 23.3° |

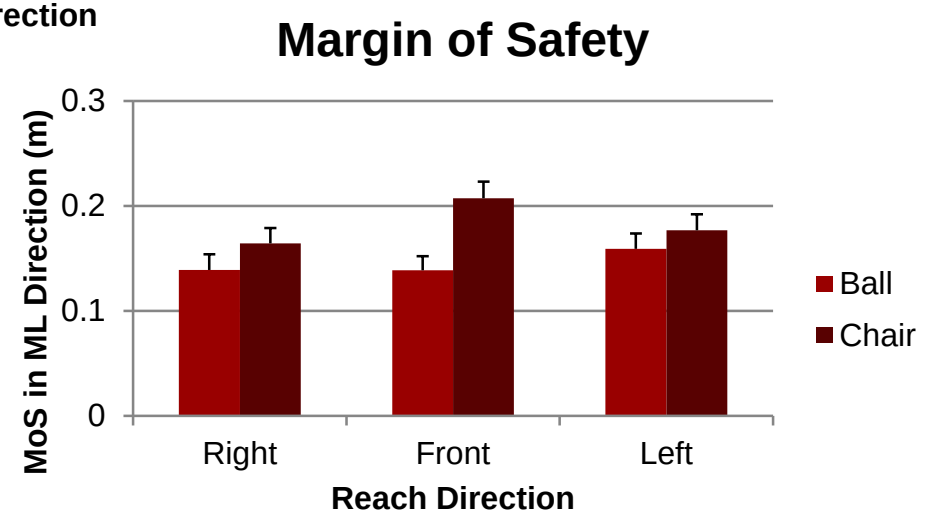
* RoM refers to range of motion in flexion/extension *

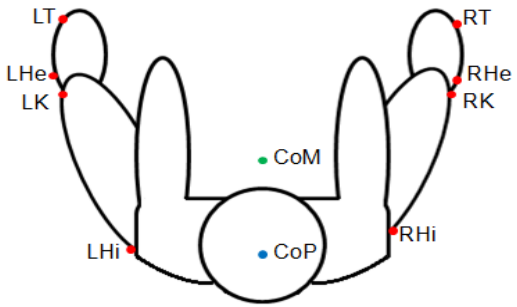
Gregory, Dunk, Callaghan *Human Factors* 48(1): 142-153, 2006.

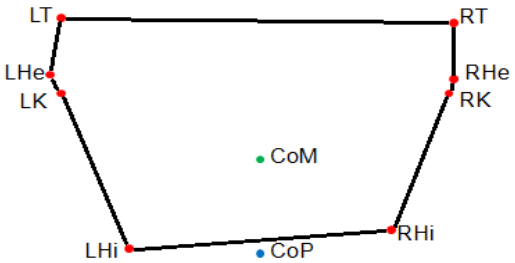


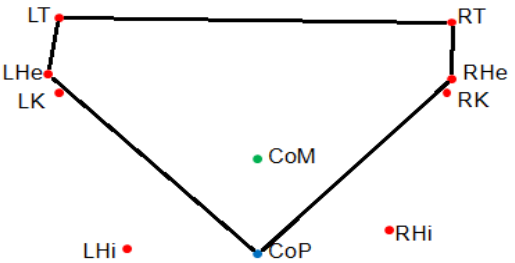

Jackson, Banerjee-Guenette, Gregory, Callaghan *Human Factors* 2012.




Karakolis & Callaghan, 2012 – In Progress

# Take Home messages

- 1) Standing and Sitting in constrained conditions can accelerate LBP

- 2) Individual risk factors are important considerations when evaluating the potential for LBP associated with standing and sitting:
  - Standing – predisposing MC strategies separated PD from NPD
  - Sitting – Gender and Movement strategies

# Take Home messages

- 3) Interventions
  - Exercise can alter individuals predisposed to LBP from Standing exposure
  - "Ergonomic" based changes in sitting can reduce LBP reporting
  - Rotation?, removal of Constraints?
- 4) Not a single solution for all individuals
- 5) Stability balls are **not** office chairs ☺

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