Welcome

APPLIED ERGONOMICS: TECHNOLOGY TO ASSESS RISK FACTORS IN THE WRIST AND HAND

Webinar will begin at 10:30am

Presented by:
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APPLIED ERGONOMICS: TECHNOLOGY TO ASSESS RISK FACTORS IN THE WRIST AND HAND

Webinar General Info
PowerPoint Presentation
Q&A

Questions
Chat is open to submit questions.
We will be answering questions through this chat feature. If due to the technical nature of the question a more thorough response is required, we will post the answer on our website within seven days of the webinar.

GOAL

- The goal of this presentation is to introduce you to technology that can either help assess risk factors of the hand and wrist during workplace tasks or assist in reducing risk factors.

Image taken from: https://www.hoffmannworkcomp.com/work-related-hand-and-wrist-injuries/

Hogan Scientific ErgoPAK

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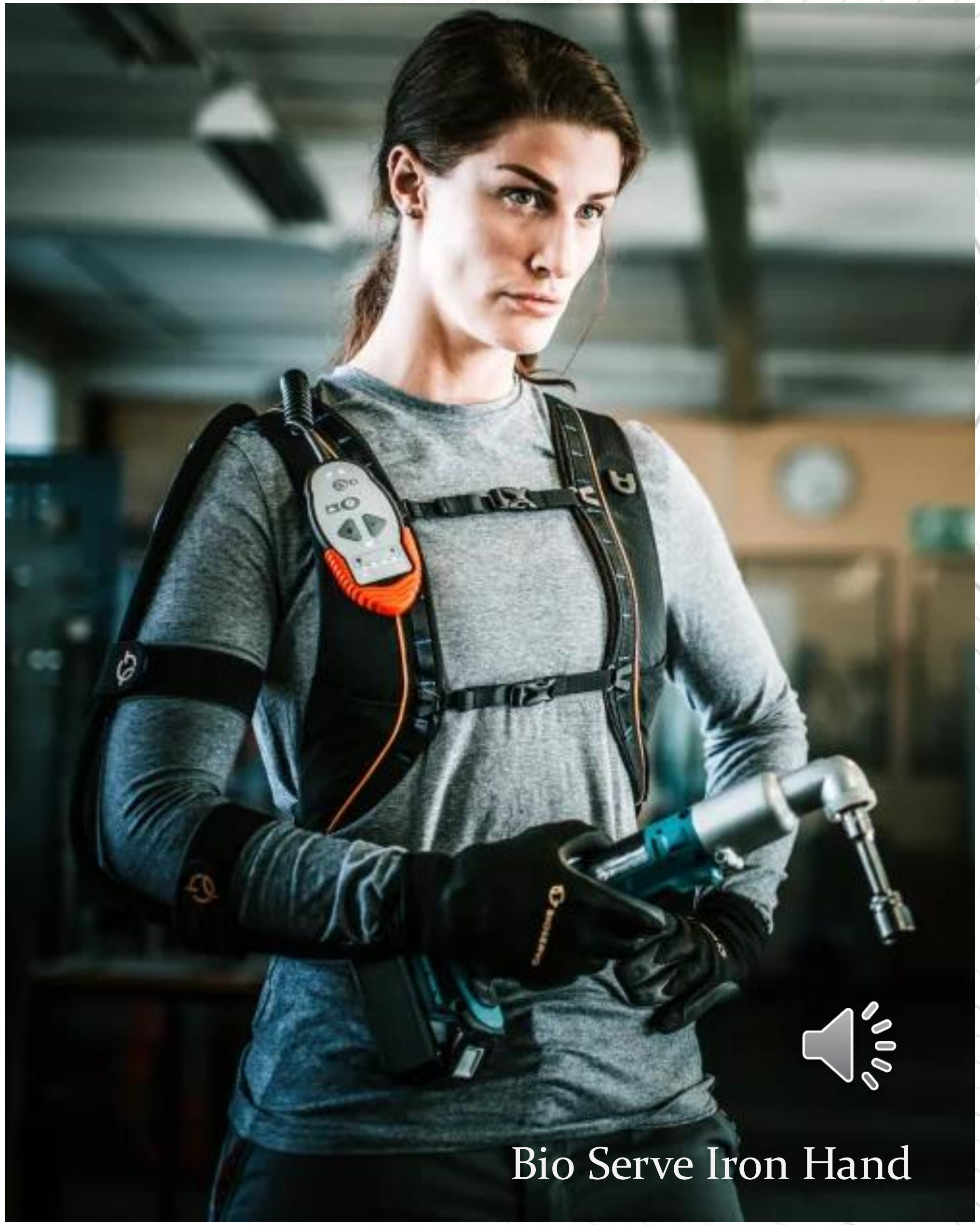
Bio Serve Iron Hand

OBJECTIVES

1

Describe ergonomic risks associated with the hand and wrist and a traditional assessment method

2

Identify two ways to assess wrist and hand risk factors using technology

- Force Sensing Equipment
- Motion Capture

3

Discuss potential uses for haptic feedback and a soft-shell robotic hand

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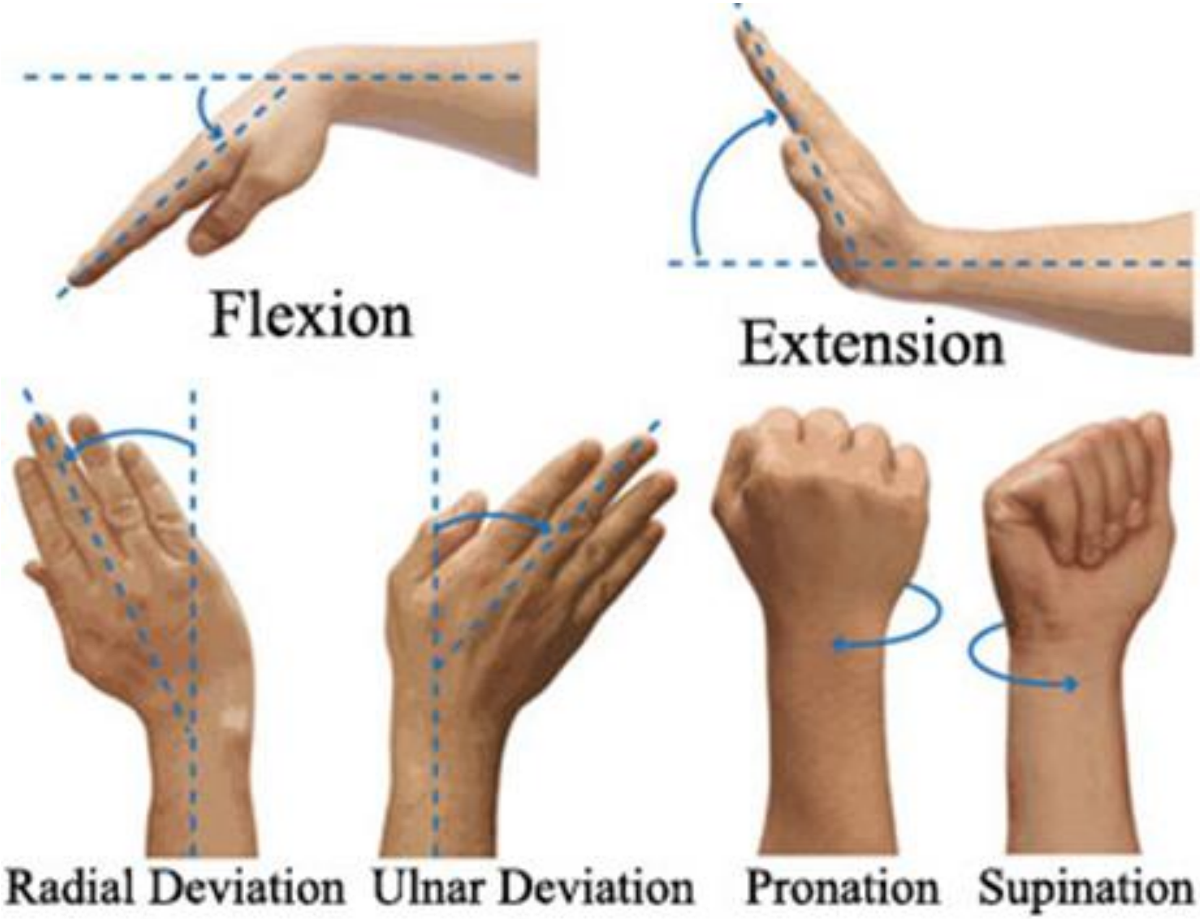
Why focus on the hand and wrist?

Postures – Anatomy - Statistics - TLVs

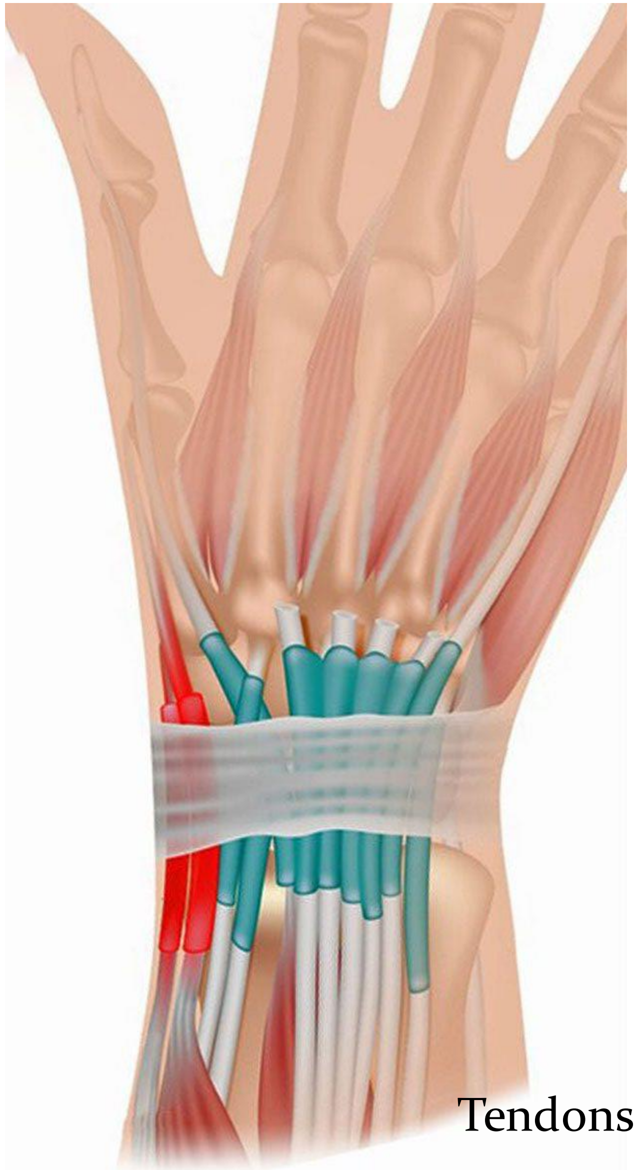
Hand and Wrist Postures



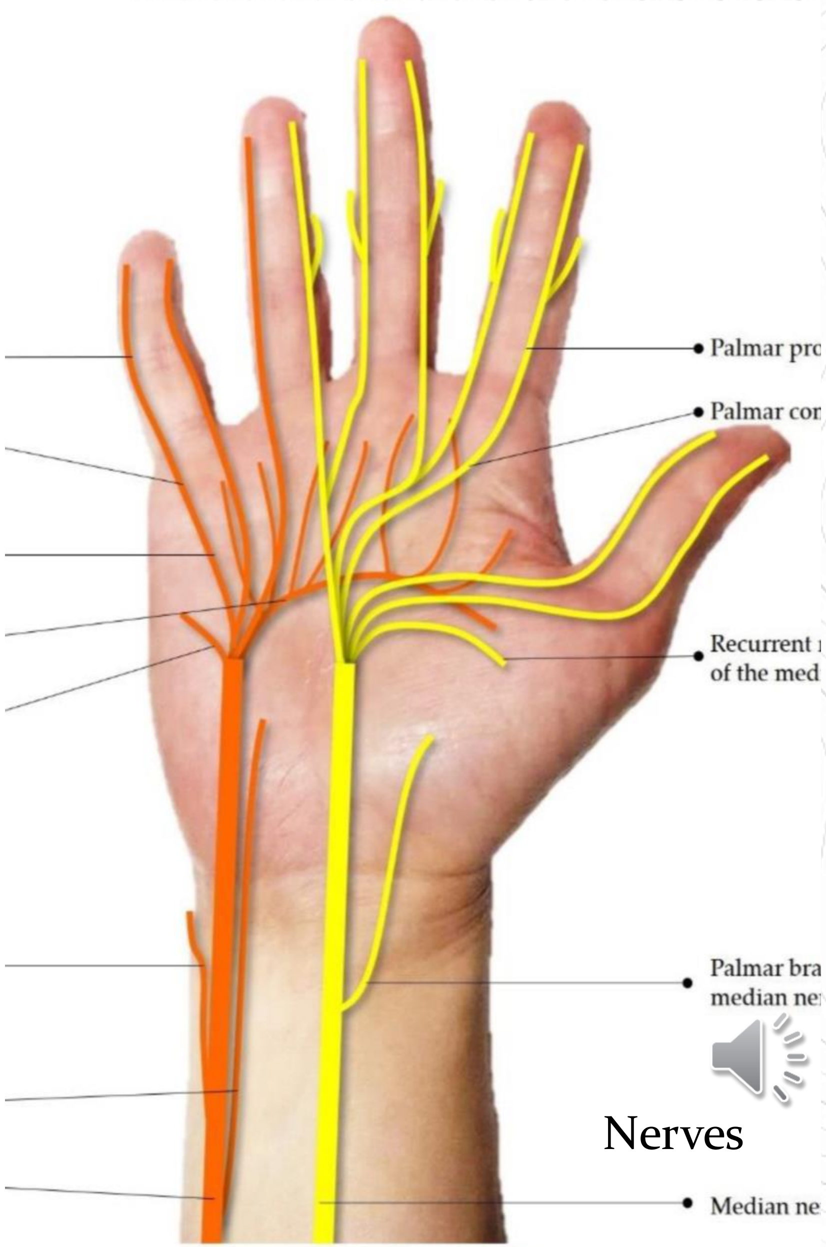
Primary Risk Factors:
Posture
Repetition
Force
Duration of Exertion

Anatomy of the Wrist

Carpal Bones

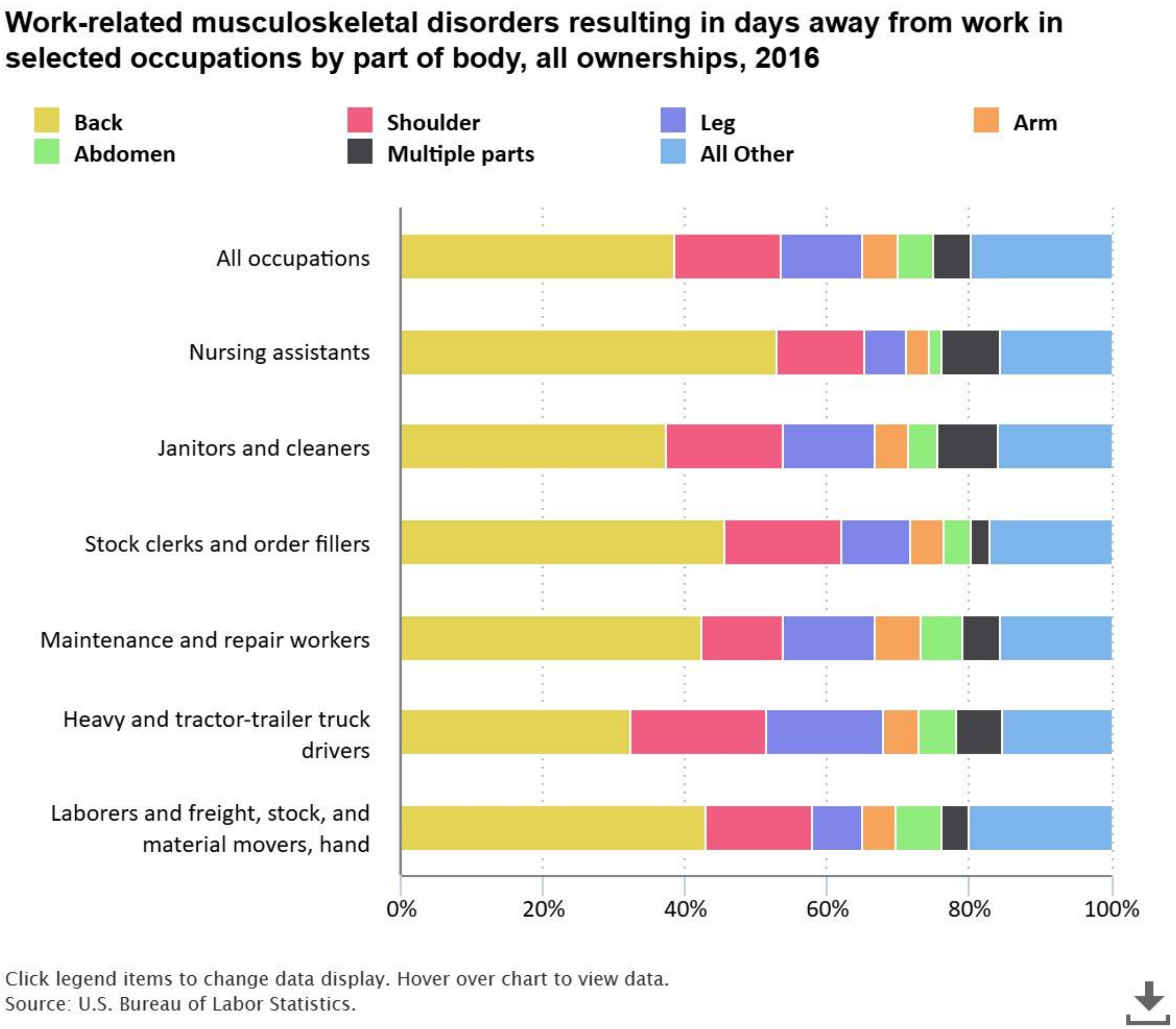


Tendons



Nerves

Musculoskeletal Disorder STATISTICS



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ACGIH TLVs

- ACGIH recognized the need for an assessment tool to help determine exposure levels for hand activity.
- “The ACGIH Hand Activity Level (HAL) Threshold Limit Value (TLV) is a risk assessment tool designed to protect workers, who perform repetitive hand exertions for 4 or more hours per day, from distal upper extremity disorders.” (p.75)

FORCE SENSING EQUIPMENT

MANUFACTURED AND CALIBRATED IN USA


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Recent Studies using Force Sensing Equipment

- Zreiqat, M., Marin, L. S., Minnick, W., Vaughan, A., & Shultz, C. (2023). Comparison of grip force at the hand-handle interface during the use of housekeeping spray bottles. *International Journal of Human Factors and Ergonomics*, *10*(3), 265-282.

- Kerner, S., Krugh, M., & Mears, L. (2022). Wearable shear and normal force sensing glove development for real-time feedback on assembly line processes. *Journal of Manufacturing Systems*, *64*, 668-675.

- Rogers, M. (2011). Identifying and Evaluating Risk Factors for Musculoskeletal Disorders in Equine Veterinary Work.

Schultz, C., Vaughan, A., Zreiqat, M., Marin, L., & Minnick, W. (2018). Ergonomics evaluation of the use of cleaning spray bottles for hotel housekeepers. ASSP Safety 2018 Professional Development Conference and Exposition, San Antonio, TX, June 19-22, 2018. *Grand prize winner poster.*

Figure 2:
Anterior Sensor View

Figure 3:
Posterior Sensor View

Figure 4:
Spray Bottle Types

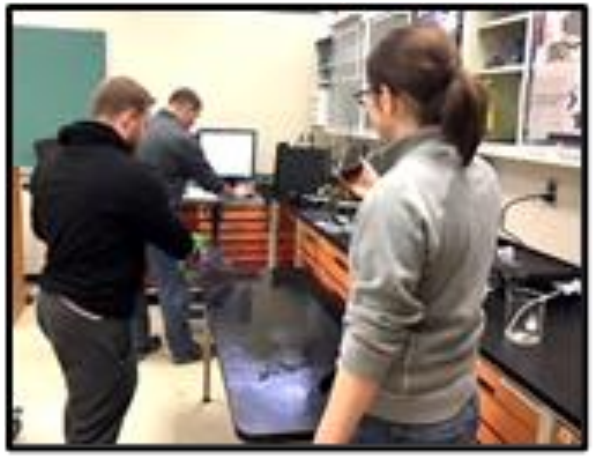
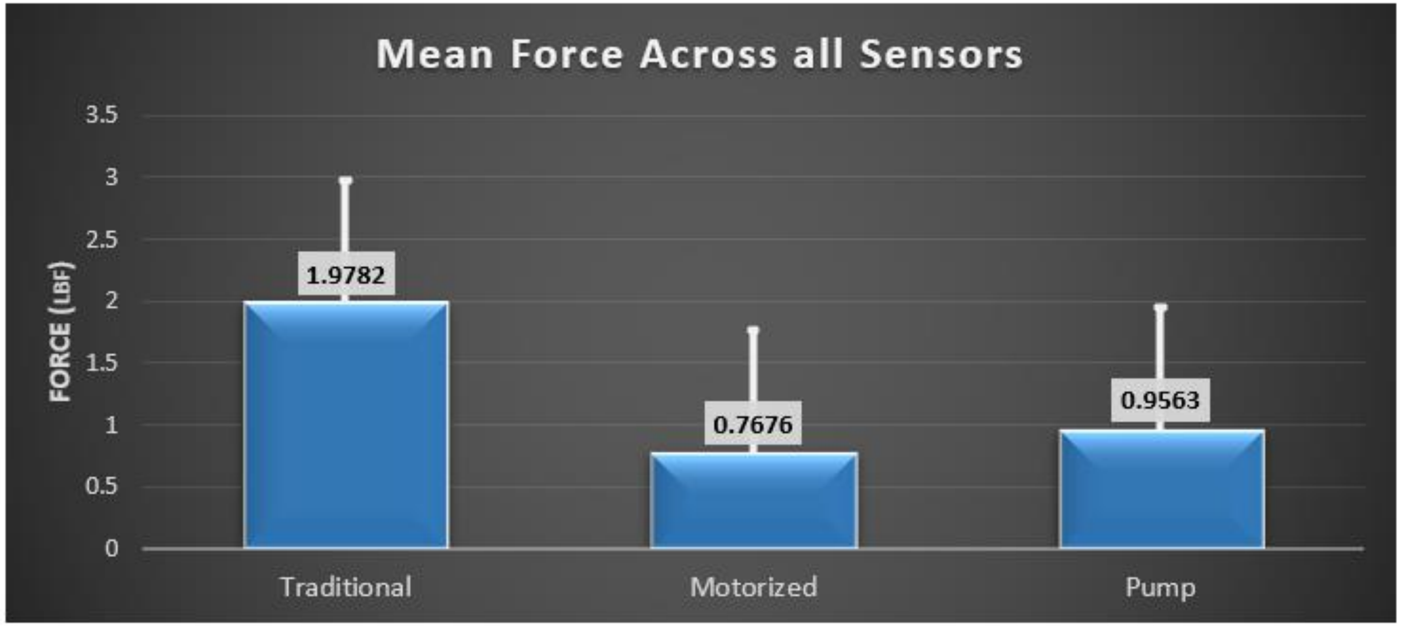
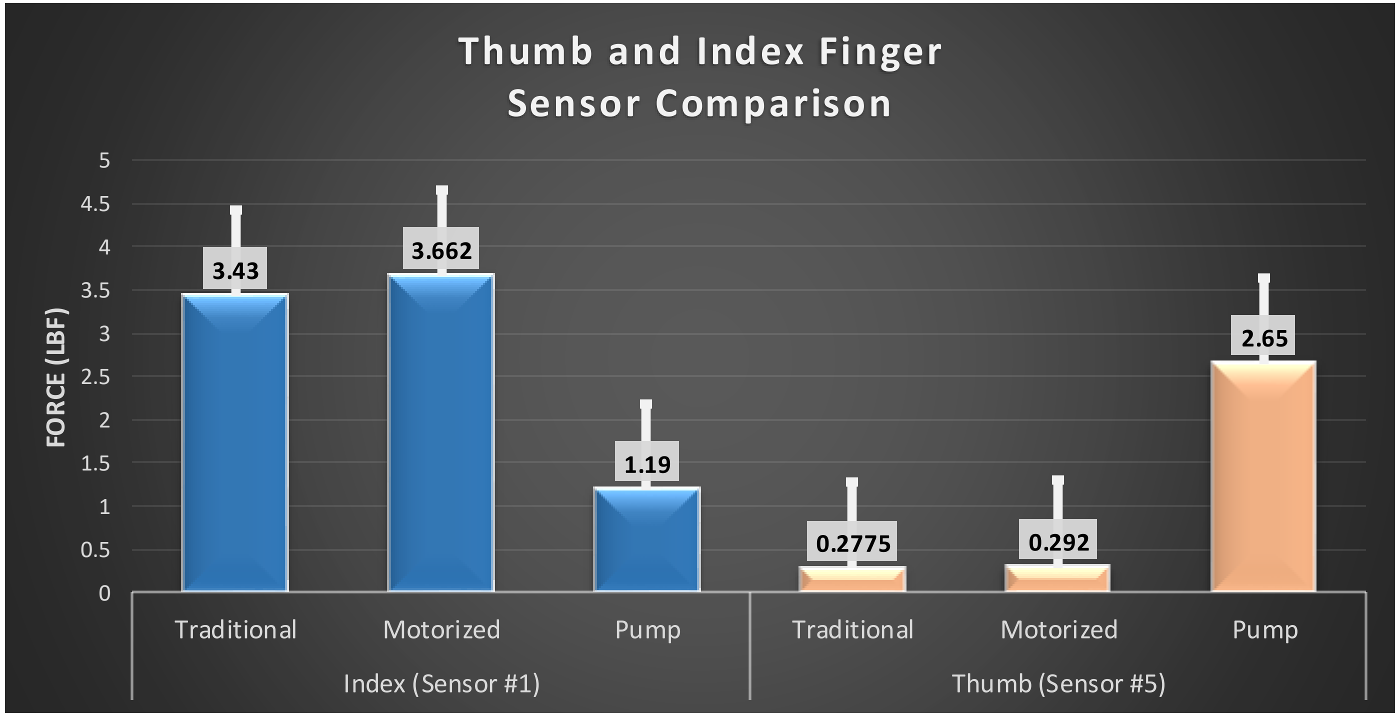


Figure 5:
Data Collection

Figure 6:
Cleaner Application



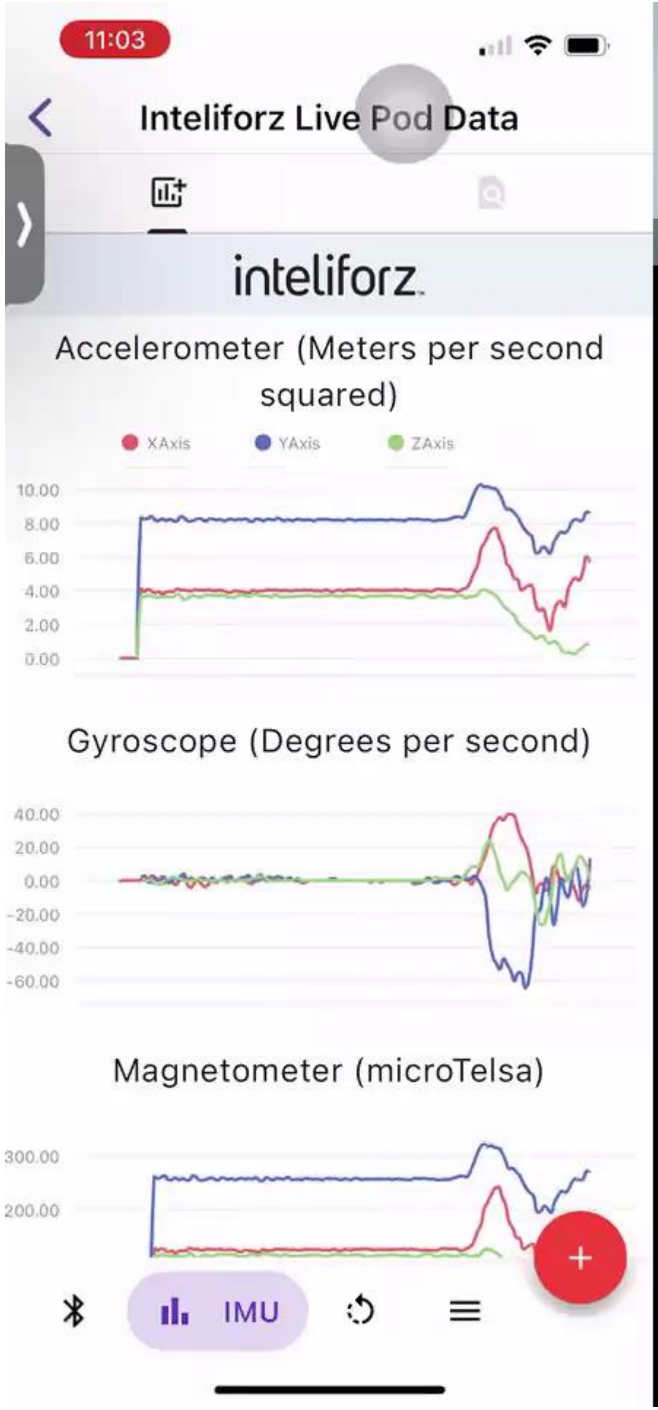


Schultz, C., Vaughan, A., Zreiqat, M., Marin, L., & Minnick, W. (2018). Ergonomics evaluation of the use of cleaning spray bottles for hotel housekeepers. ASSP Safety 2018 Professional Development Conference and Exposition, San Antonio, TX, June 19-22, 2018. *Grand prize winner poster.*

Motion Capture and Haptic Feedback

Motion Capture Use

- Determine degree of extreme posture and their duration
  - Compare interventions or solutions
  - Identify ranges of ‘safe’ hand/wrist postures or duration and enable haptic feedback when outside of those ranges.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Inteliforz Live Pod Data
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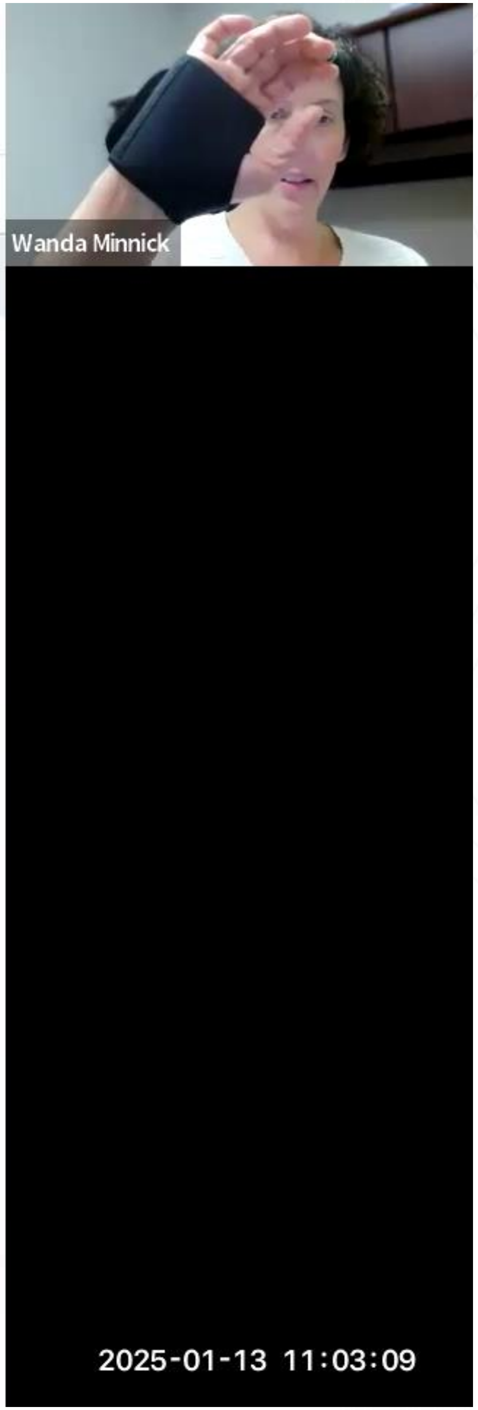
Accelerometer (Meters per second squared)
XAxis
YAxis
ZAxis
10.00
8.00
6.00
4.00
2.00
0.00
Gyroscope (Degrees per second)
40.00
20.00
0.00
-20.00
-40.00
-60.00
Magnetometer (microTelsa)
300.00
200.00
IMU


Wanda Minnick
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Haptic Feedback

- Lind, C. M., Diaz-Olivares, J. A., Lindecrantz, K., & Eklund, J. (2020). A wearable sensor system for physical ergonomics interventions using haptic feedback. *Sensors*, *20*(21), 6010.

"This study shows that the use of haptic feedback for work technique training has the potential to significantly reduce the time in adverse upper-arm postures after short periods of training. The system can increase the awareness of the situations that create adverse upper-arm postures. The haptic feedback was experienced positive and usable by the participants and this kind of extrinsic biofeedback was effective in supporting learning how to improve postures and movements" (p.20)

Robotic Assisted Glove


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Soft Exoskeleton Background

- “In the context of physical work, the term exoskeleton refers to a body-worn support system that acts mechanically on the user’s body to reduce work-related stress” (p. 1577)
- “The current state of scientific knowledge about the effectiveness of exoskeletons is contradictory” (p. 1578)
- “There are no controlled longitudinal studies showing that exoskeletons prevent work-associated musculoskeletal complaints or musculoskeletal disorders” (p. 1578)

Mayer, T. A., Harsch, A. K., Koska, D., Hensel-Unger, R., & Maiwald, C. (2022). Effects of an active hand exoskeleton on forearm muscle activity in industrial assembly grips. *Work*, *72*(4), 1577-1591.

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Research Studies

Cousins, D., Porto, R., Bigelo, A., Fox, R., Libs, B., Holmes, M., & Cort, J. (2024). Effects of the Ironhand® Soft Exoskeleton on Forearm Muscle Activity During in Field Automotive Assembly Tasks. *IISE Transactions on Occupational Ergonomics and Human Factors*, 1-9.

- Sample size = 12, limited generalizability, muscle activity was reduced in one grip posture, however, muscle activity increased in other postures.

Mayer, T. A., Harsch, A. K., Koska, D., Hensel-Unger, R., & Maiwald, C. (2022). Effects of an active hand exoskeleton on forearm muscle activity in industrial assembly grips. *Work*, *72*(4), 1577-1591.

- Results varied depending on gender and grip technique.

In Conclusion

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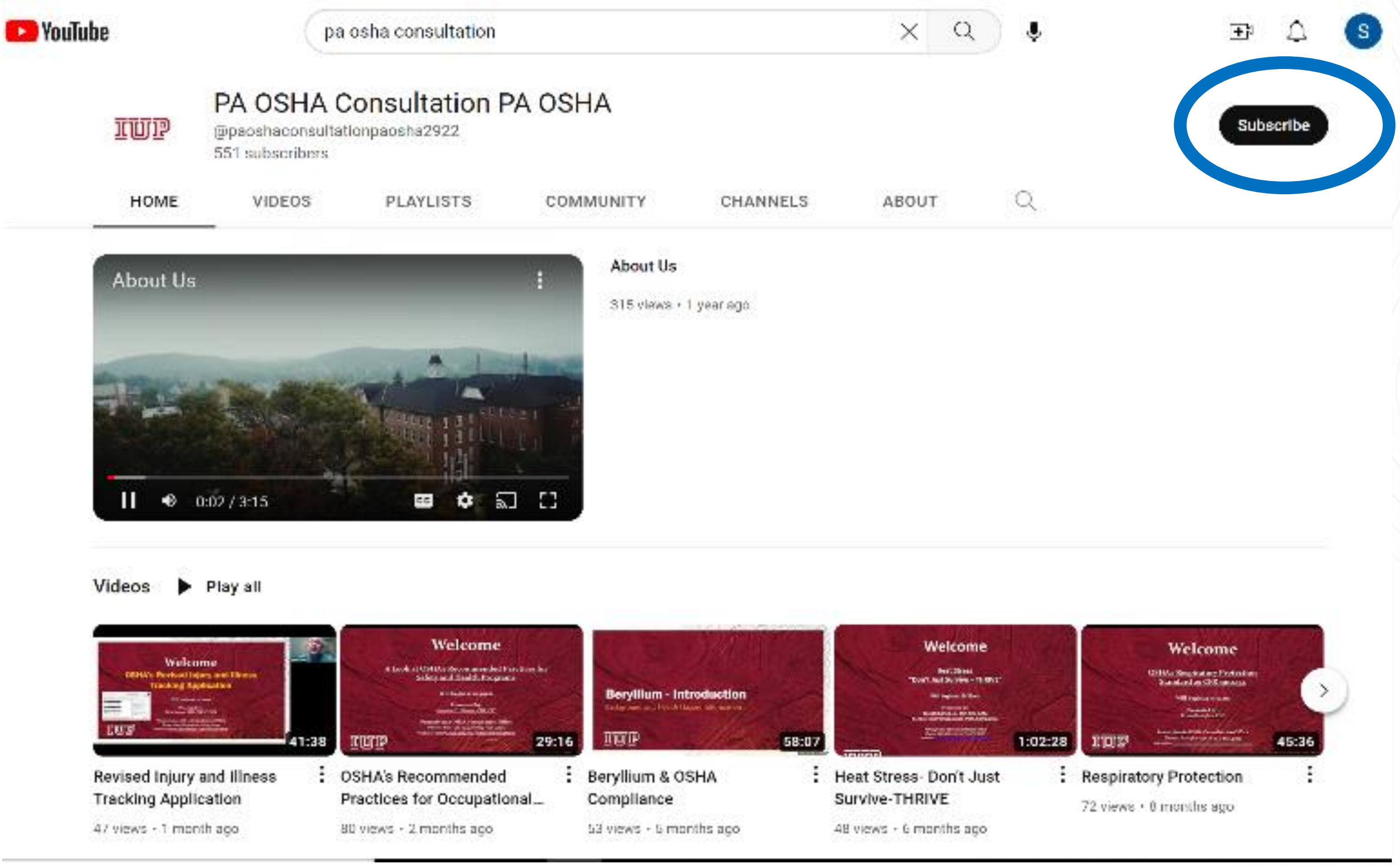

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SOURCES

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- Intelliforz Ansell
- BioServe Ironhand
- https://brandondonnellymd.com/wrist-conditions/wrist-tendonitis/ (visual, slide)
- https://en.wikipedia.org/wiki/Carpal_bones (visual, slide)
- https://www.mdpi.com/2075-4418/13/11/1928 (visual, slide)
- Zreiqat, M., Marin, L. S., Minnick, W., Vaughan, A., & Shultz, C. (2023). Comparison of grip force at the hand-handle interface during the use of housekeeping spray bottles. *International Journal of Human Factors and Ergonomics*, *10*(3), 265-282.
- https://www.bls.gov/opub/ted/2018/back-injuries-prominent-in-work-related-musculoskeletal-disorder-cases-in-2016.htm

SOURCES

- Rempel, D. (2018). 1631c Recent changes to the ACGIH hand activity level TLV.
- Cousins, D., Porto, R., Bigelo, A., Fox, R., Libs, B., Holmes, M., & Cort, J. (2024). Effects of the Ironhand® Soft Exoskeleton on Forearm Muscle Activity During in Field Automotive Assembly Tasks. *IISE Transactions on Occupational Ergonomics and Human Factors*, 1-9.
- Mayer, T. A., Harsch, A. K., Koska, D., Hensel-Unger, R., & Maiwald, C. (2022). Effects of an active hand exoskeleton on forearm muscle activity in industrial assembly grips. *Work*, *72*(4), 1577-1591.