Musculoskeletal Disorders: Designing for a Healthier and Resilient Workforce

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Kia ora

STATEMENT SLIDE

I have no conflicts of interest to disclose

Background

Salt's Mill, UK

Auckland University of Technology (AUT), NZ
Te Wānanga Aronui o Tāmaki Makau Rau

HSE Science and Research Centre, UK

Aims

- Musculoskeletal disorders (MSD) – what do the statistics tell us?
- What's the current thinking around potential MSD contributory risk factors?
- Reflect on the past to direct future approaches
- Where might future technology be used to better understand the problem and direct MSD interventions

Musculoskeletal disorders (MSD)

- MSD are the leading contributor (1.71 billion) to disability worldwide
- Low back pain is the single leading cause in 160 countries (570 M prevalent cases)
- MSD significantly:
  - limits mobility and dexterity
  - leads to early retirement
  - Contributes to lower levels of well-being
  - reduces ability to participate in society

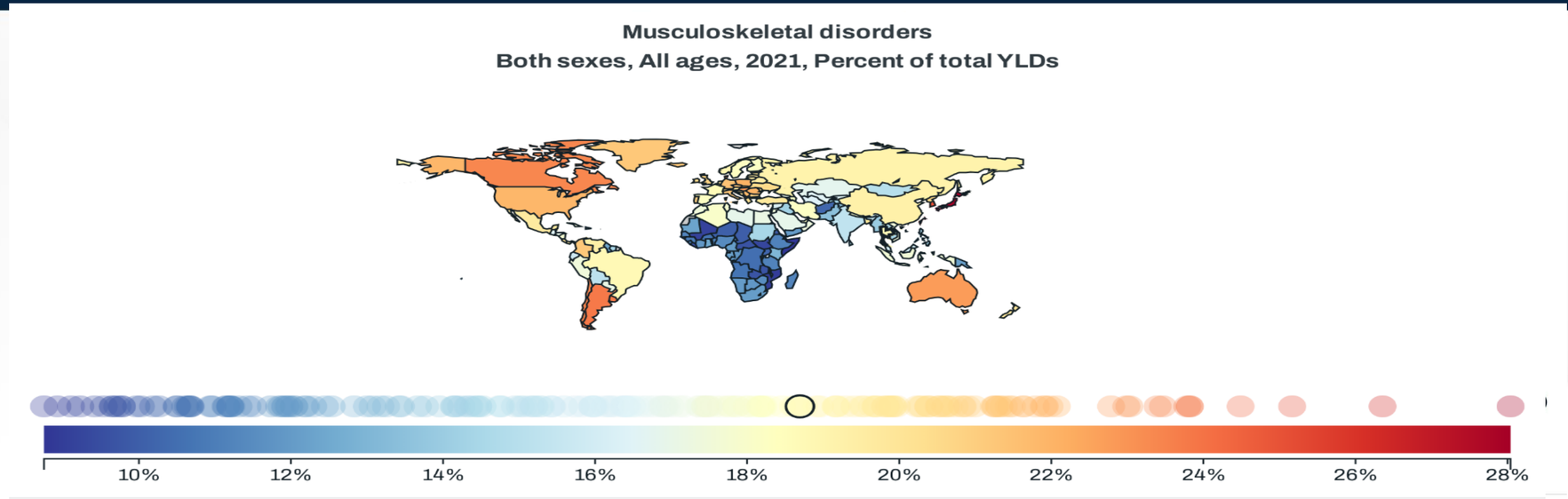
“Ignored pandemic”

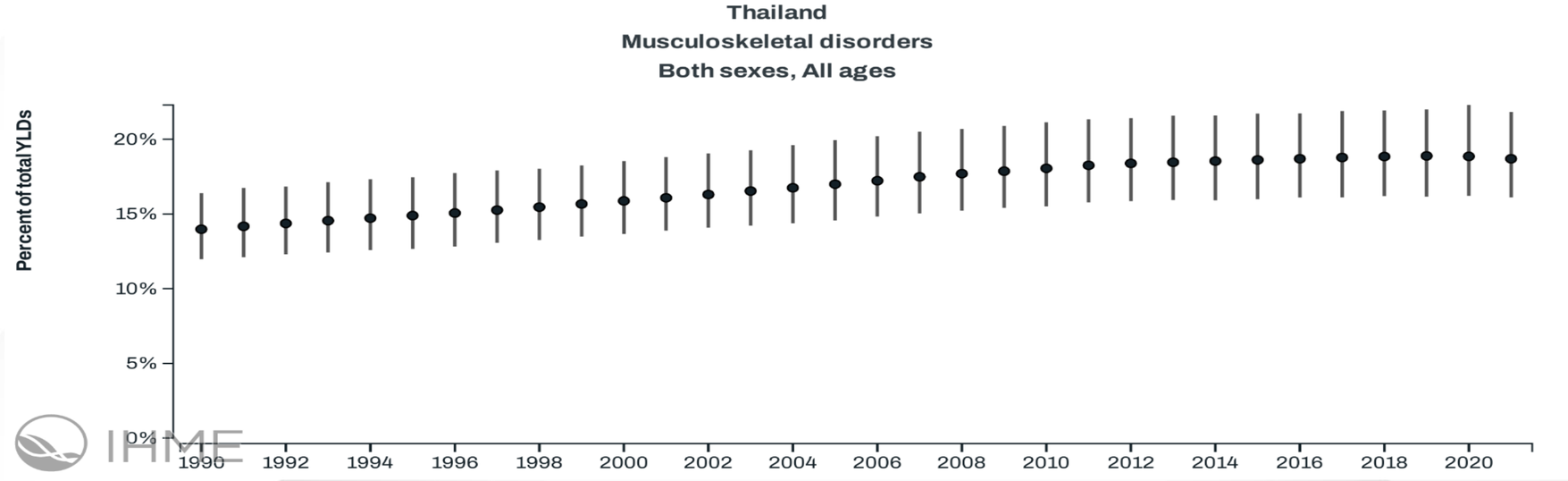
- Those with MSD are at increased risk of developing other noncommunicable diseases, such as cardiovascular disease, mental health issues
- 50–70% of MSD are considered work-related

WHO (2022)

World Health Organization https://www.who.int/news-room/fact-sheets/detail/musculoskeletal-conditions

MSD: Years lived with disability

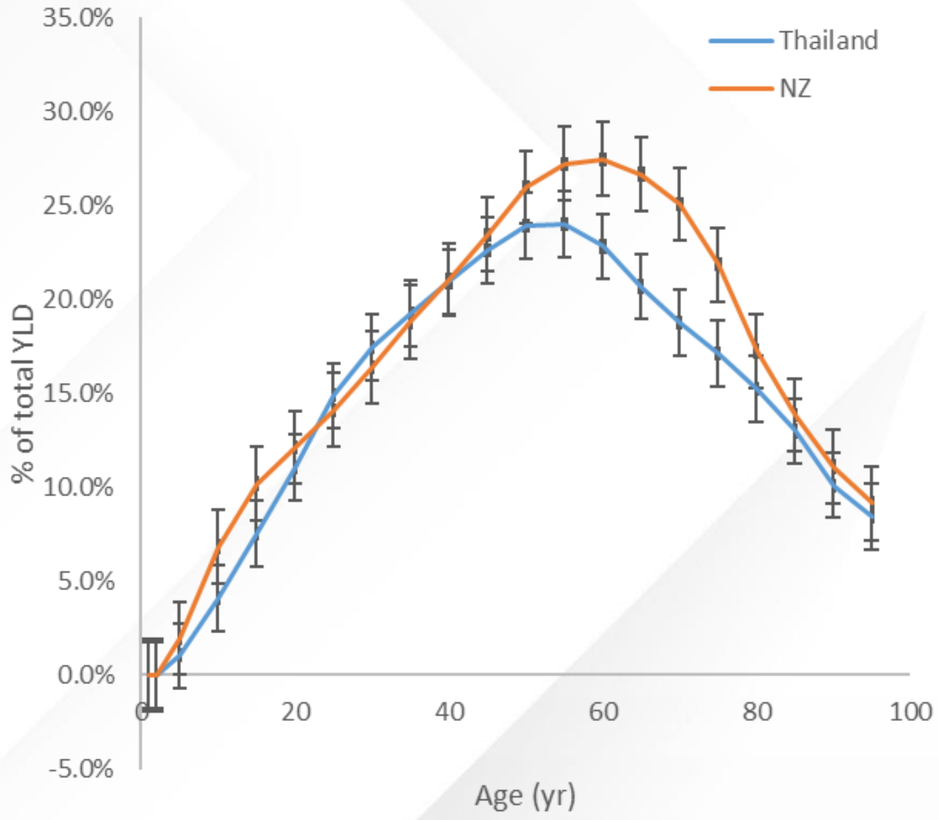




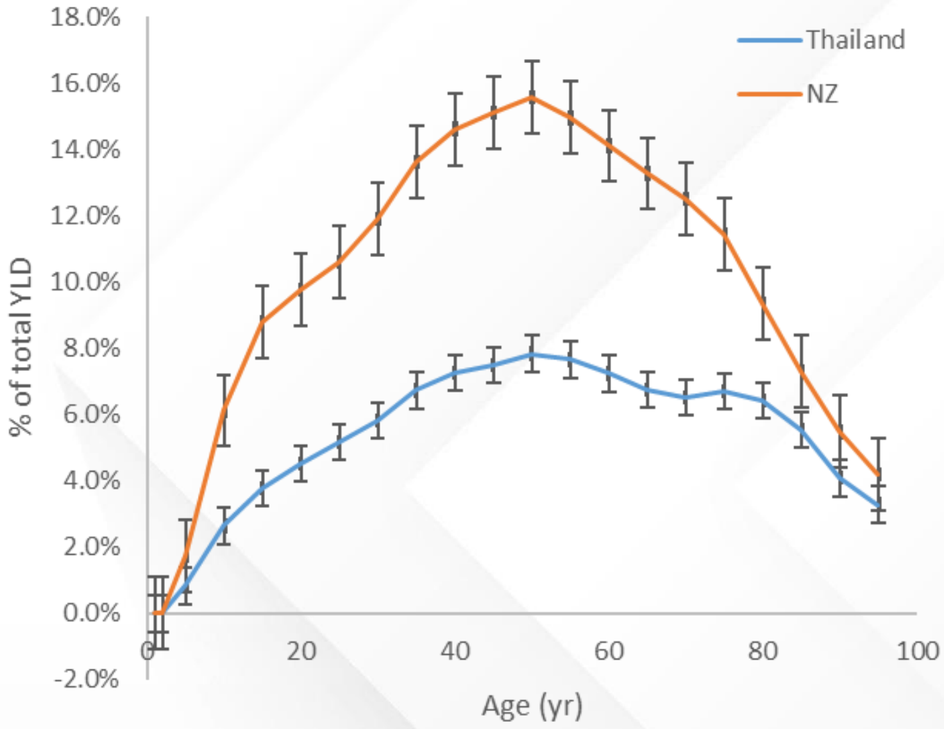
IHME

MSD: Years lived with disability

Musculoskeletal disorders



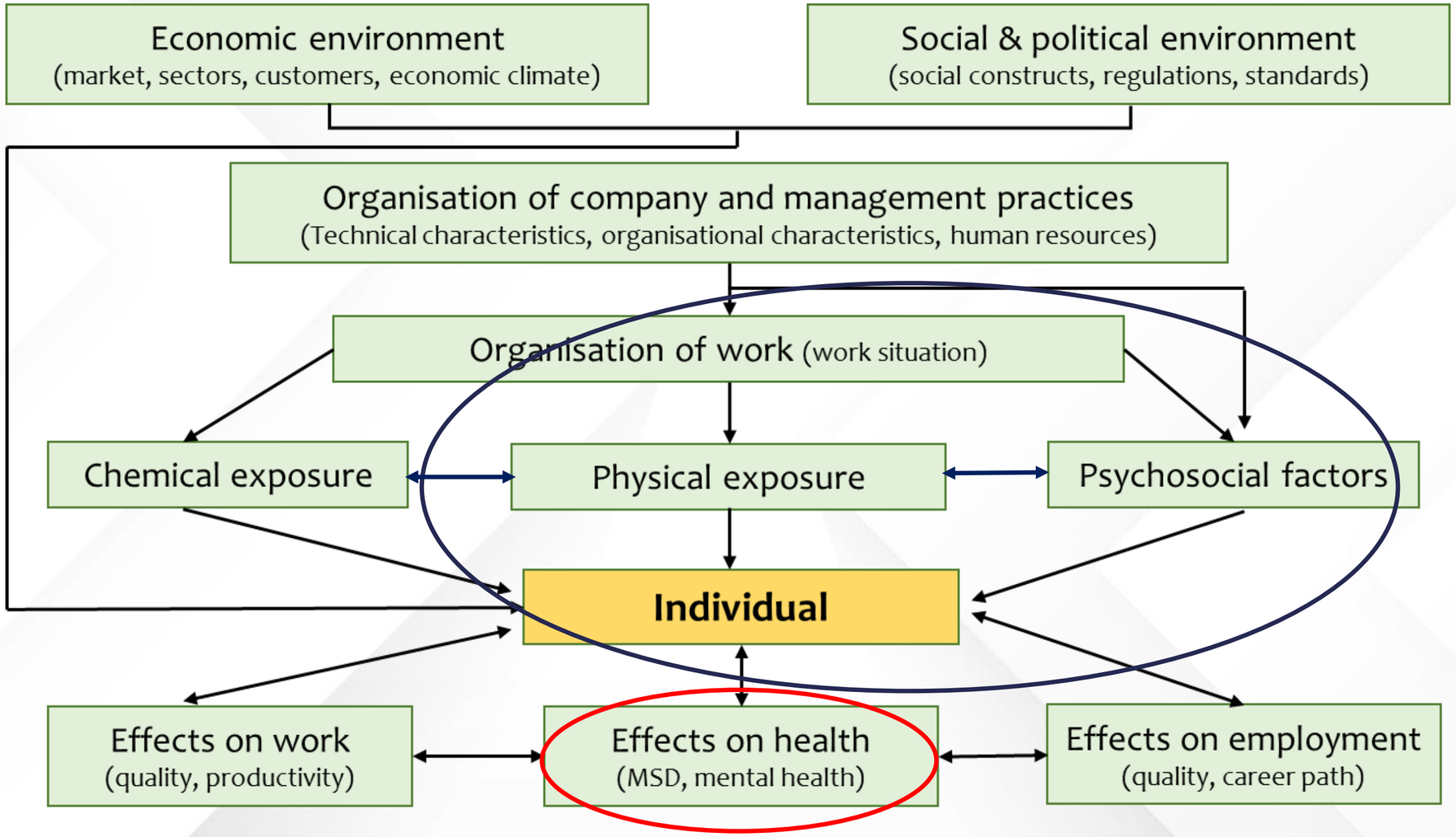
Low Back Pain



IHME

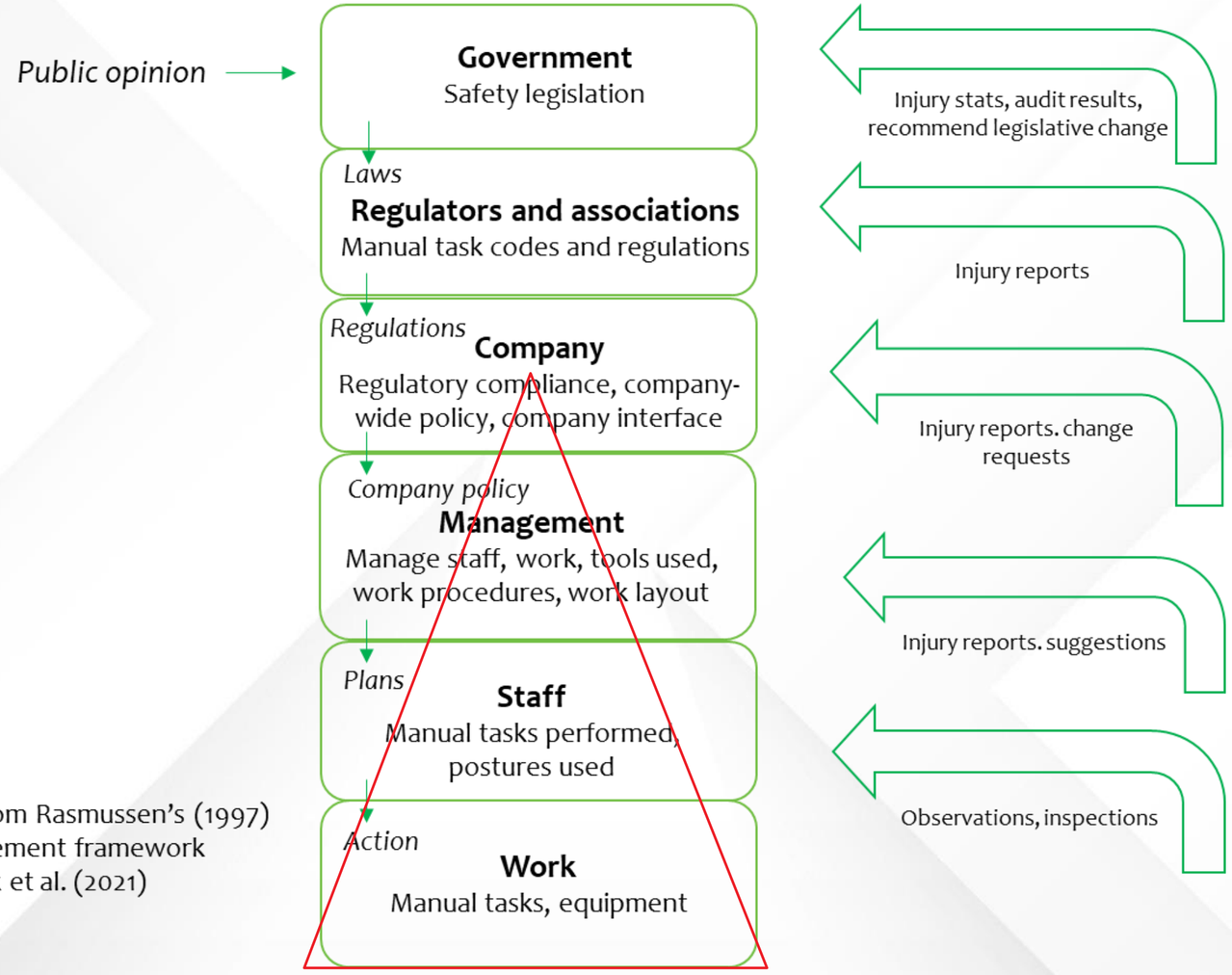
MSD: Why have we seen little change?

Multidimensional model of work-related musculoskeletal health



Roquelaure (2018)

Manual handling: systems thinking



Adapted from Rasmussen's (1997) risk management framework
McCormack et al. (2021)

Manual handling

MH: training and education

- Does it work?
- Manual material handling training is of questionable value according to five systematic reviews/meta-analyses

  (Haslam et al., 2007; Martimo et al., 2007; Clemes et al., 2009; Verbeek et al., 2011; Hogan et al., 2014)

- Denis et al. 2020: systematic review of 77 MH training programmes
  - Contents were surprisingly uniform, with an emphasis on adopting the safe handling technique commonly known as “straight back, bent knees”,
  - Little (to no) attention to the work conditions that might correct behaviour

MH: training and education

- Inadequate training methods due to lack of applicability or lack of rationale

Gagnon (2003)

- Lack of consideration for adaptability to suit variations in task, workplace and worker

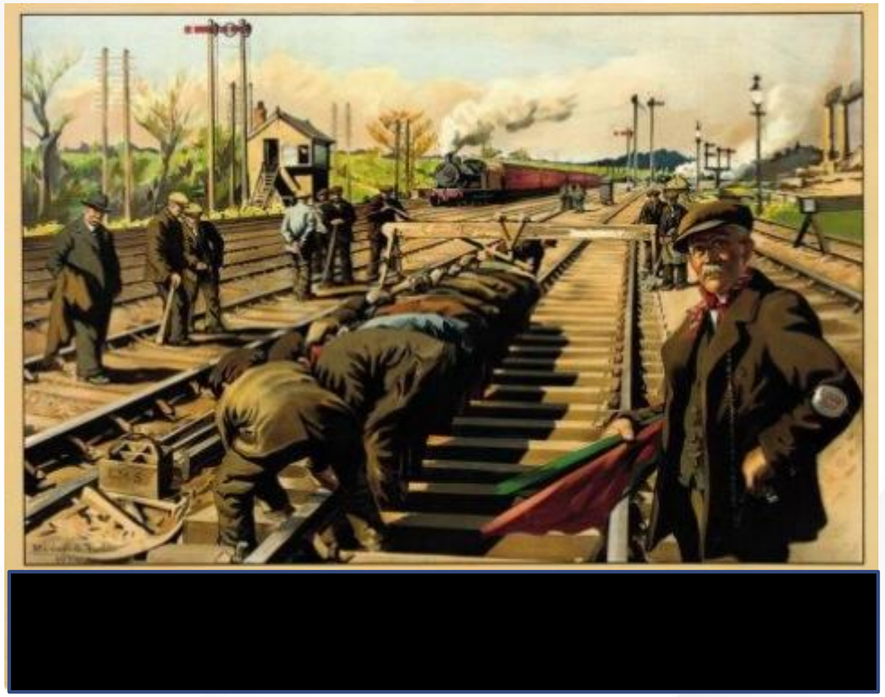
St-Vincent et al. (1989)

- Quality of training programme rarely questioned

Sedgwick and Gormley (1998)

- What is a “safe handling technique”?
  - ‘Bend your knees and keep your back straight’
  - ‘Squat don’t stoop’
  - ‘Keep the natural curves of the back’

MH: training and education

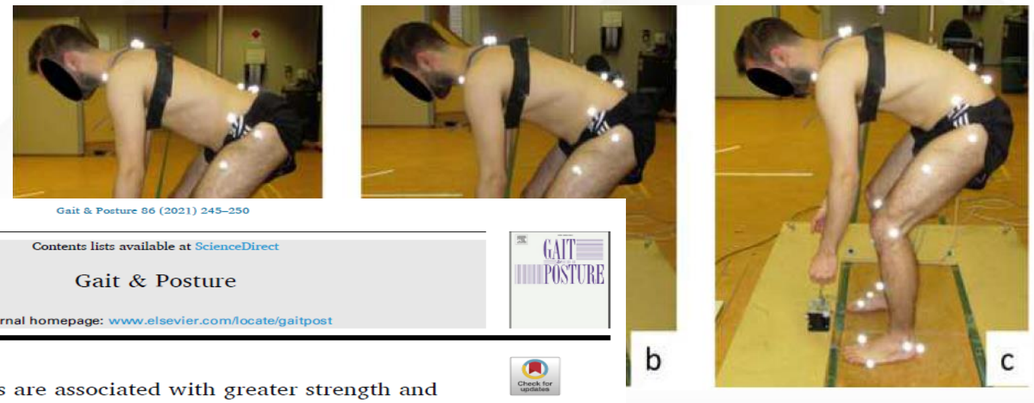


1930's

2020

MH: lumbar posture

- Few occupational lifting tasks can be performed using a squat technique
- Science – squatting can have an increased physiological cost and depending on the characteristics of the load, it may not even reduce the forces on the spine
- Back extensors appear stronger in more flexed lumbar postures



Gait & Posture 86 (2021) 245–250

Contents lists available at ScienceDirect

Gait & Posture

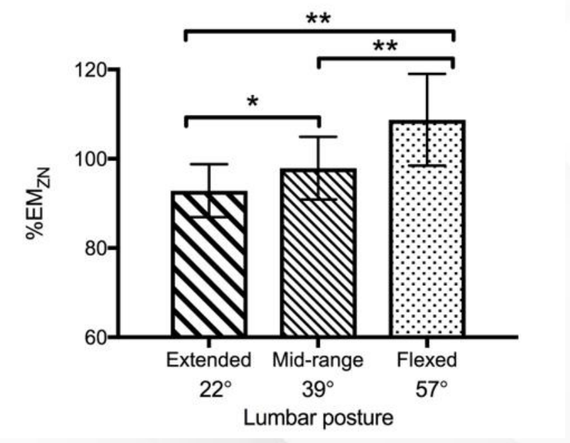
journal homepage: www.elsevier.com/locate/gaitpost

Full length article

Flexed lumbar spine postures are associated with greater strength and efficiency than lordotic postures during a maximal lift in pain-free individuals

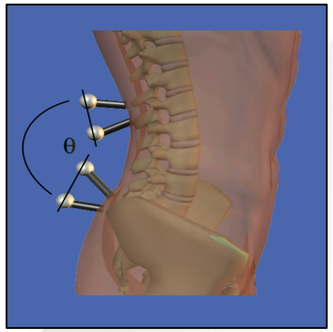
Grant Mawston [a,*], Laura Holder [a], Peter O'Sullivan [b], Mark Boocock [a]

[a] Health and Rehabilitation Research Institute, Department of Physiotherapy, Auckland University of Technology, New Zealand
[b] School of Physiotherapy and Exercise Science, Curtin University, Perth, Western Australia, Australia

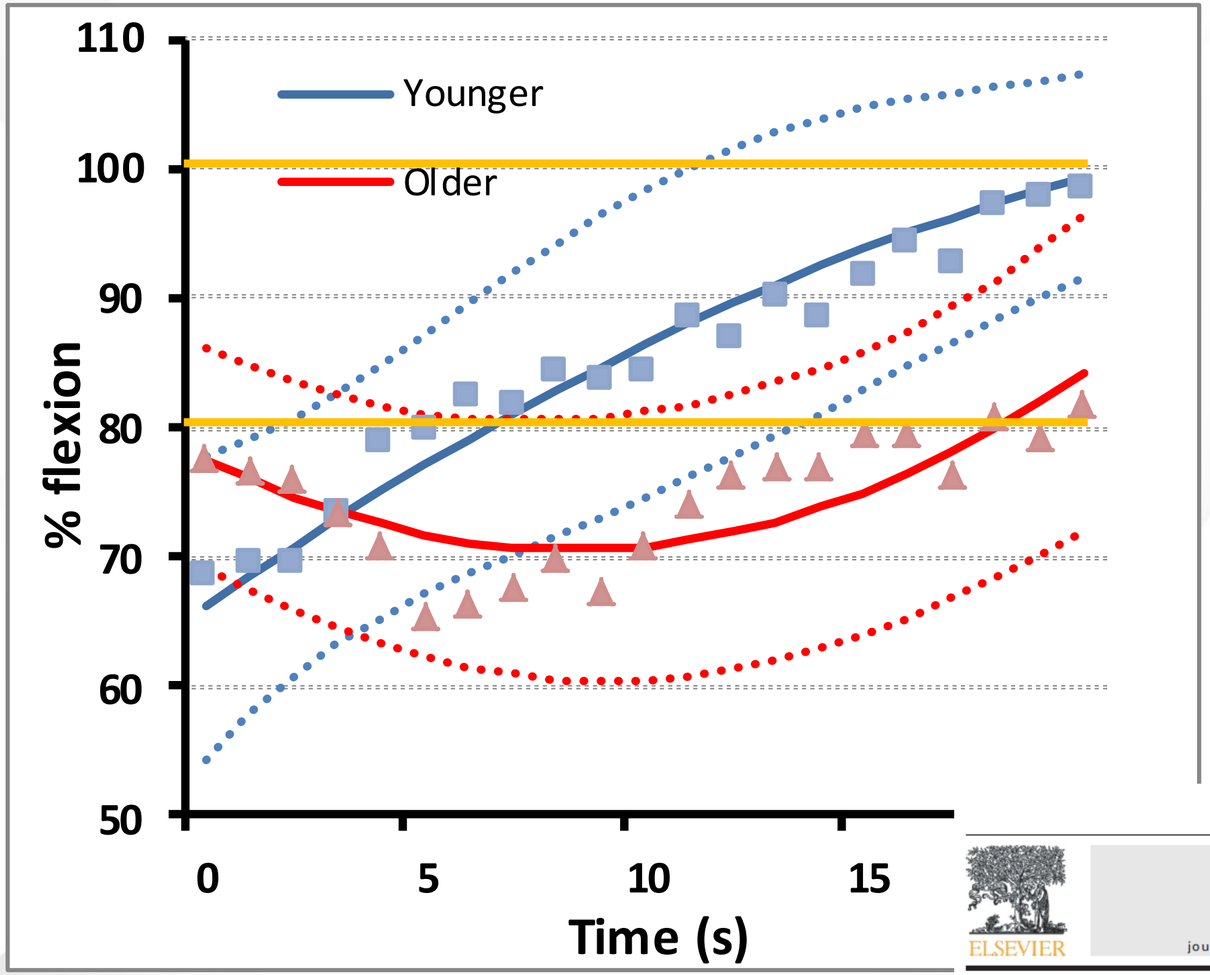


MH: age and fatigue

- 14 Young (mean= 24 yr) and 14 middle aged (47 yr) participants
- Repeat (10 lifts/min) lifting and lowering a box (13 kg) from a shelf (15 cm above floor) to upright standing for max 20 min



MH: age and fatigue



Clinical Biomechanics 30 (2015) 136–143

Contents lists available at ScienceDirect

Clinical Biomechanics

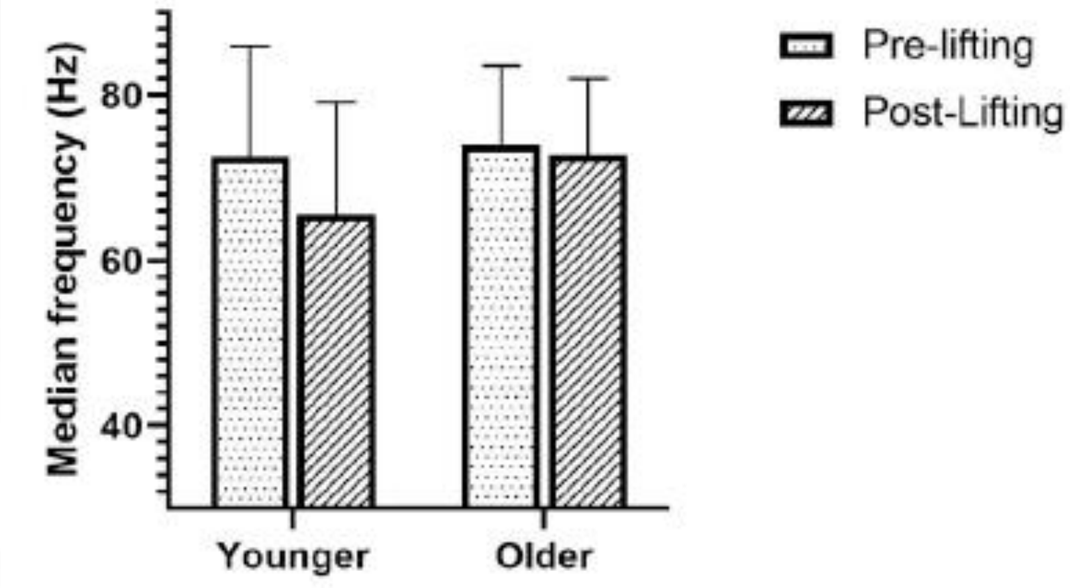
journal homepage: www.elsevier.com/locate/clinbiomech

Age-related differences do affect postural kinematics and joint kinetics during repetitive lifting

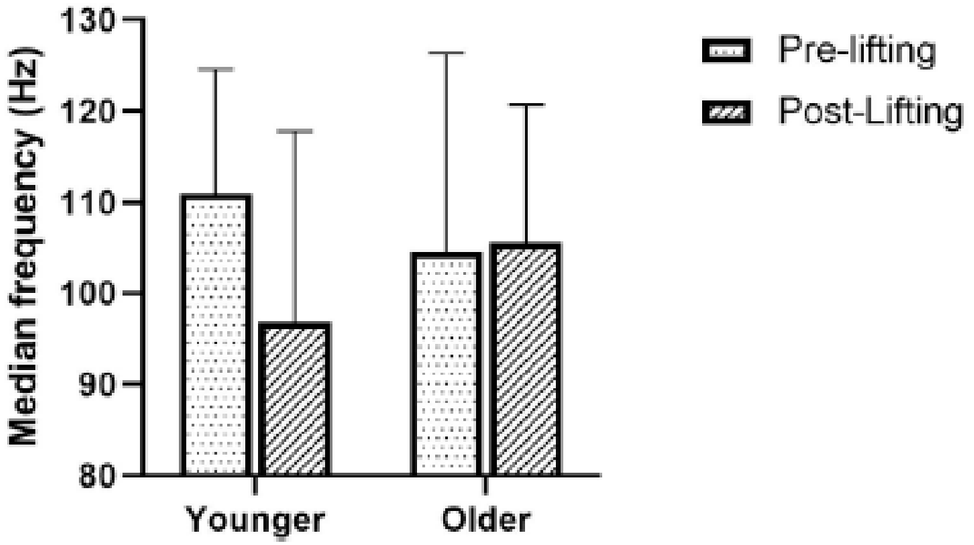
Mark G. Boocock *, Grant A. Mawston, Steve Taylor

Health and Rehabilitation Research Institute, Auckland University of Technology, New Zealand

MH: age and fatigue



Upper Erector Spinae



Lower Erector Spinae

Journal of Electromyography and Kinesiology 55 (2020) 102482

Contents lists available at ScienceDirect

Journal of Electromyography and Kinesiology

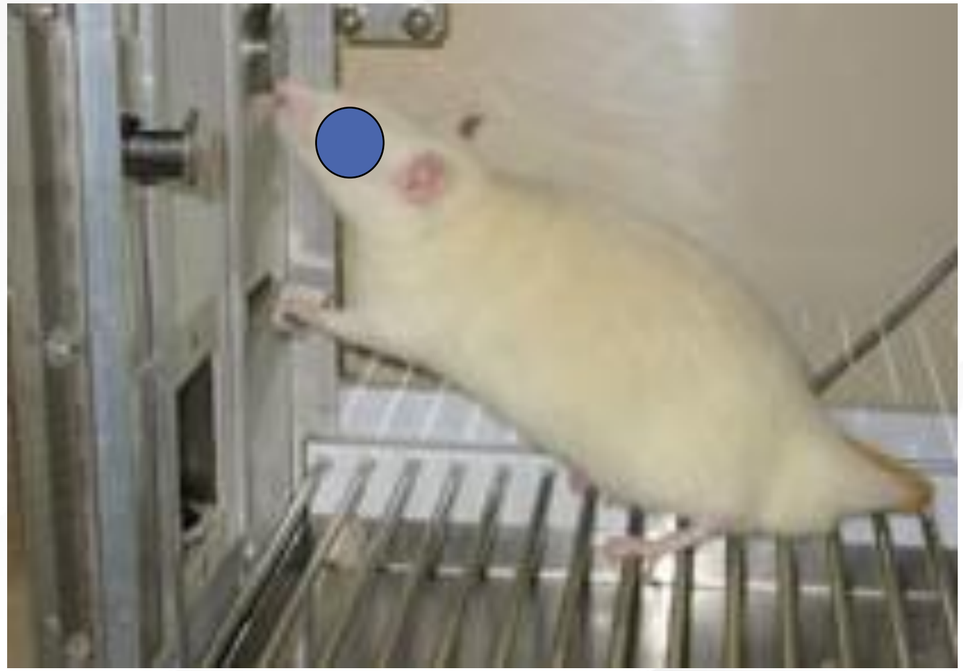
journal homepage: www.elsevier.com/locate/jelekin

The influence of age on spinal and lower limb muscle activity during repetitive lifting

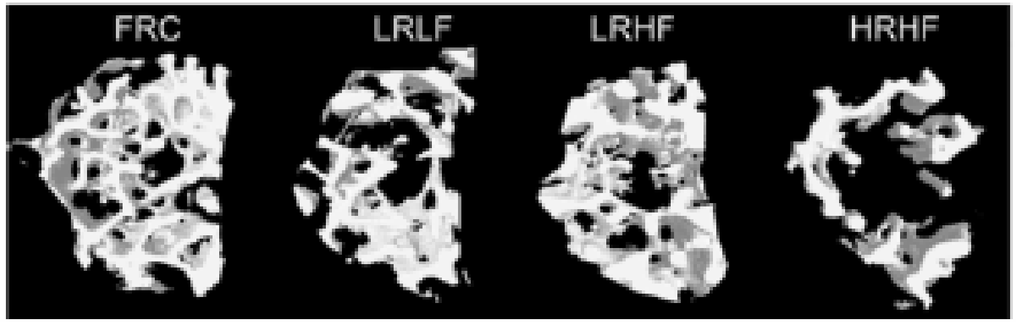
Mark G. Boocock *, Steve Taylor, Grant A. Mawston

Health and Rehabilitation Research Institute, Auckland University of Technology, New Zealand

MSD: repetition and force



Bone quality



Bone resorption after performance of 2hr/day, 3 days/week for 12 week task at:
Low Rep Low Force (LRLF)
Low Rep High Force (LRHF)
High Rep High Force (HRHF)

- Prolonged performance of HRHF tasks exhibited significantly increased risk for MSD, while performance of moderate level tasks exhibited adaptation to task demands

Barbe et al. 2013

MH: What should we be advocating and how might we affect change?

MH: training and education

- Training - proper consideration of the physical realities of the:
  - workplace
  - load placement with respect to height, depth, obstacles
  - load characteristics

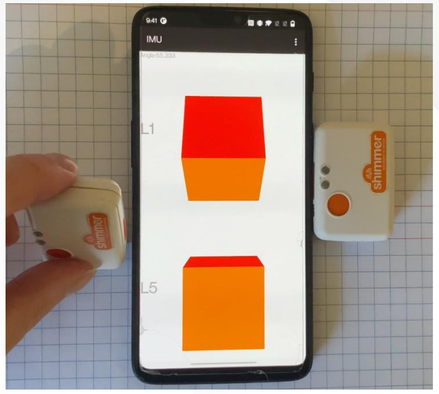
- Training - task realism
  - meaningful
  - challenging
  - familiar
  - interesting

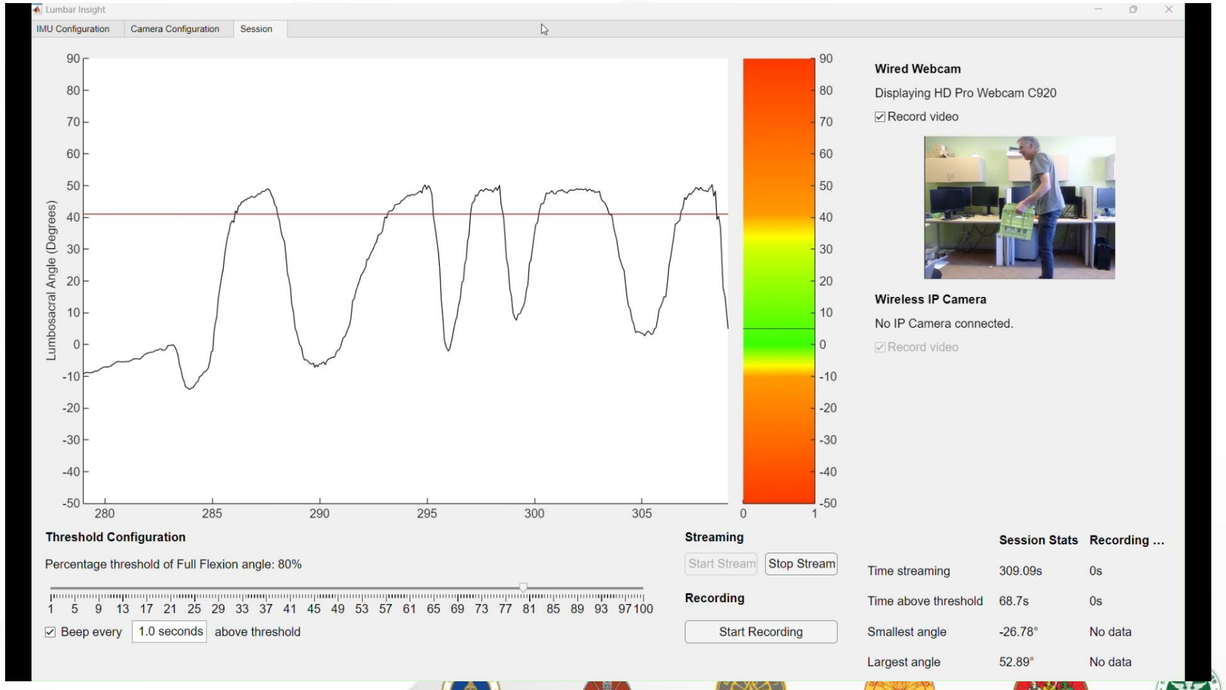
Denis et al. (2020)

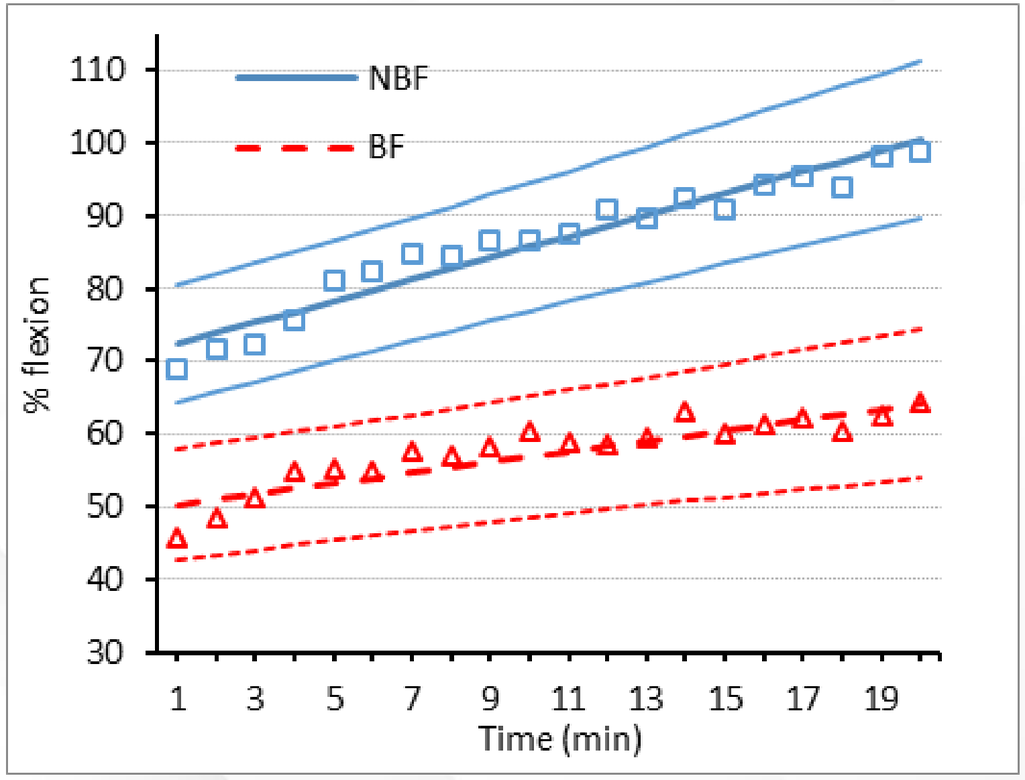
- Training – learning from experts may encourage workers to identify new ways of handling

- System thinking approach - the working context (work organisation)

MH: biofeedback intervention

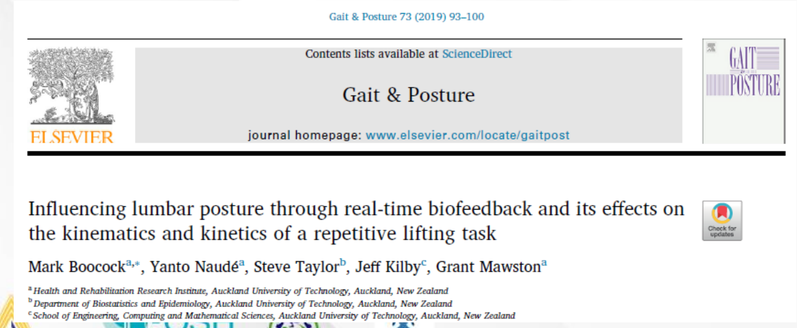






MH: biofeedback intervention

- Lumbar posture biofeedback enabled participants to control lumbar posture and they were not reliant on feedback
  - offers a potential adjunct to educate handlers when lifting
- Biofeedback had no adverse effects on lower limb joint moments
  - may provide a useful approach for young, inexperienced workers
- A strategy adopted by participants involved increased knee and hip angular velocities
  - lower limb power training may be beneficial as part of a lifting programme


Gait & Posture 73 (2019) 93–100

Contents lists available at ScienceDirect

Gait & Posture

journal homepage: www.elsevier.com/locate/gaitpost

Influencing lumbar posture through real-time biofeedback and its effects on the kinematics and kinetics of a repetitive lifting task

Mark Boocock[a,*], Yanto Naude[a], Steve Taylor[b], Jeff Kilby[c], Grant Mawston[a]

[a] Health and Rehabilitation Research Institute, Auckland University of Technology, Auckland, New Zealand
[b] Department of Biostatistics and Epidemiology, Auckland University of Technology, Auckland, New Zealand
[c] School of Engineering, Computing and Mathematical Sciences, Auckland University of Technology, Auckland, New Zealand

MH: wearable technology

Systematic reviews: the effectiveness of augmented feedback from wearable motion capture systems to reduce postural exposure

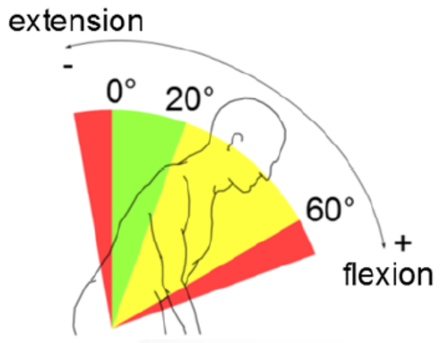
- May improve posture, although not pain

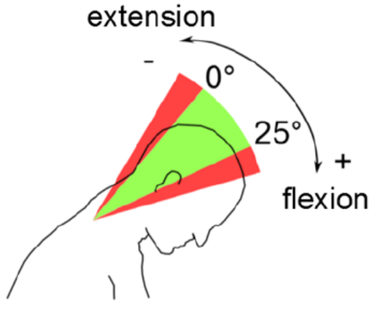
Lee et al. (2021)

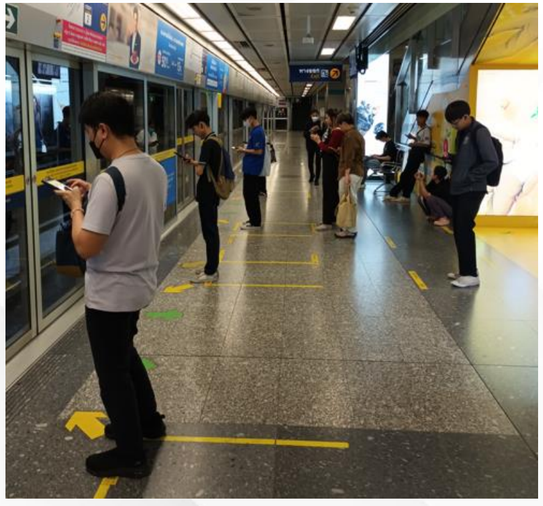
- In controlled environments, strong evidence to no evidence, depending on the time elapsed after feedback administration.
- In real work environments, very limited evidence to no evidence

Lind (2024)

Exposure limits: dose-response

Parameter	Direction of movement	Guideline values for evaluation [°]	
Inclination of the trunk  	**+**: forwards (flexion) **–**: backwards (extension)	**green:** **yellow:** **red:** **red:**	**0 to 20** **20 to 60** **> 60** **< 0** **with reference to ISO 11226 [4] and EN 1005-4 [5]** (without consideration of the secondary conditions stated in the standard)

Bending of the neck	Direction of movement	Guideline values for evaluation [°]	
 	**+**: forwards (flexion) **–**: backwards (extension)	**green:** **red:** **red:**	**0 to 25** **> 25** **< 0** **with reference to ISO 11226 [4]** (without consideration of the secondary conditions stated in the standard)

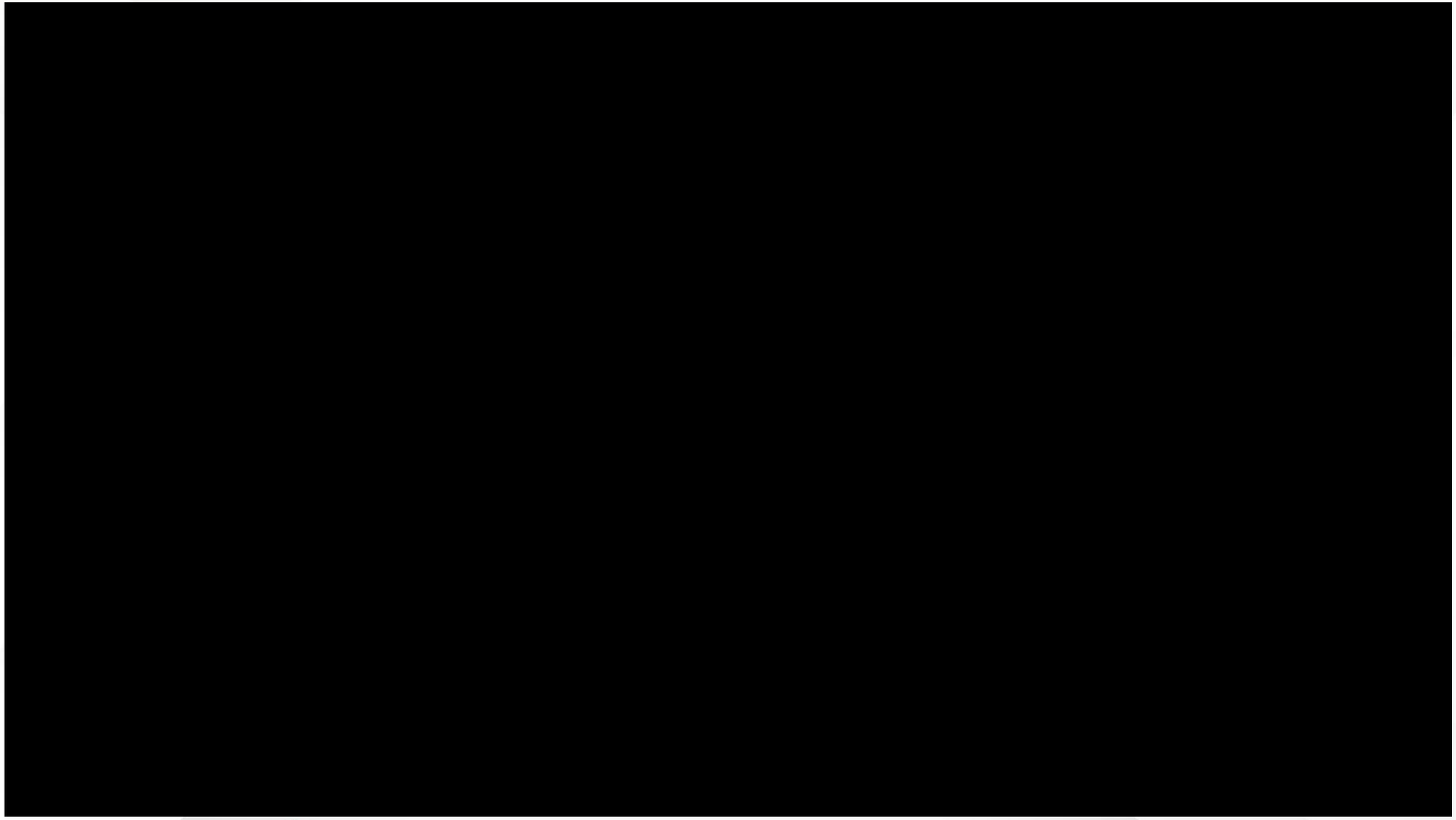


MSD: future opportunities

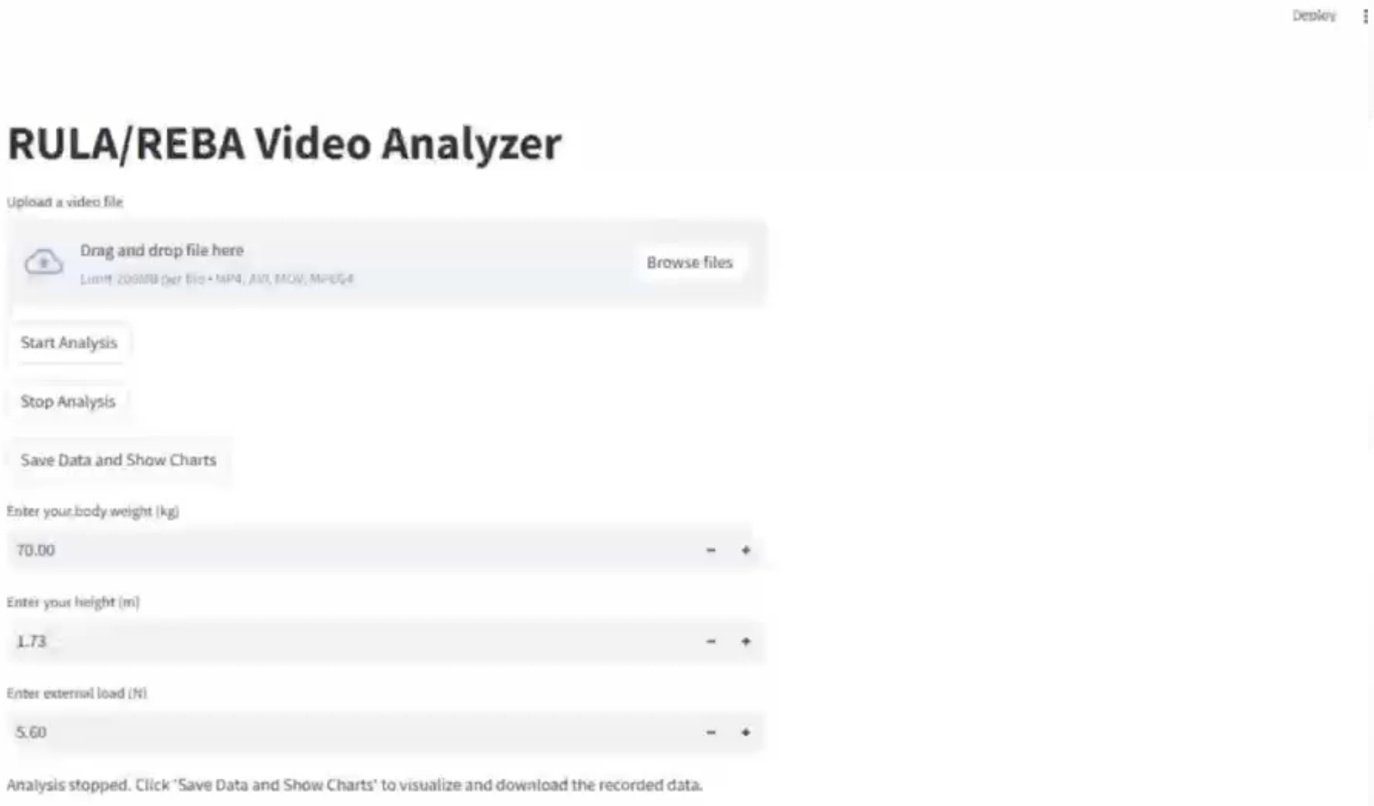
Real-time risk assessment

Inertia Measurement Units (IMU)
Movella XSens

Markerless tracking



Markerless tracking



Upload video/WebCam

Summary

- The extent of MSD worldwide remains a major concern and it appears little has changed over the past 30 years in tackling these conditions
- A shift in thinking (systems- based approach) may be necessary to address the multifactorial nature of the condition and its range of contributory risk factors
- Training and education should not be considered a lost cause, we may need to reconsider how we go about training and education, its content and delivery
- There is a need for more research to better understanding injury mechanisms and dose-response relationship
- New technology provides some potential new and exciting opportunities

Thank you

ขอบคุณ

Tēnā koutou

APOSHO38, Thailand
https://aposho2024.com/