



Wearable Ergonomics – Measured Management of Worker Performance and Injury Prevention

Agenda

- Introduction
 - Who is Briotix?
 - Who am I?
- Ergonomic Problems
 - Basic Movement
 - Injuries
 - Waste
- Exoskeleton Field Trials
- Exoskeleton Considerations
- Wearable Sensor Considerations



Who is Briotix Inc.?

GLOBAL LEADERS IN ERGONOMICS, INJURY PREVENTION, RETURN TO WORK AND ONSITE REHABILITATION

Experience the Briotix Difference...



AT THE SCALE & PRICE YOU NEED

We work with Fortune 500 companies all the way down to a single office.



NO JOB IS TOO HARD

From offshore oil rigs, to world wide office locations and highly sensitive clean rooms – no job is too hard.



NEXT GENERATION SMART

A technology enabled partner for your business, reaching your workforce with more effective tools.

Briotix Mission, Vision, Values



Transforming Organizations by Unlocking Human Potential.



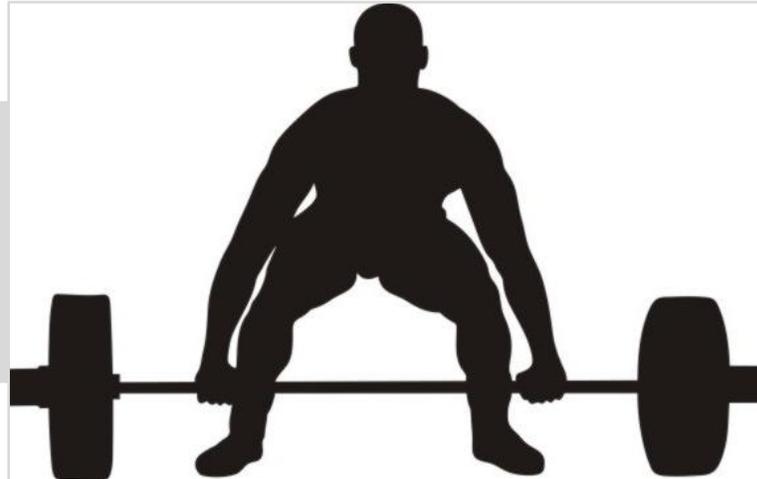
Delivering a competitive advantage through the application of science in the physical, cognitive, and organizational disciplines.



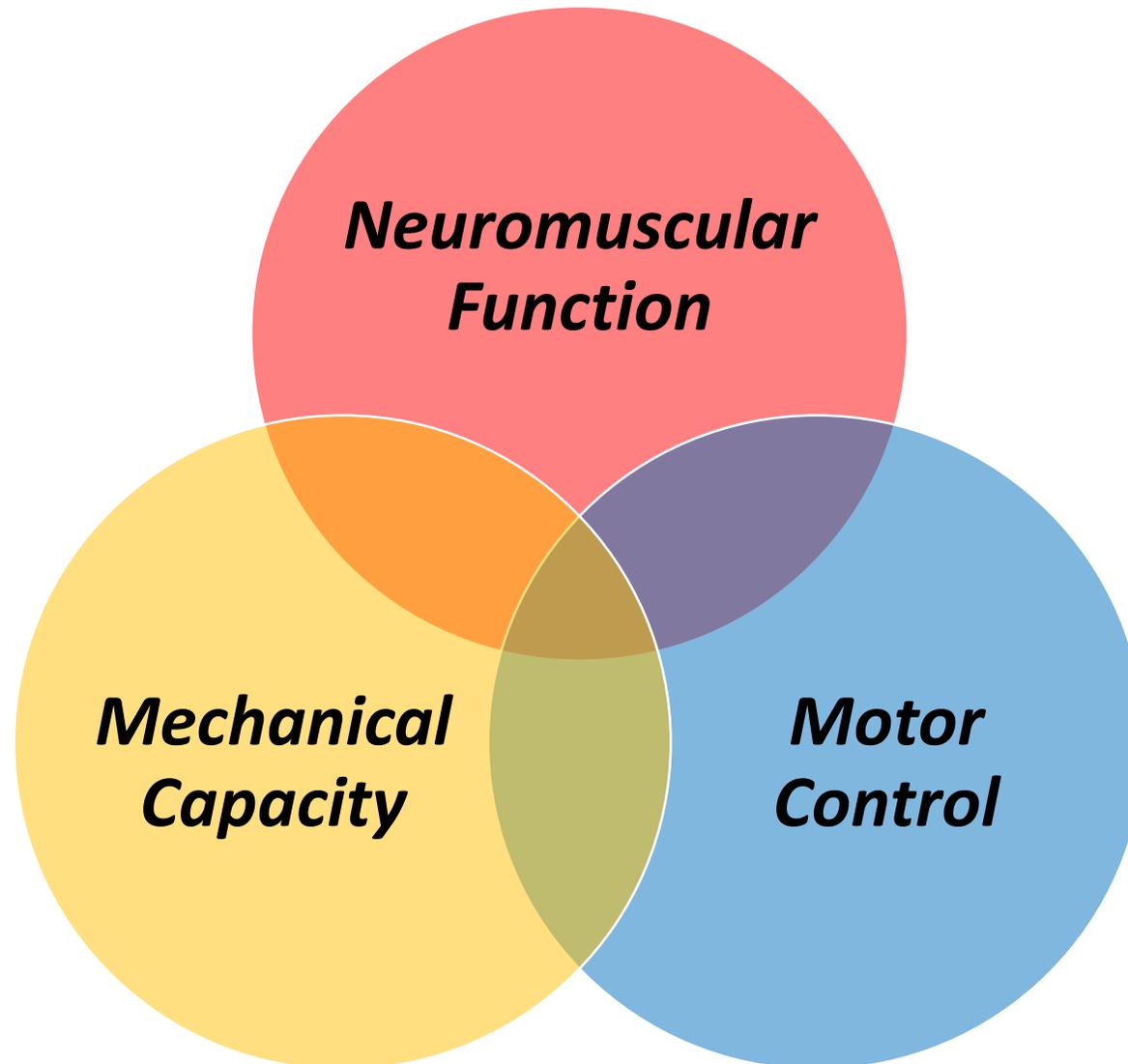
- Apply our passion and innovative spirit to what we do
- Deliver meaningful results with every client
- Work in a way that makes our mothers proud
- Care about people

Who am I?

Matthew Marino, PT, MSPT, CPE, CWcHP, CSCS, TSAC-F, CPT, SFMA, FMS



Interdependent Systems



Injury Risk Factors

Research Summary:

- Previous Injury (24)
- Asymmetries (8)
- Motor Control (7)
- BMI (5)

(# prospective studies)



Disparities In Movement Quality And Capacity



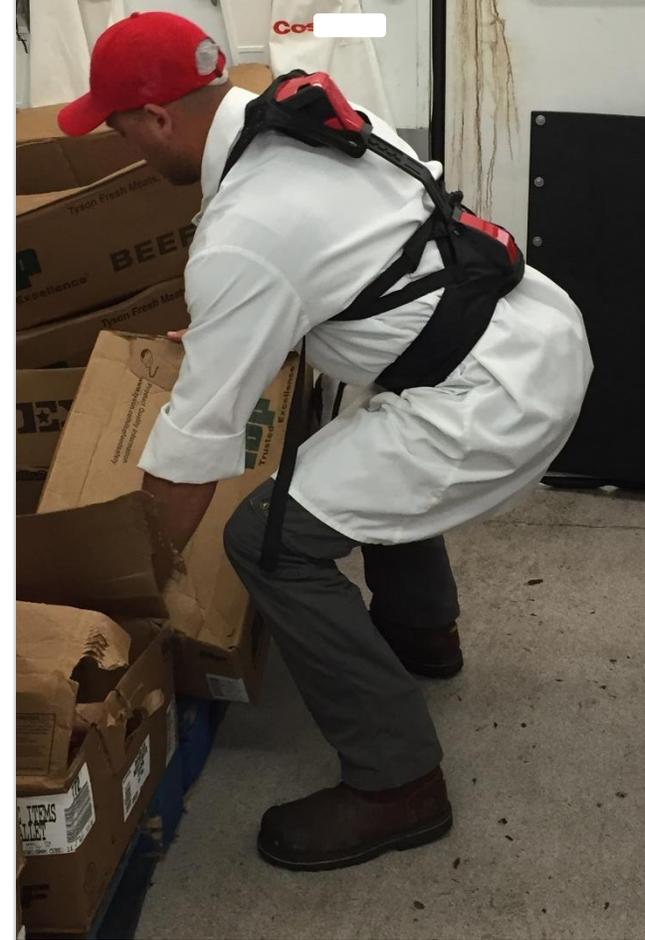
Functional Movement Screen (FMS) Results:

This employee failed 5 out of 7 movement tests

He has prior injuries

He has poor motor control

He has asymmetrical movement patterns



Functional Movement Screen (FMS) Results:

This employee failed 1 out of 7 movement tests

He has no prior injuries

He has good motor control

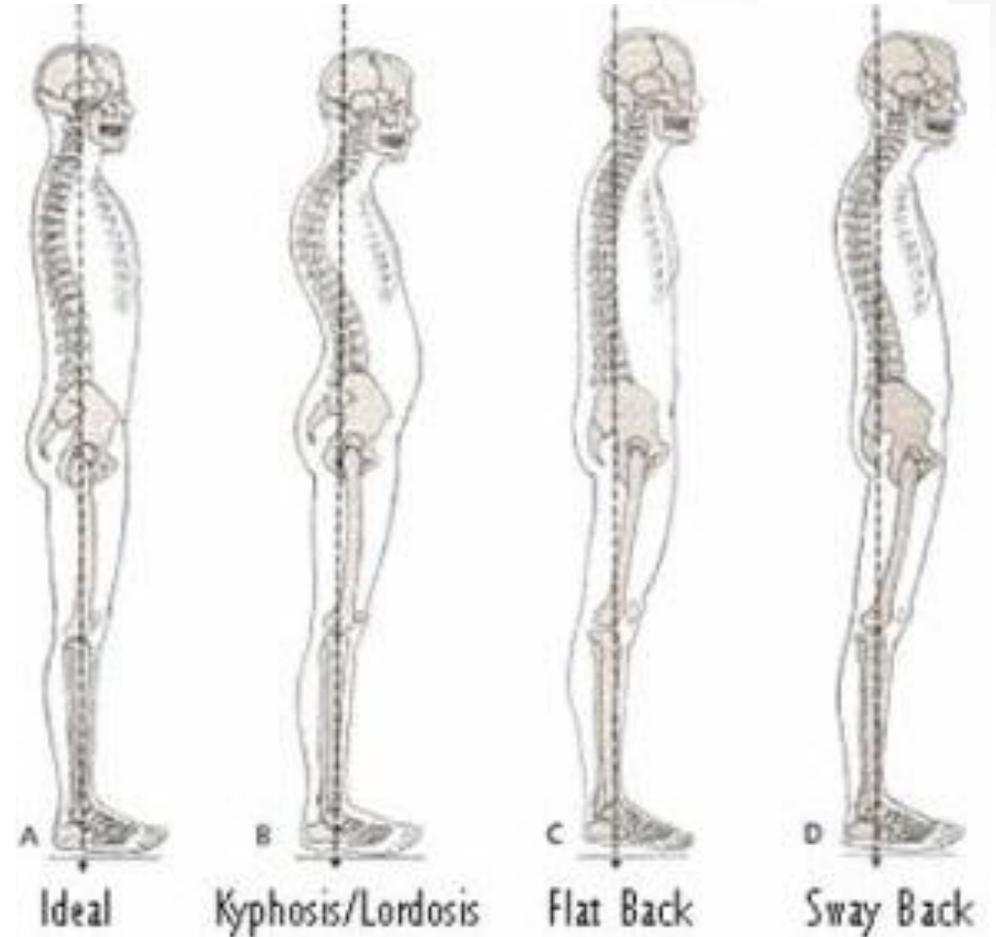
He has symmetrical movement patterns

Posture Matters

Research Summary:

- Researchers are attempting to identify the “best” standing or sitting posture (Dolphens, O’Sullivan, Claus, Collins)
- Correlation between various postures and neuromuscular function (Park, Sapsford, Jull, Chan, Tsao; Hodges; Claus, Ainscought Potts, Capson, Collins)
- Correlation between various postures and pain (Dolphens, Straker, Edmondston)

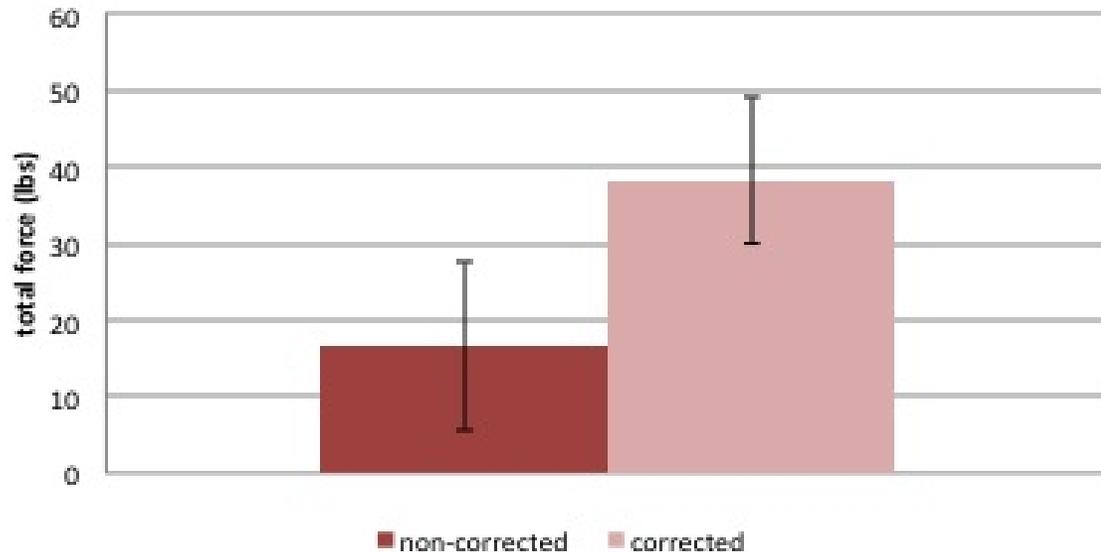
Kendall Postural Types



Posture Matters

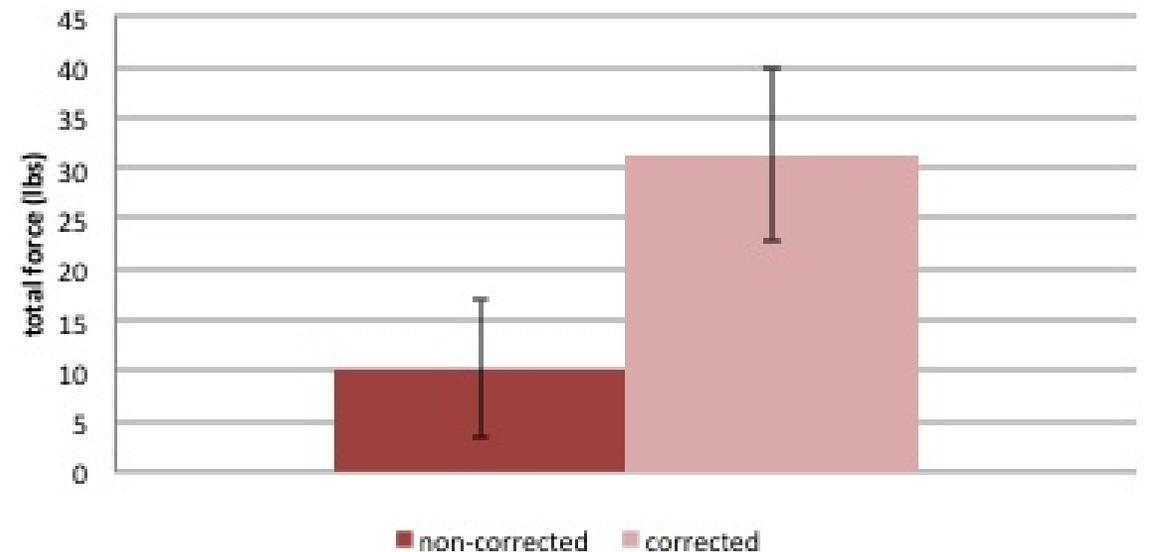
The Reliability and Validity of the Saliba
Postural Classification System
Collins, Johnson, Godwin, and Pappas
JMMT, July 2016

Vertical Compression Test (VCT): Shoulder Mean Vertical Force



Mean increase in force with correct posture 20 lbs

Elbow Flexion Test (EFT): Forearm Mean Vertical Force



Mean increase in force with correct posture 22 lbs

Work Related Injuries Are A Problem

Shoulder:
7.5 million
MD visits

Back:
21 million
MD visits

Knee:
12 million
MD visits

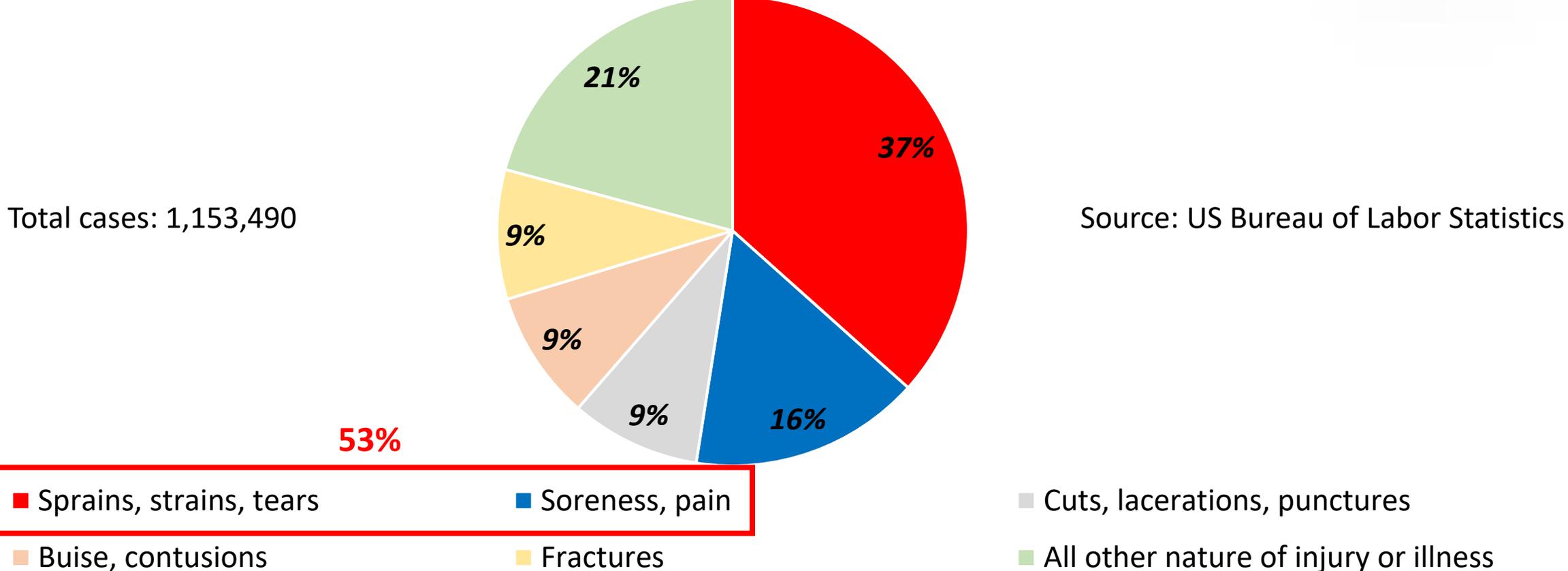
80% of people will have back pain in their lifetime

\$50 billion/year spent in USA on low back injuries

Back pain is the leading cause of disability worldwide, causing more lost workdays than everything except the common cold

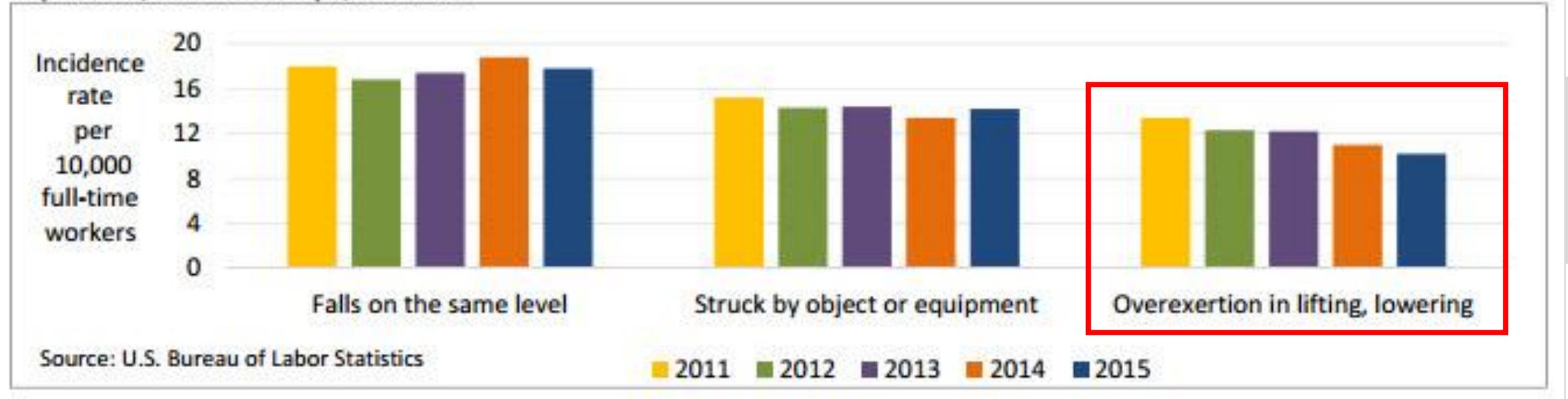
Nature Of Injuries Requiring Days Away From Work

% distribution for occupational injuries and illnesses with days away from work by selected nature of injury or illness, all ownerships, 2015



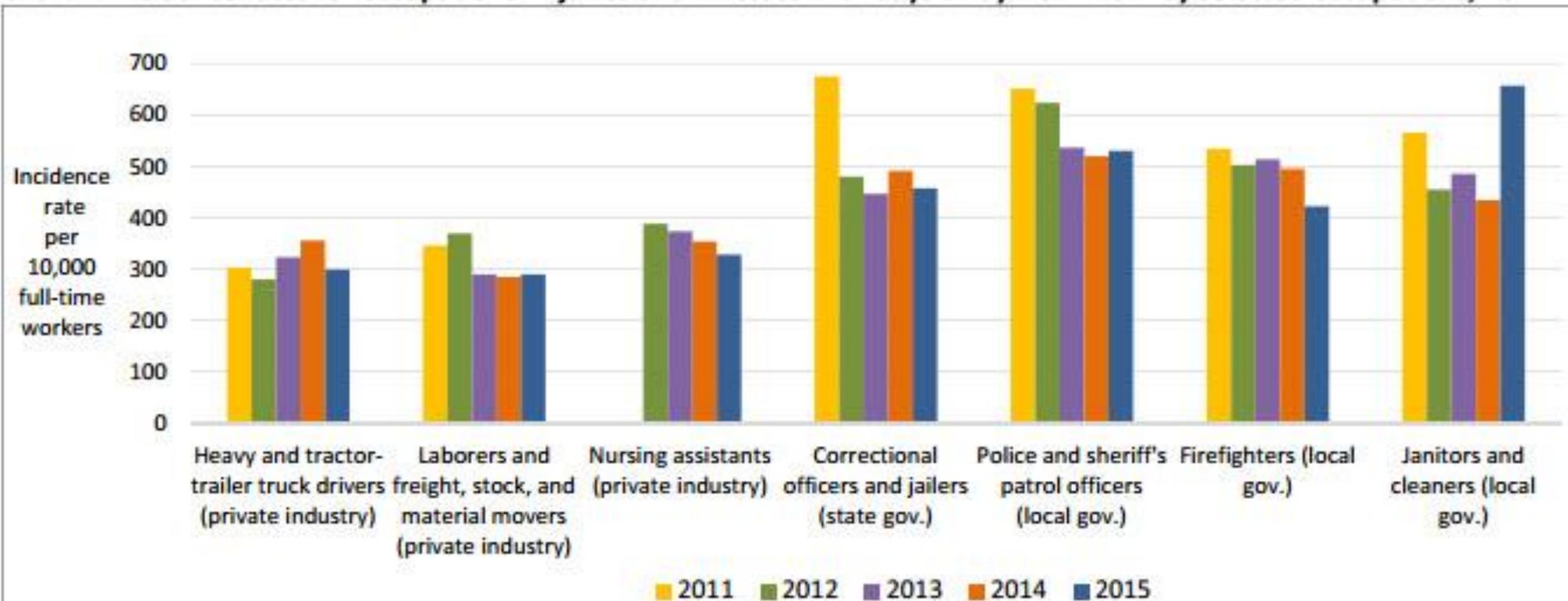
Causes Of Injuries Requiring Days Away From Work

Chart C. Incidence rates for occupational injuries and illnesses with days away from work by selected detailed events or exposures, all ownerships, 2011-15



Top Occupations With Injuries Requiring Days Away From Work

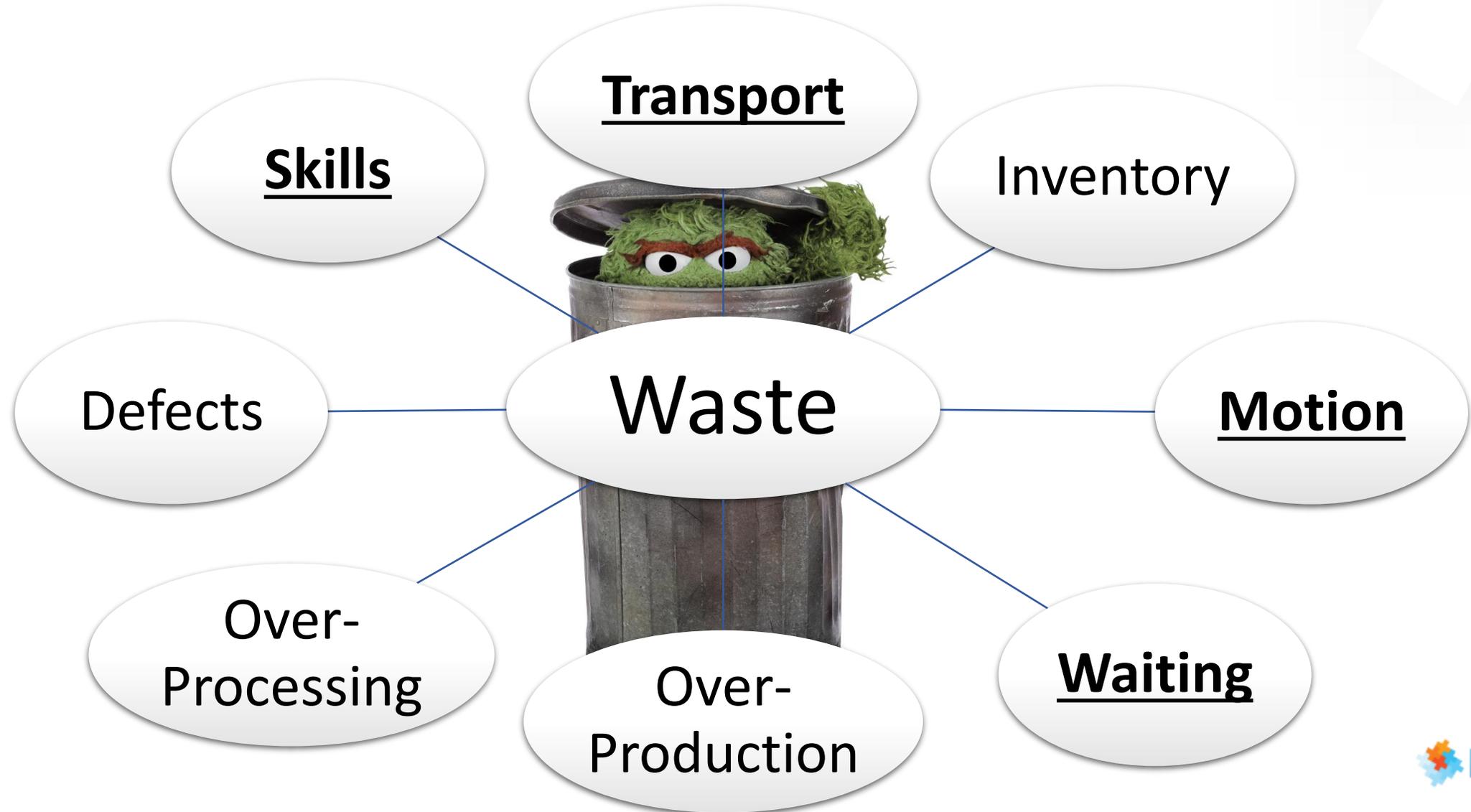
Chart A. Incidence rates for occupational injuries and illnesses with days away from work by selected occupations, 2011-15



Note: These occupations had at least 0.1 percent of employment and among the highest case counts in their respective ownership classes.

Source: U.S. Bureau of Labor Statistics

Work System Waste



Exoskeleton Applications

Industry

Defense/Military

Rehabilitation

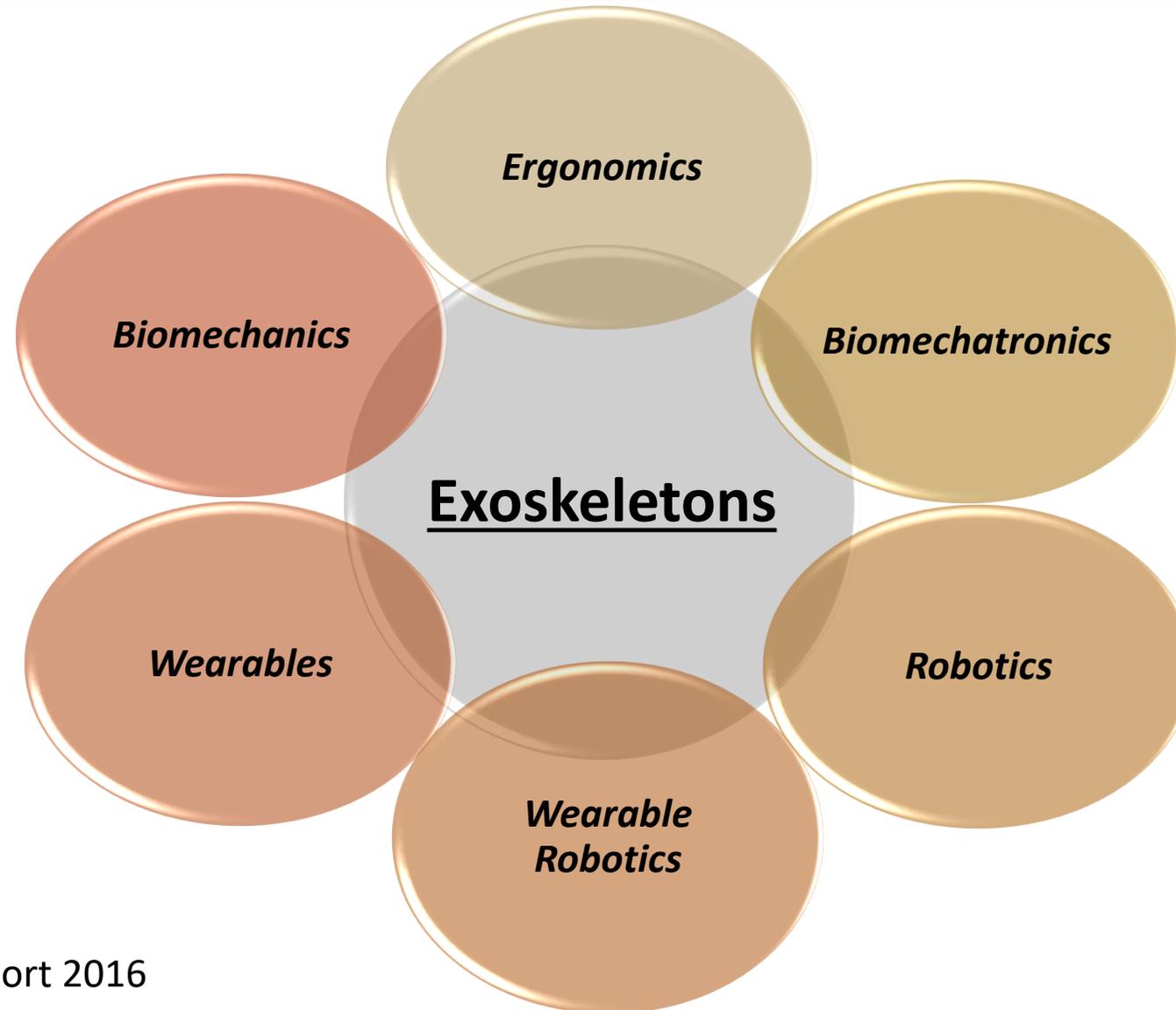
Mobility

Recreation/Sports

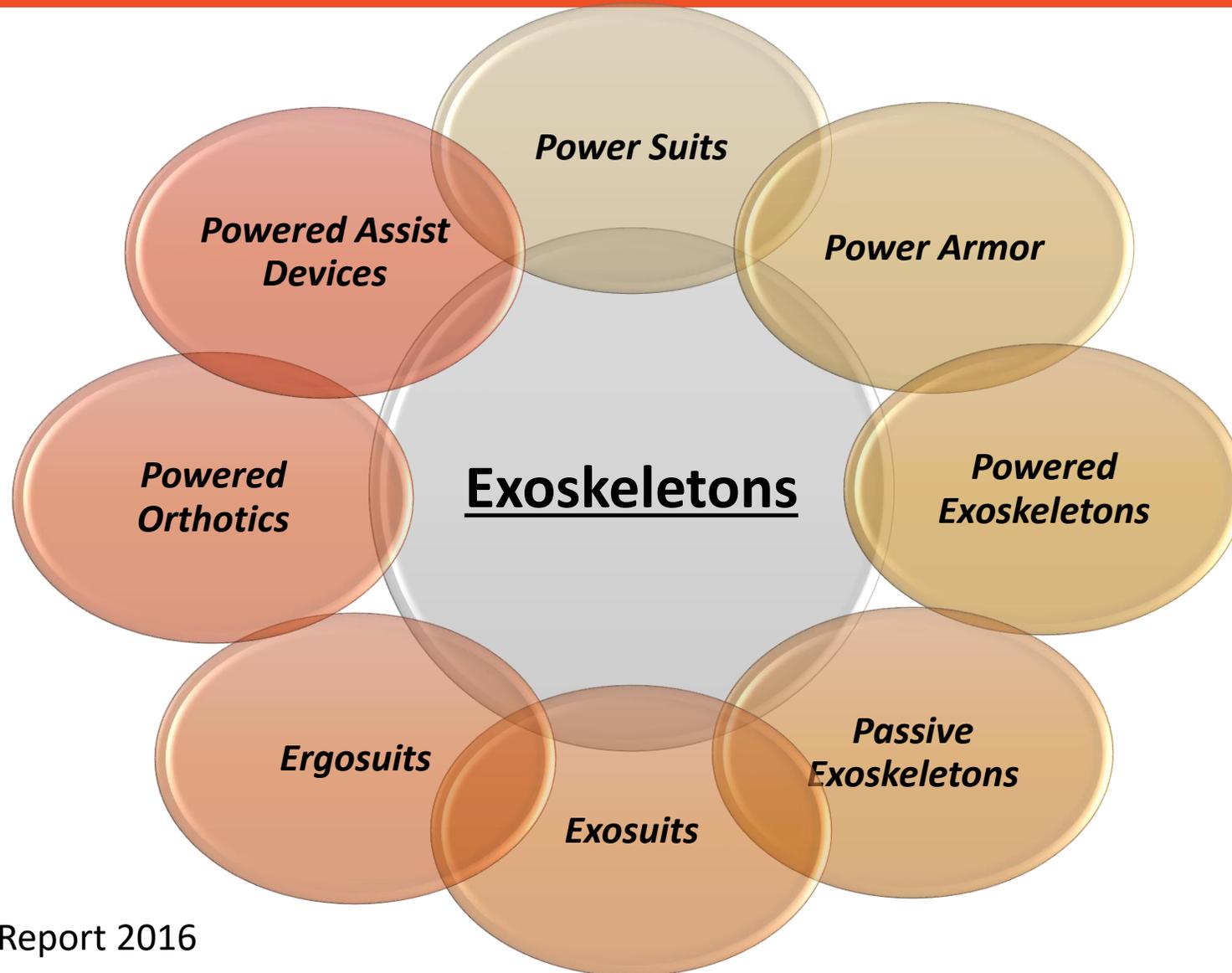
Prosthetics & Orthotics



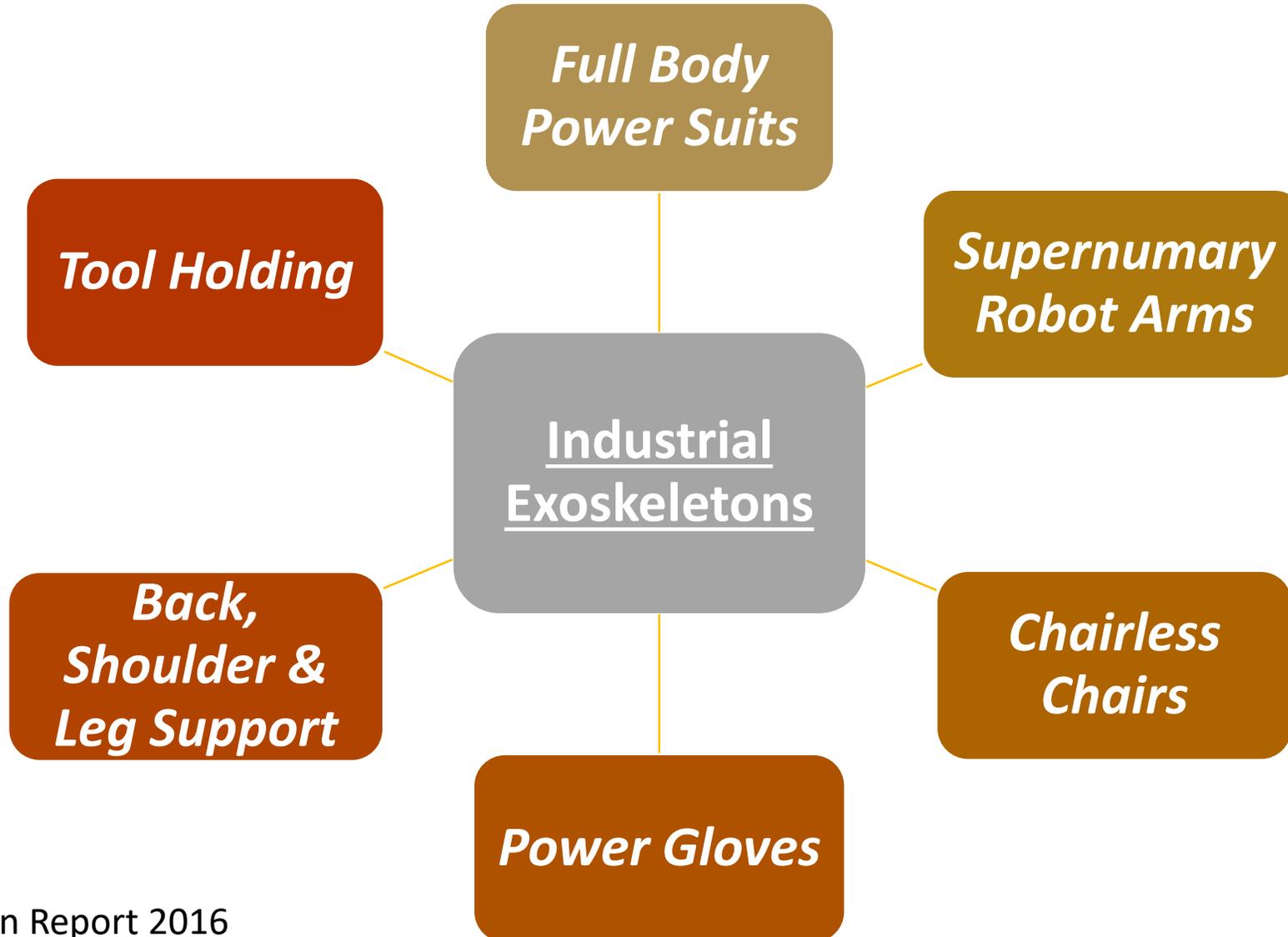
Overlapping Areas of Exoskeleton Expertise



Exoskeleton Categories



Industrial Exoskeleton Types



Industrial Exoskeleton Literature

Exoskeletons for industrial application and their potential effects on physical work load.

de Looze MP, et al. Ergonomics. 2016.

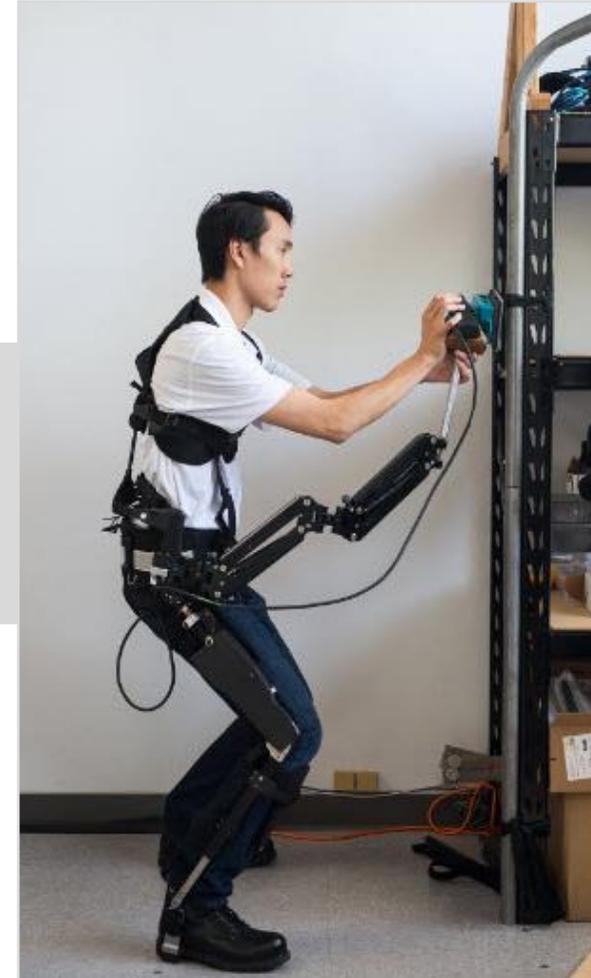
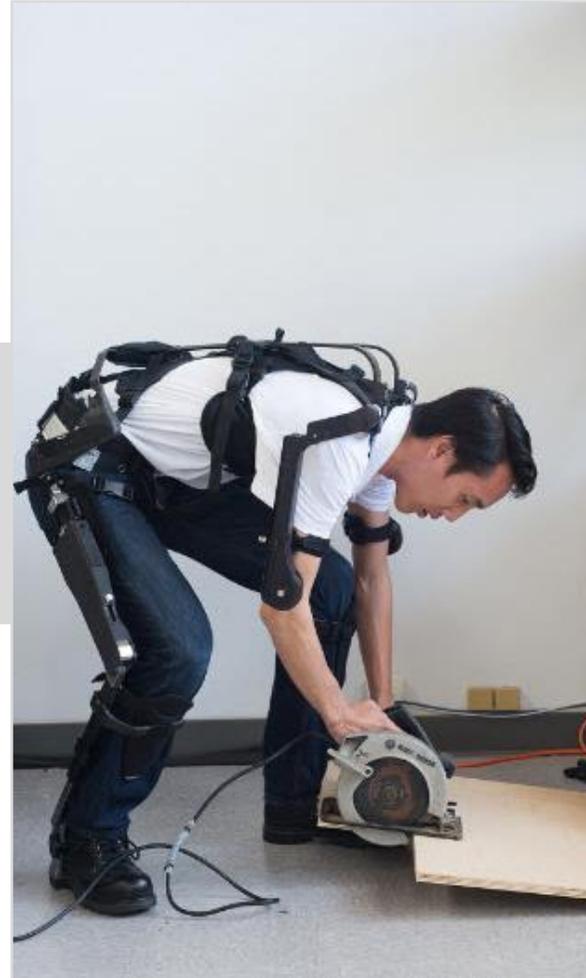
[Show full citation](#)

Abstract

The aim of this review was to provide an overview of assistive exoskeletons that have specifically been developed for industrial purposes and to assess the potential effect of these exoskeletons on reduction of physical loading on the body. The search resulted in 40 papers describing 26 different industrial exoskeletons, of which 19 were active (actuated) and 7 were passive (non-actuated). For 13 exoskeletons, the effect on physical loading has been evaluated, mainly in terms of muscle activity. All passive exoskeletons retrieved were aimed to support the low back. Ten-forty per cent reductions in back muscle activity during dynamic lifting and static holding have been reported. Both lower body, trunk and upper body regions could benefit from active exoskeletons. Muscle activity reductions up to 80% have been reported as an effect of active exoskeletons. Exoskeletons have the potential to considerably reduce the underlying factors associated with work-related musculoskeletal injury. Practitioner Summary: Worldwide, a significant interest in industrial exoskeletons does exist, but a lack of specific safety standards and several technical issues hinder mainstay practical use of exoskeletons in industry. Specific issues include discomfort (for passive and active exoskeletons), weight of device, alignment with human anatomy and kinematics, and detection of human intention to enable smooth movement (for active exoskeletons).



Field Trial #1: SuitX Modular Agile Exoskeleton (MAX)

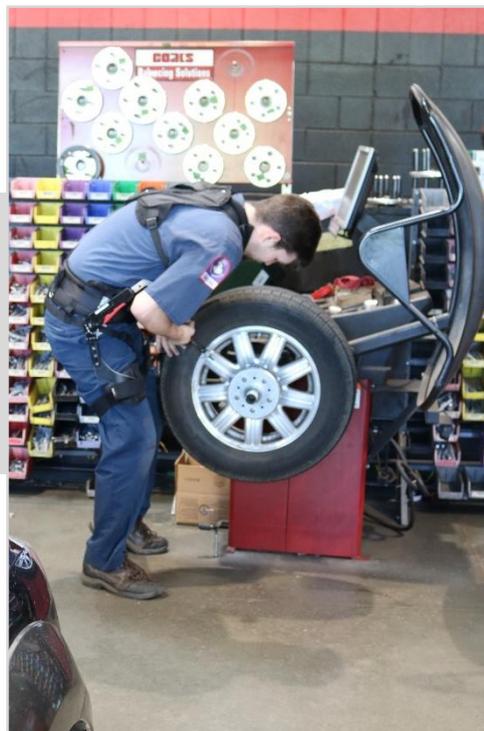


MAX components: BackX, LegX, ShoulderX, Balancing Tool Holder

SuitX MAX Trial – BackX In Meat Dept



SuitX MAX Trial – BackX In Tire Dept



SuitX MAX Trial – BackX In Deli Dept

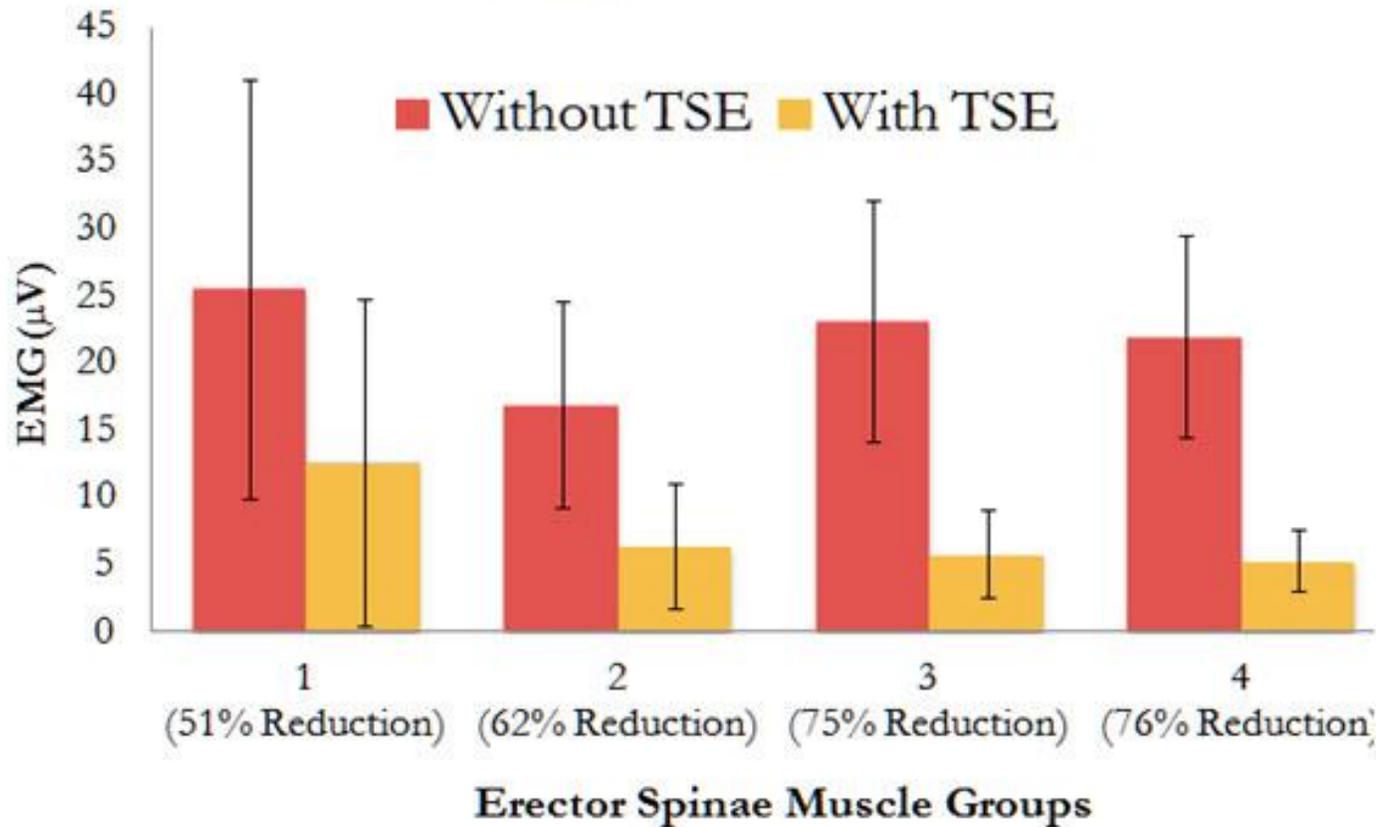


SuitX MAX Trial – BackX In Produce Dept



BackX EMG Data

Electromyography (EMG) Test Result



1. Left Lumbar Erector Spinae
2. Right Lumbar Erector Spinae
3. Left Thoracic Erector Spinae
4. Right Thoracic Erector Spinae

BackX Survey Data (n=5)

- 3/5 felt the exo would reduce work related fatigue
- 3/5 felt the exo would improve work performance
- 4/5 felt the exo would help them manage musculoskeletal health
- 4/5 would use the exo for at least part of their work day
- The exo can be worn over work clothing and under a jacket
- The fit of the exo is very important for comfort and successful outcomes



Field Trial #2: StrongArm Technologies FLx Ergoskeleton

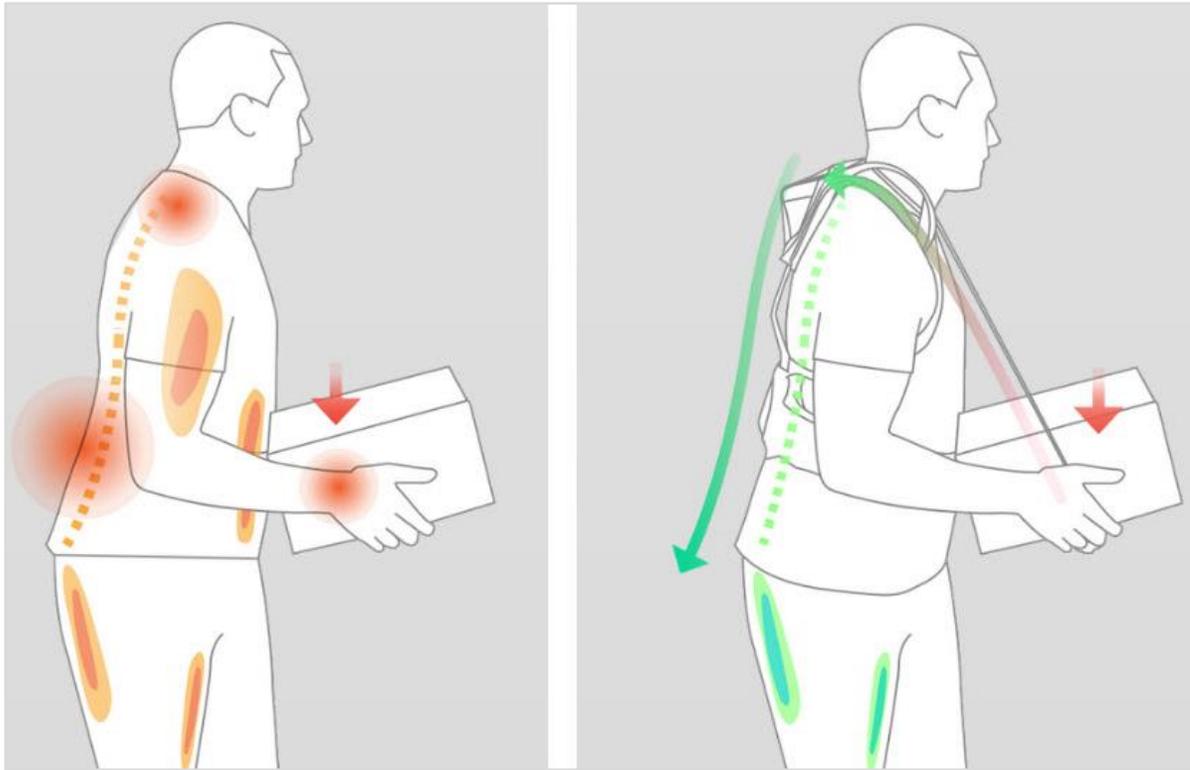


V22 Ergoskeleton

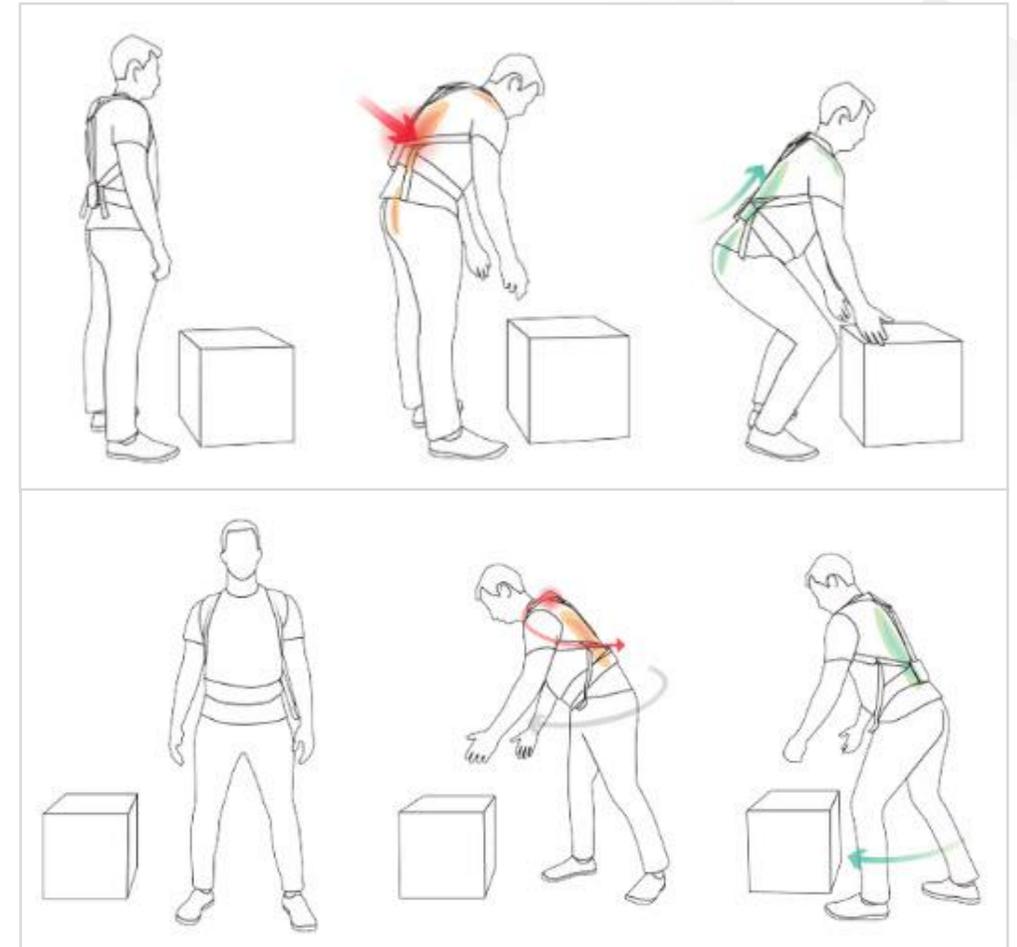


FLx Ergoskeleton

V22 & FLx Ergoskeleton Details



V22 Ergoskeleton is considered a Load Re-Distribution Lift Assist Device



FLx Ergoskeleton is considered a Postural Support Device 

StrongArm Trial – FLx Ergoskeleton In Meat Dept



Before



After

FLx Ergoskeleton Survey Data (n=3)

- The workers felt the exo provided them with a reminder to avoid bending and twisting via tactile cues from the device – “It talks to me”
- The workers felt the belt provided some low back bracing
- The exo can be worn over work clothing and under a jacket
- The fit of the exo is very important for successful outcomes



Considerations for Industrial Exoskeletons

Goal

Powered or Passive

Body Part & Joints Involved

Movement Limitation

Fatigue

Balance

Size & Weight

Clothing, PPE, Tool Belts

Adjustability, Comfort & Fit

Don/Doff Time & Complexity

Pitfalls



Considerations for All Wearable Technology

Wearability

Usability

Customization

Durability

Ergonomics

Overload

Satisfaction

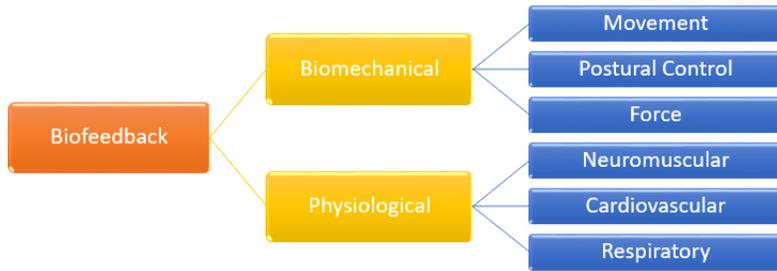
Pitfalls



Wearable Sensor Applications

Wearable Sensors in Physical Therapy

Biofeedback has been used in rehab for over 50 years



Giggins et al. Journal of NeuroEngineering and Rehabilitation 2013, 10:60



Wearable Sensors in Fitness

What can we do with data from a GPS watch and HR monitor?



Wearables Sensors in Ergonomics

With the exception of the LMM, wearable sensor use in ergonomics is relatively new and not widely accepted as a standard practice, yet...

However, sensors may be critical for testing exoskeletons...

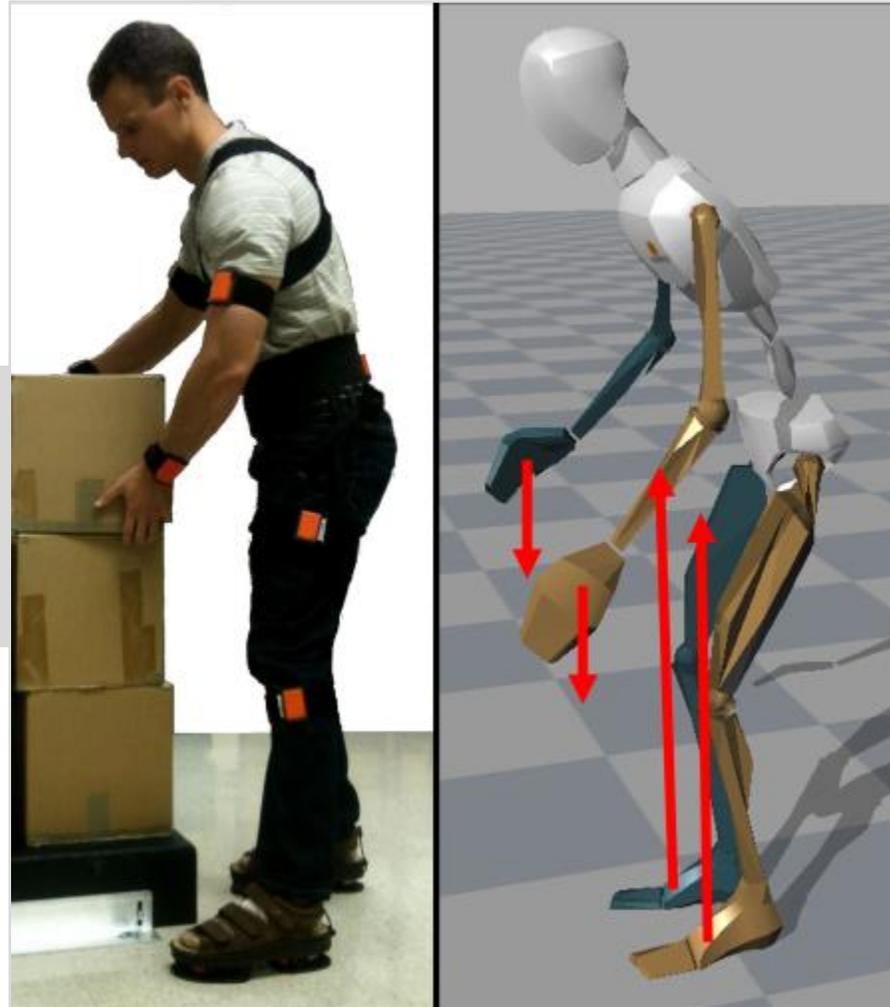


<https://spine.osu.edu/risk-exposure-quantification>

<https://www.strongarmtech.com/products#fuse>



The Future of Ergonomics?



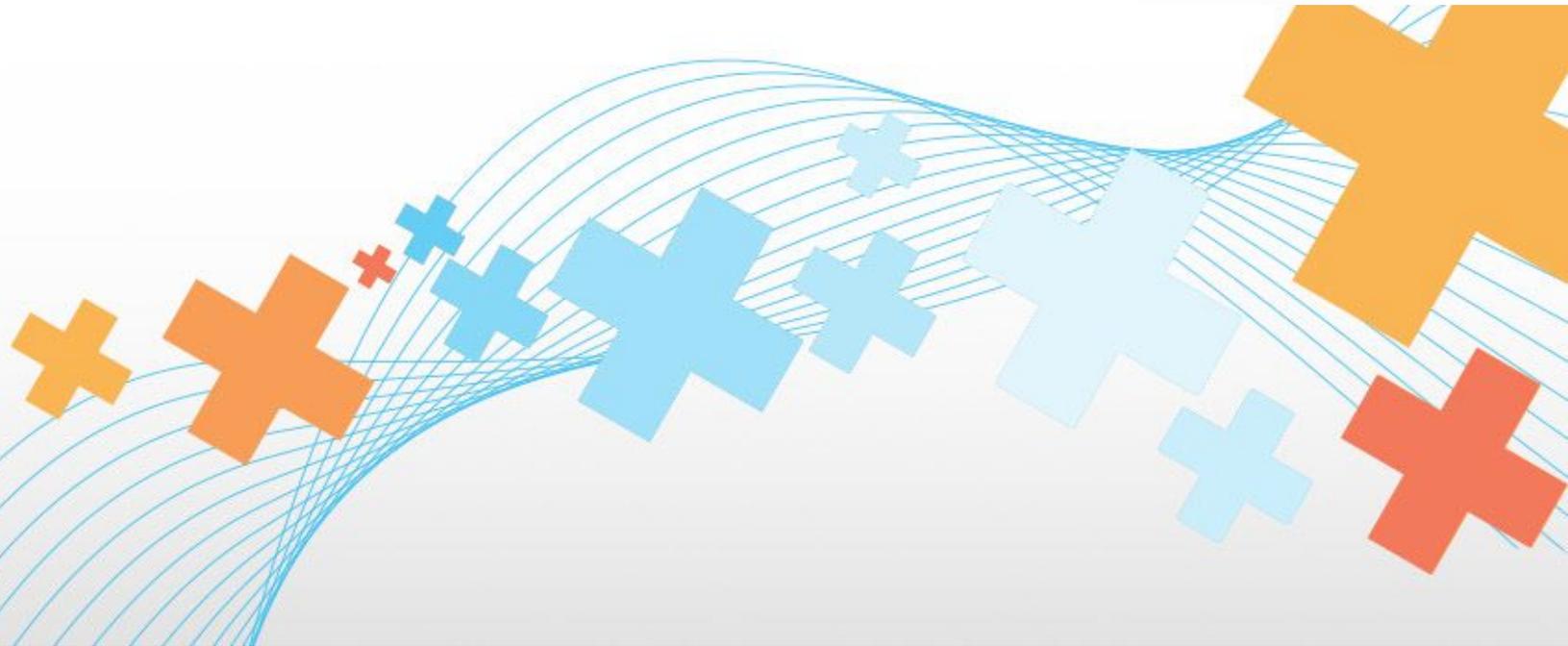
Faber et al. A novel wearable measurement system for ambulatory assessment of joint loading in the occupational setting

Let's Review

- Humans are not created equal
- Injuries are a huge problem
- Exoskeletons and wearable sensors are here
- Traditional ergonomic assessment methods are not sensitive to exoskeleton benefits
- Wearable sensor technology may be the best way to evaluate exoskeleton technology in the field
- Further research is needed



Thank You!



Matthew Marino, PT, MSPT, CPE, CWcHP, CSCS, TSAC-F, CPT, SFMA, FMS

Lead Ergonomist with Briotix Inc.

matthew.marino@Briotix.com

503-863-6062

