Is the Sliding Sheet Good Enough? Guidelines for Practice Based on Biomechanical Evaluation of Repositioning Technology

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Disclosures

- Neal Wiggermann and Victor Zhou are employees of Hill-Rom
- Nany McGann participates on the Hill-Rom/Liko SPHM Advisory Council

Patient Handling Injury

On average, in the previous 12 months, (Davis, 2015)

- 55% of caregivers reported experiencing **back** pain or injury
- 44% experienced **shoulder** pain/injury
- 36% experienced **lower extremity** pain/injury

82% of patient handling injuries occurred when lift equipment was not used (Gomaa, 2015)

Each year, an estimated 12% of nurses leave the profession due to chronic back pain

Sources: Davis and Kotowski, 2015. Prevalence of musculoskeletal disorders... *Human factors*, *57*(5), pp.754-792.
Nelson, A., Baptiste, A. (September 30, 2004). "Evidence-Based Practices for Safe Patient Handling and Movement". *Online Journal of Issues in Nursing*. Vol. 9 No. 3, Manuscript 3.
Gomaa, A. E., Tapp, L. C., Luckhaupt, S. E., Vanoli, K., Sarmiento, R. F., Raudabaugh, W. M., ... & Sprigg, S. M. (2015). Occupational traumatic injuries among workers in health care facilities—United States, 2012–2014. *MMWR. Morbidity and mortality weekly report*, *64*(15), 405.

Background

Repositioning patients in bed is most common patient handling activity (Poole-Wilson, 2015; Vailiadou, 1995)

Manual repositioning is associated with risk of musculoskeletal injury (Marras, 1999)

Assistive devices have been studied, but often:

- One or few devices
- A single patient weight
- No biomechanical modeling or estimation of injury risk

Objective

- Evaluate risk of caregiver injury when repositioning patients in bed for several combinations of 1) repositioning activity, 2) patient weight and 3) repositioning aid

Guidelines for Physical Loading – A Quick Overview

Lifting: risk of back injury increases when spine compression exceeds **3400 N** [764 lbs]

- NIOSH lifting equation (Waters, 1993)
- 35 lbs lift limit for patient handling (Waters, 2007)

Pushing and Pulling: Psychophysical tables from Liberty Mutual Tables (aka "Snook Tables") (Ciriello, 1993)

- Exceeding psychophysical limits associated with injury (Herrin, 1986)
- Example: Pull force of 55 lbs every 30 minutes is acceptable to 75% of females

Waters, T. R., Putz-Anderson, V., Garg, A., & Fine, L. J. (1993). Revised NIOSH equation for the design and evaluation of manual lifting tasks. *Ergonomics*, *36*(7), 749-776.

Waters, T. R. (2007). When is it safe to manually lift a patient?. *AJN The American Journal of Nursing*, *107*(8), 53-58.

Herrin, G. D., Jaraiedi, M., & Anderson, C. K. (1986). Prediction of overexertion injuries using biomechanical and psychophysical models. *American Industrial Hygiene Association Journal*, *47*(6), 322-330.

Ciriello, V. M., Snook, S. H., & Hughes, G. J. (1993). Further studies of psychophysically determined maximum acceptable weights and forces. *Human factors*, *35*(1), 175-186.

Translating Guidelines to Healthcare

Compared to the study populations used to develop the manual material handling guidelines, the nursing population is older, heavier, and more deconditioned:

- Median age of workforce:
  - 1996: 38.3 years
  - 2016: 42.0 years
- US Population with Obesity:
  - 1975: 12%
  - 1995: 22%
  - 2014: 34%

Conclusion – guidelines might not be sufficiently conservative to protect workers

Sources:
BLS, 2017. Accessed Feb 7, 2019. https://www.bls.gov/emp/tables/median-age-labor-force.htm
NCD Risk Factor Collaboration. (2016). Trends in adult body-mass index… *The Lancet*, *387*(10026), 1377-1396.

Methods

Participants

- Caregivers
  - N = 10
  - Height: 170 cm (SD 7.6 cm)
  - Weight: 80.4 kg (SD 16.6 kg)
  - Experience 7.5 years (SD 3.7 years). All >1 year experience, regularly reposition patients

- “Patients”
  - 50 kg [110 lbs]
  - 77 kg [170 lbs]
  - 141 kg [311 lbs]

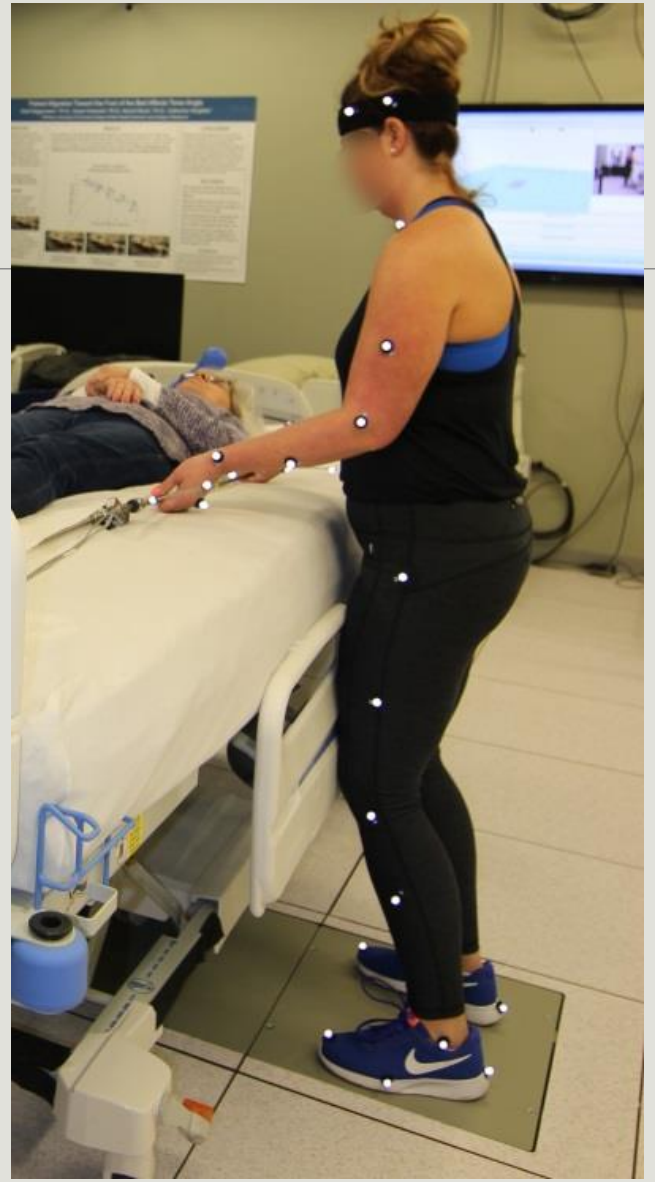
Methods

Equipment

- Motion Capture
- Ground Reaction Force
- Pull Force

Procedure

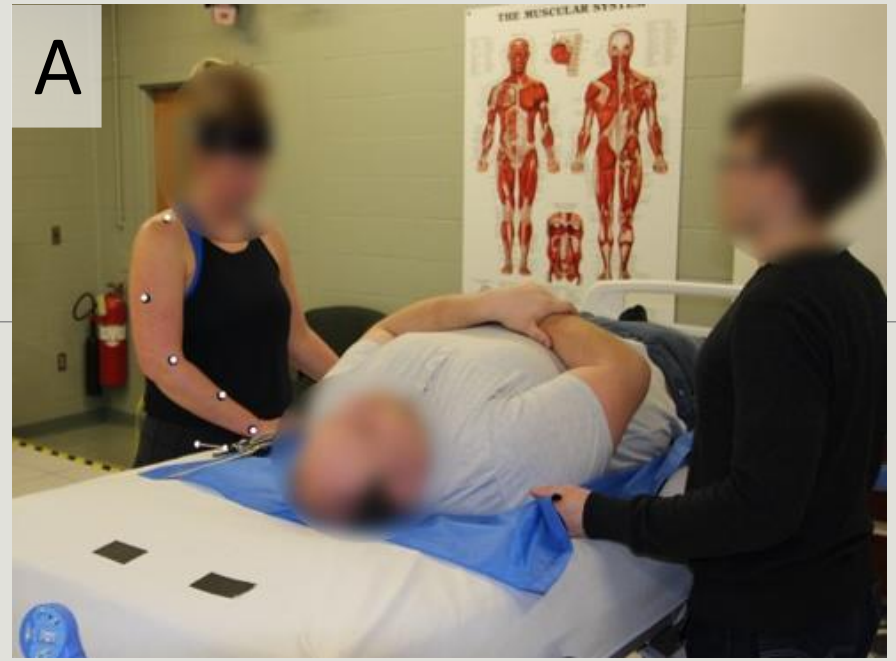
- 90 Trials per subject
- Order of test conditions partially randomized

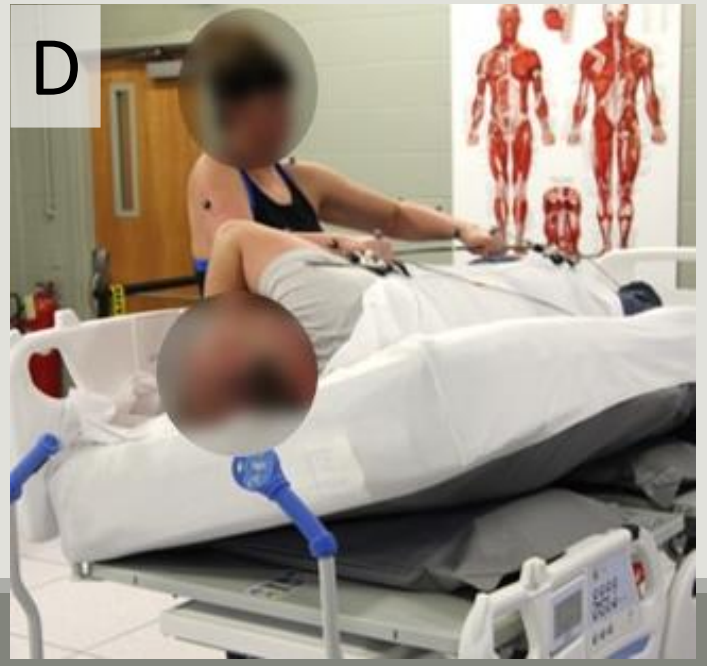


Methods

Repositioning Activities Studied

A. Pull up in Bed
B. Lateral Transfer
C. Lateral Reposition
D. Turning





Methods

Repositioning Aids

- Draw sheet (control)
- Friction reducing sheets (used as a pair)
- Turn and position system
- Air assisted lateral transfer device

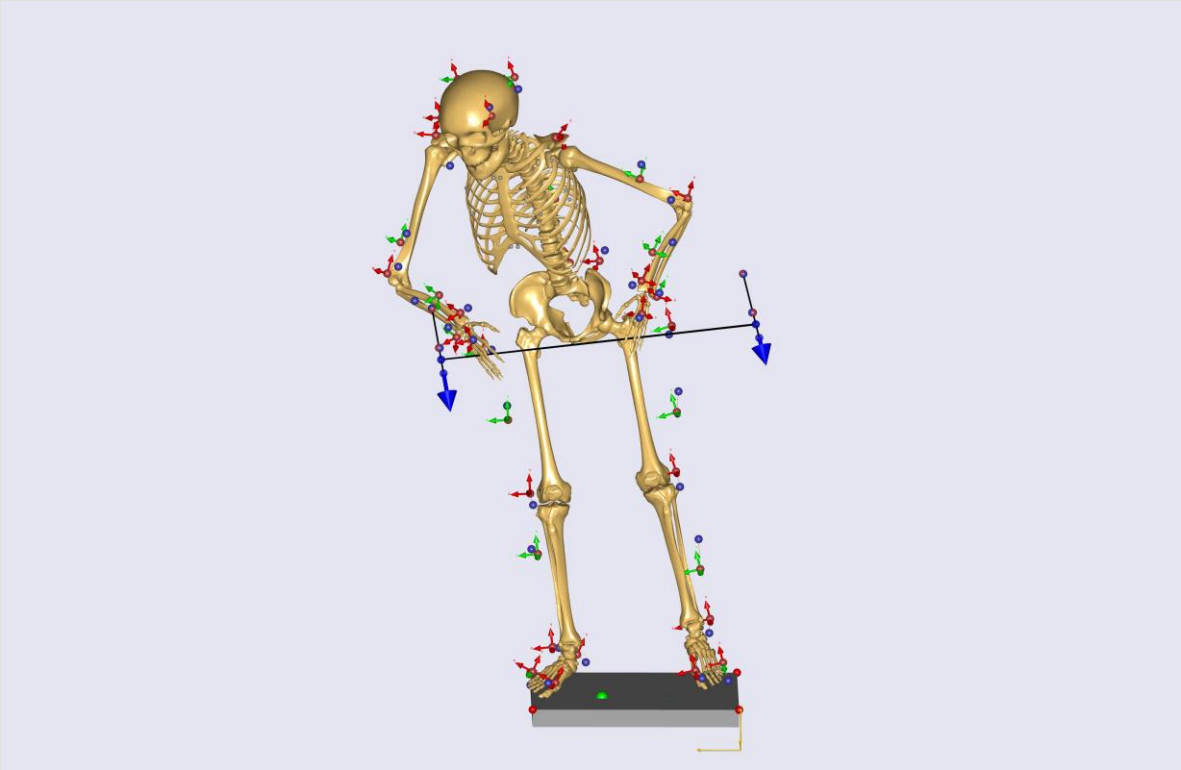
Methods – Outcome Variables

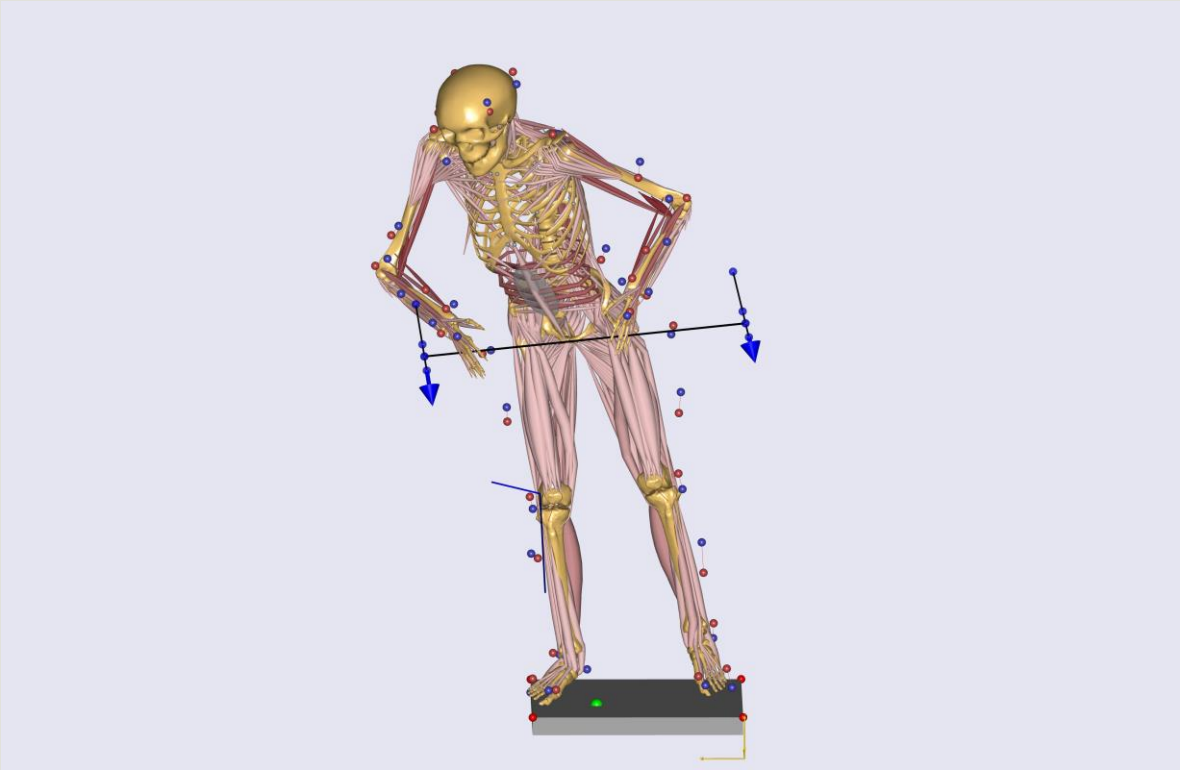
Hand Forces

Biomechanical model

- L5/S1 Spine compression
- Muscle activity estimates

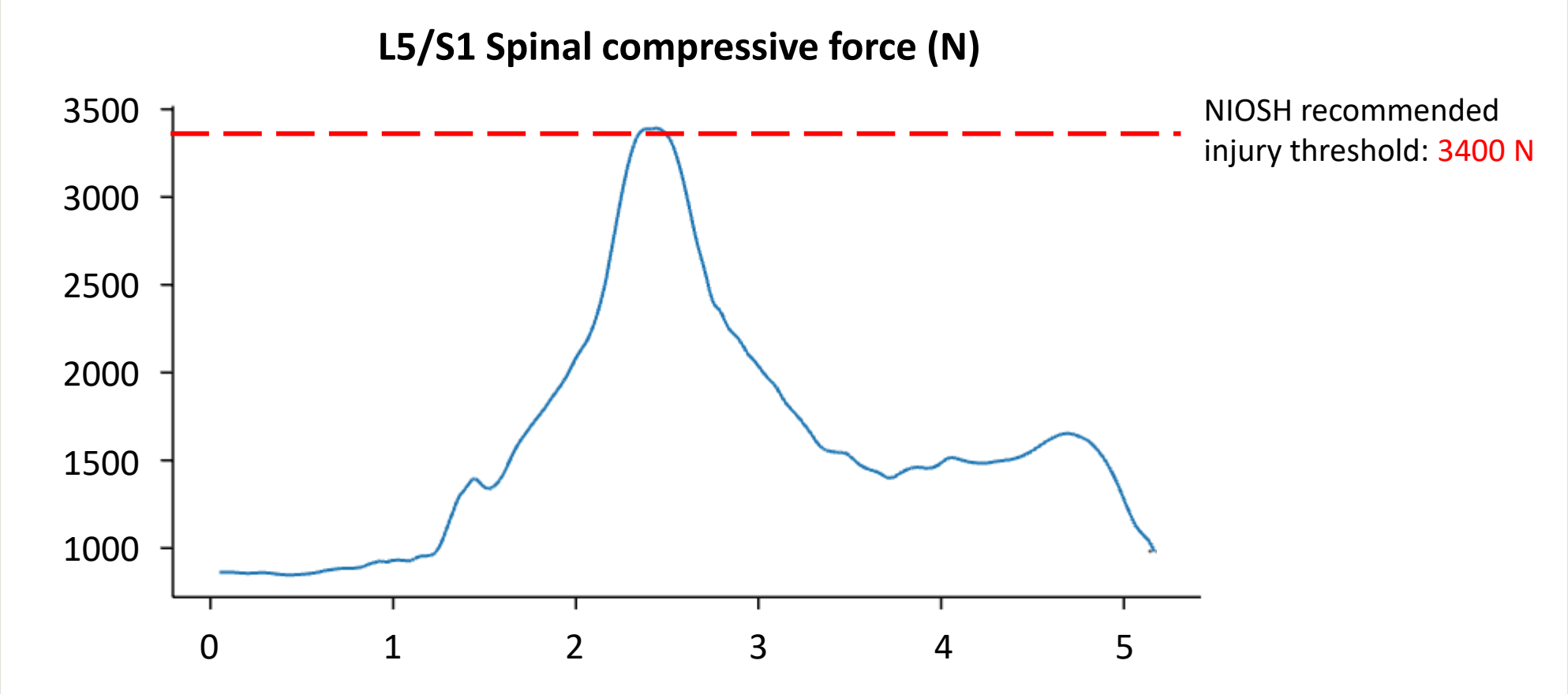
Methods – Biomechanical Model





Bassani, T., Stucovitz, E., Qian, Z., Briguglio, M., & Galbusera, F. (2017). Validation of the AnyBody full body musculoskeletal model in computing lumbar spine loads at L4L5 level. Journal of biomechanics, 58, 89-96.
Damsgaard, M., Rasmussen, J., Christensen, S. T., Surma, E., & De Zee, M. (2006). Analysis of musculoskeletal systems in the AnyBody Modeling System. Simulation Modelling Practice and Theory, 14(8), 1100-1111.

Methods – Biomechanical Model

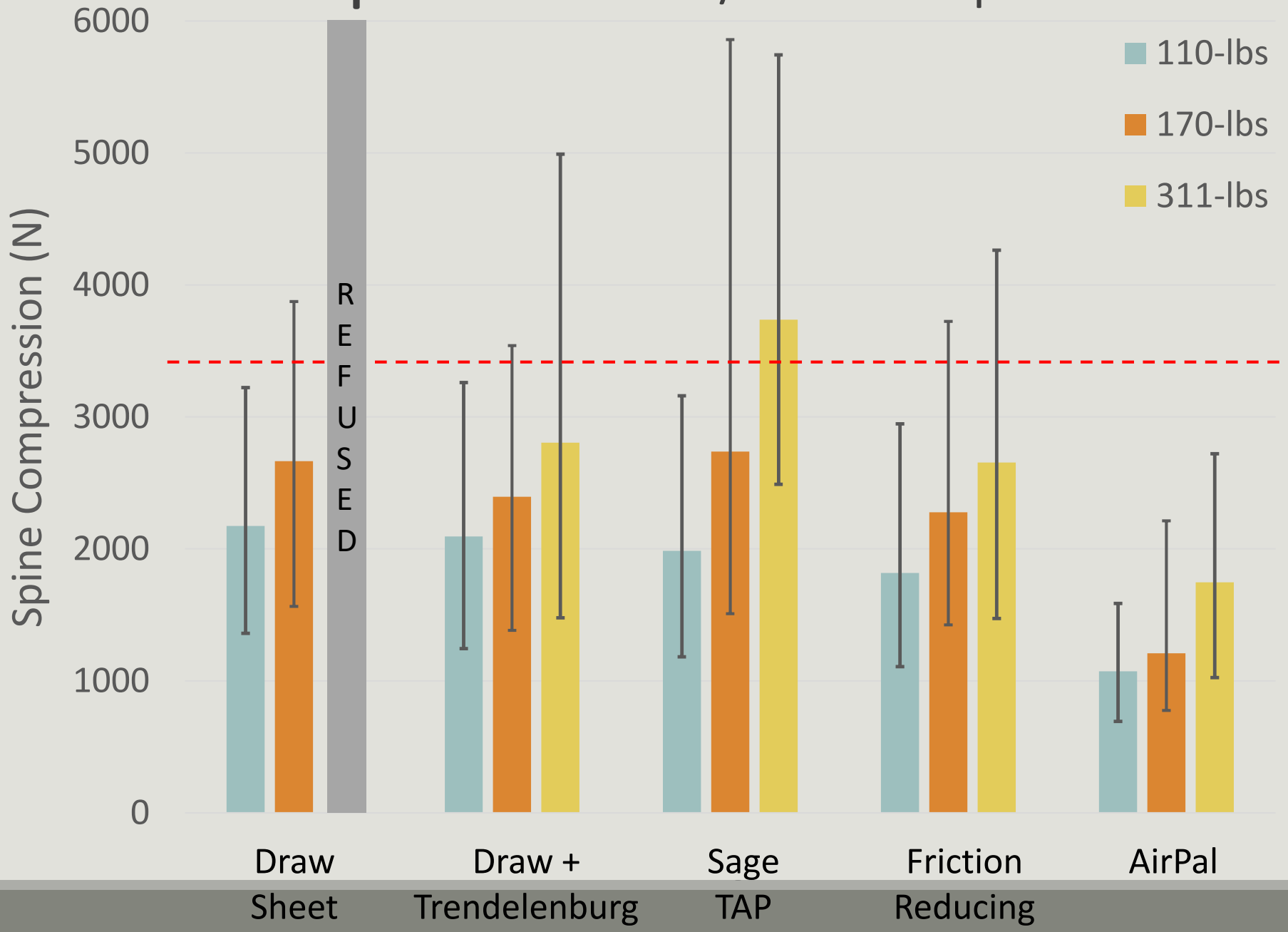


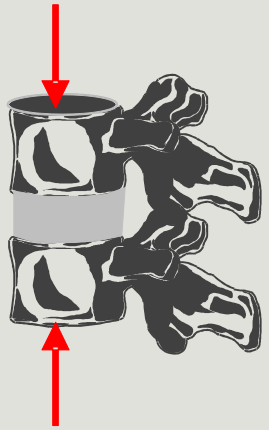
Muscle Activation and Injury

- A strong association between overexertion and musculoskeletal injury has been demonstrated in a large number of epidemiological studies in various regions of human body (Kumar 2001).
- High muscle exertion should be avoided to reduce the risk of musculoskeletal injury.
- When performing occupational tasks, a muscle activity of over 60% MVC is generally considered high exertion (Jakobsen et al., 2014).

References:
Jakobsen, M. D., Sundstrup, E., Persson, R., Andersen, C. H., & Andersen, L. L. (2014). Is Borg's perceived exertion scale a useful indicator of muscular and cardiovascular load in blue-collar workers with lifting tasks? A cross-sectional workplace study. European journal of applied physiology, 114(2), 425-434.
Kumar, S. (2001). Theories of musculoskeletal injury causation. Ergonomics, 44(1), 17-47.

Pull up in bed – L5/S1 Compression





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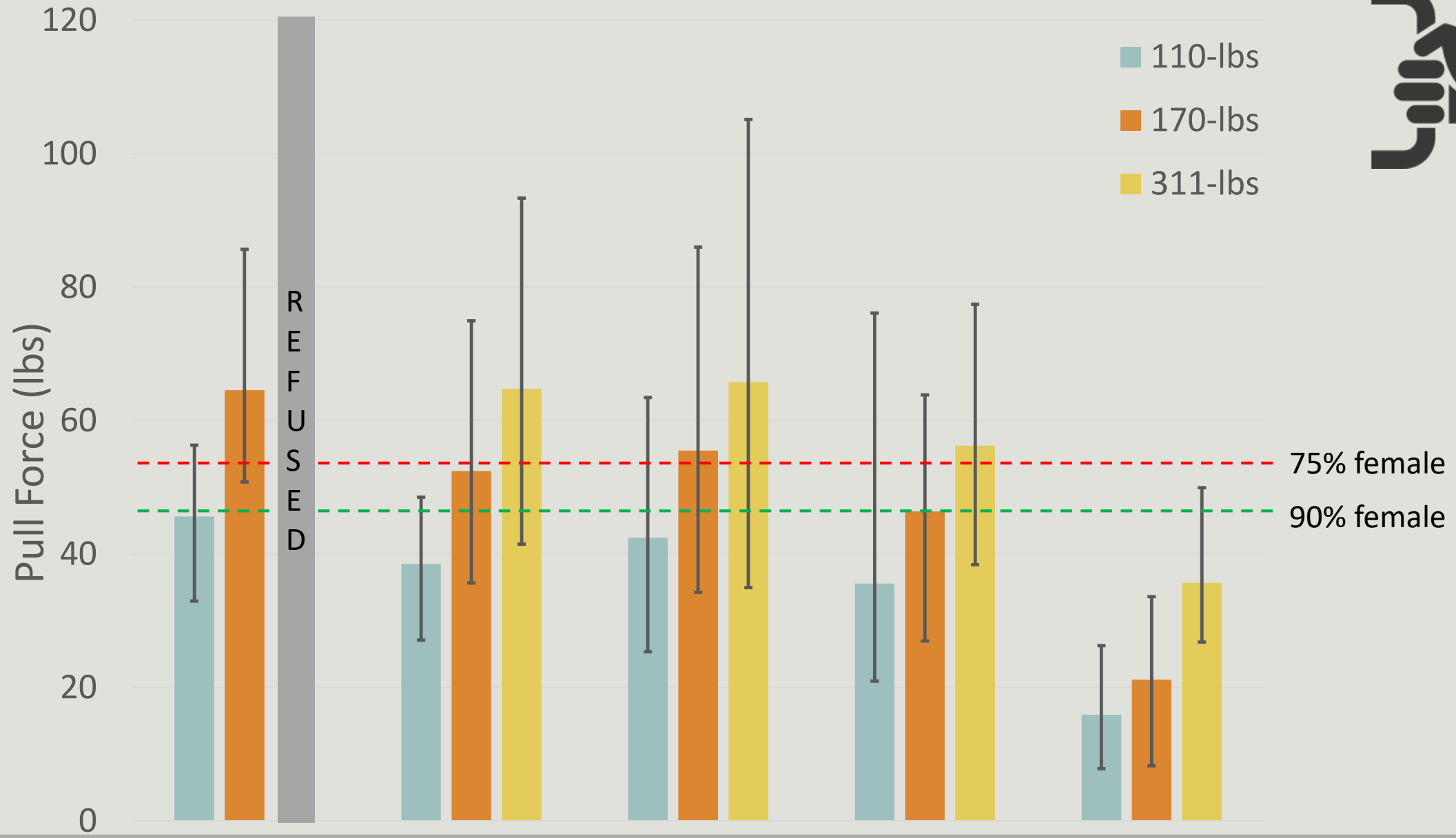
Pull up in bed – Pull Force



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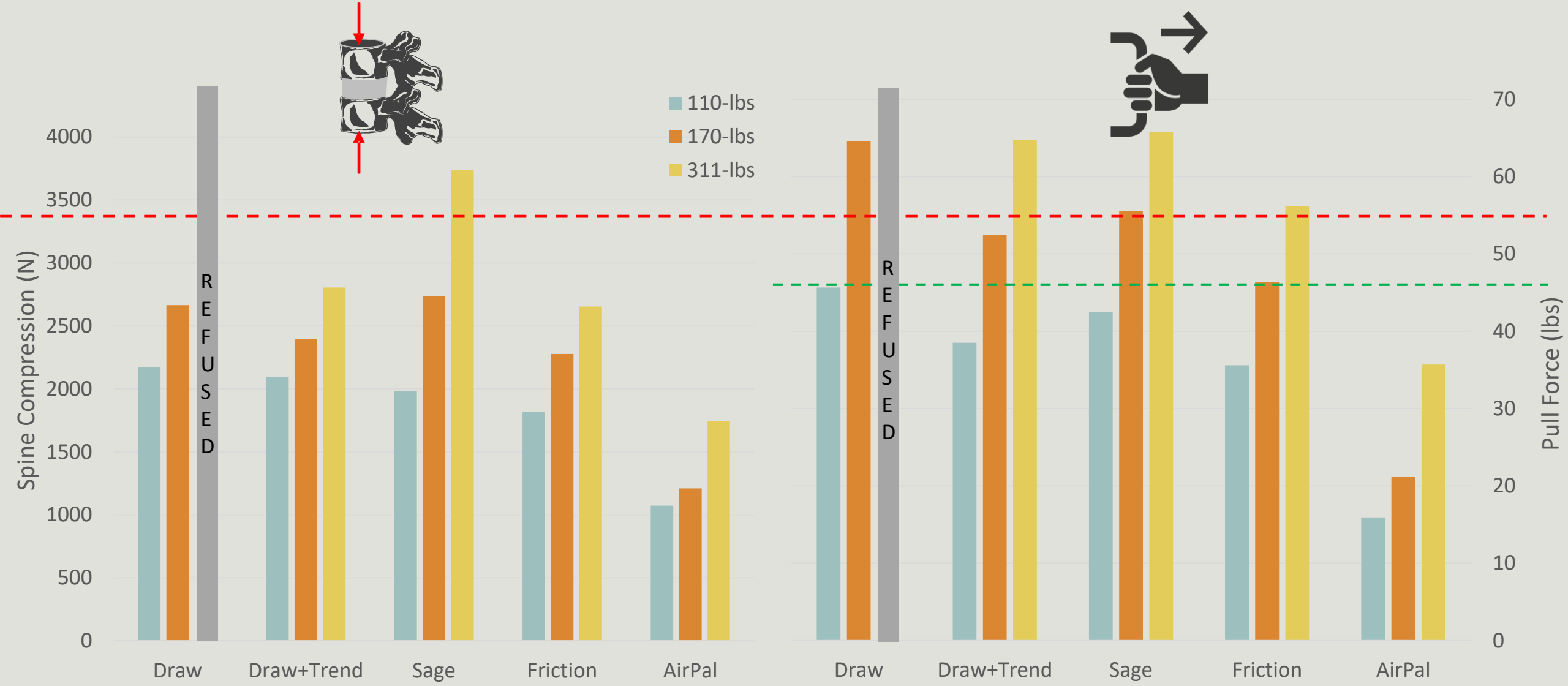
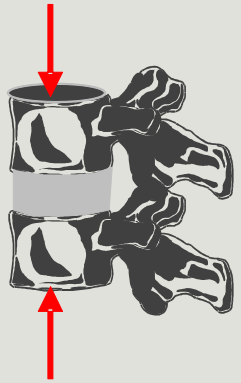
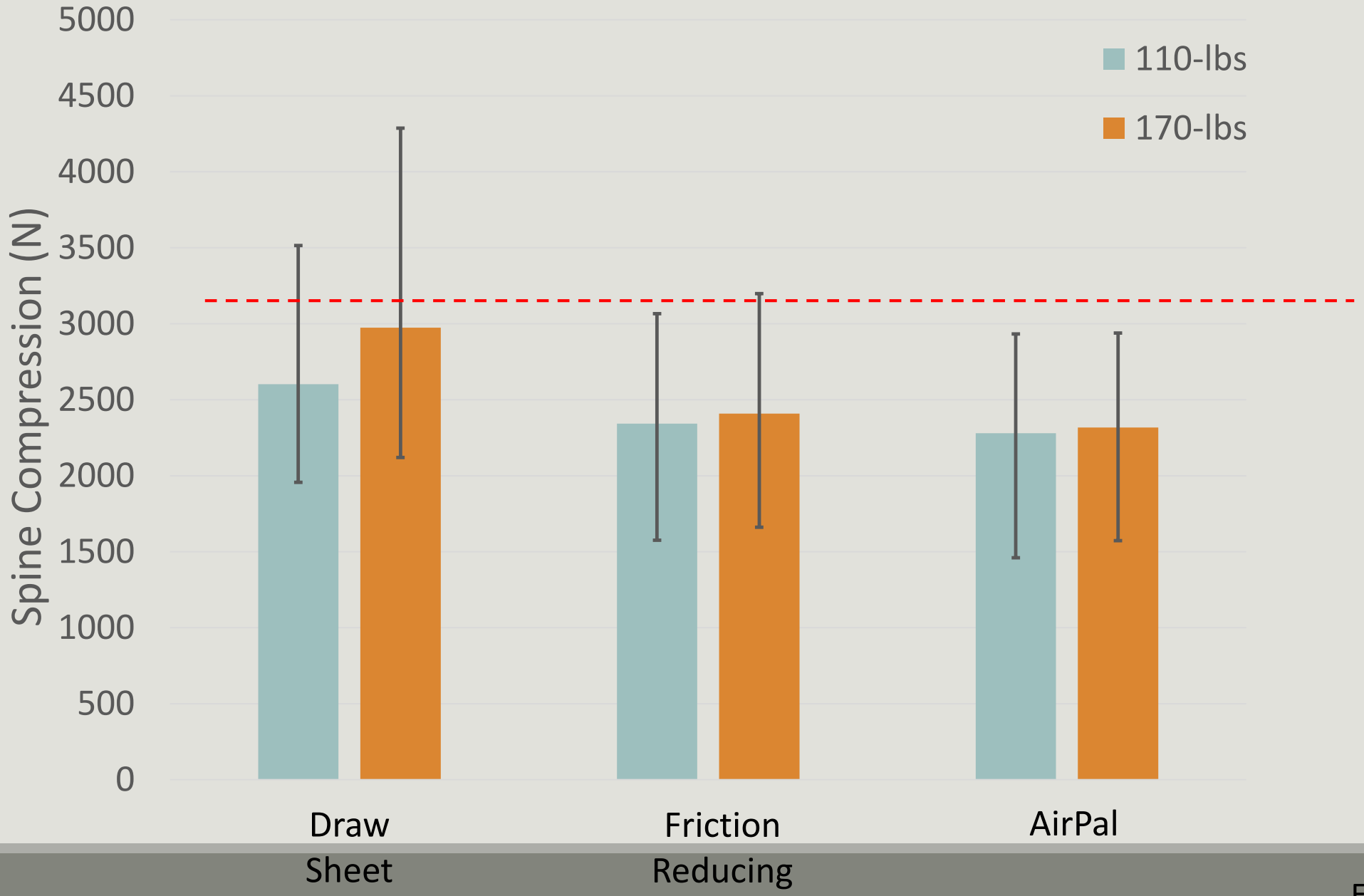
Pull up in bed – Spine Compression vs. Pull Force



Lateral Transfer – L5/S1 Compression





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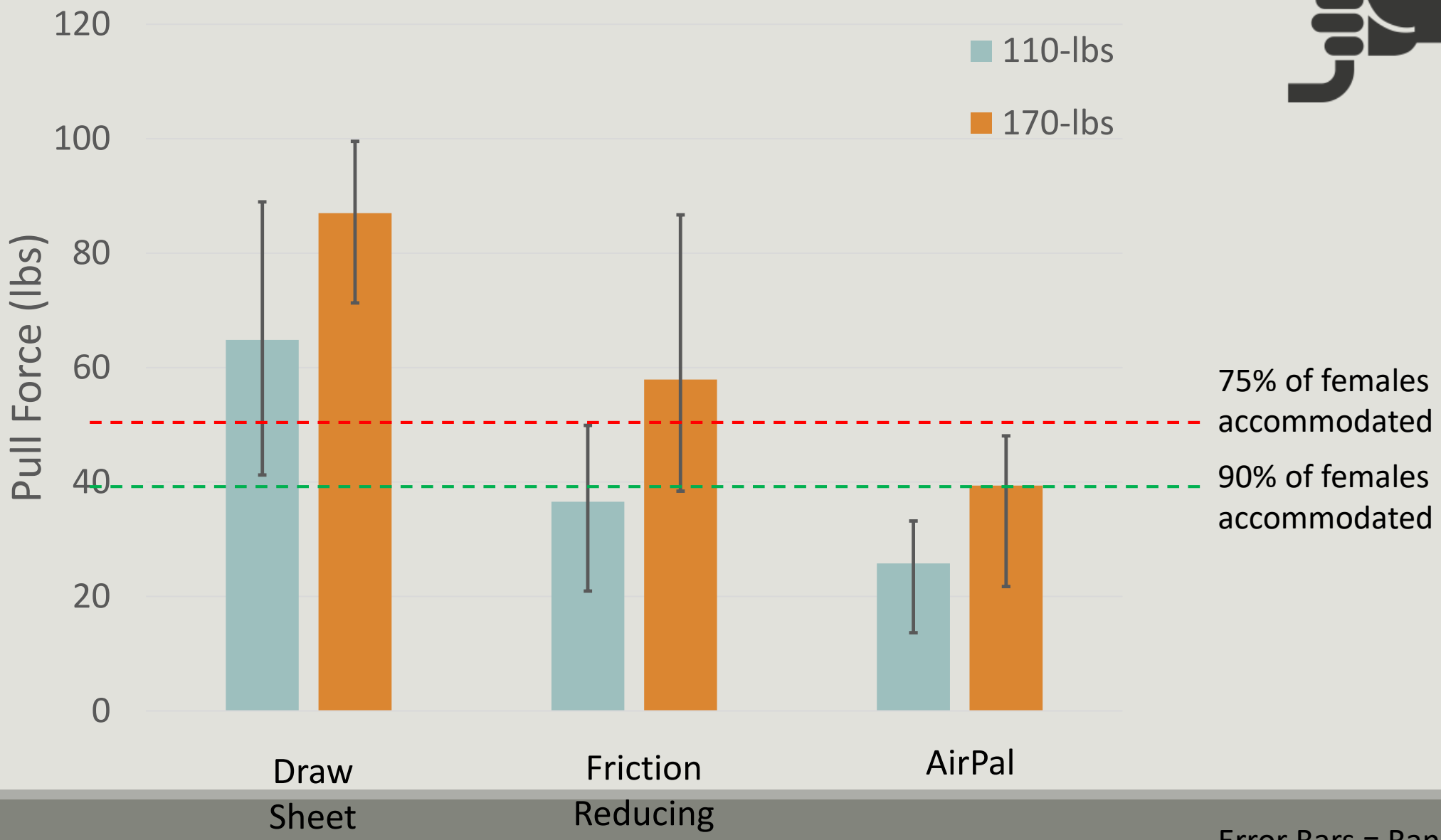
Lateral Transfer – Pull Force



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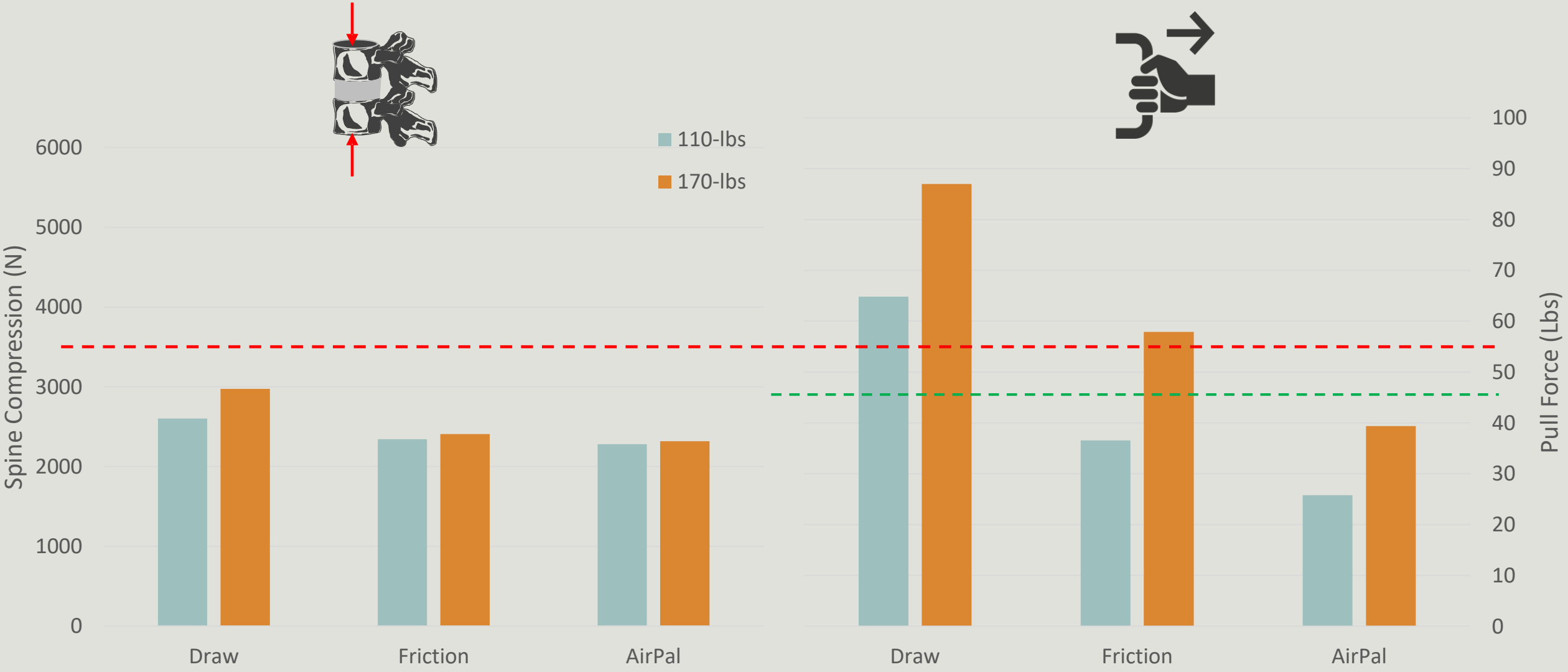
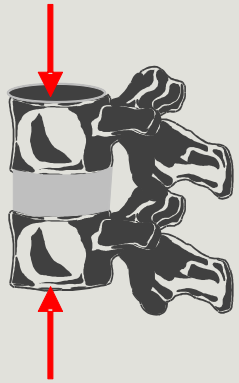
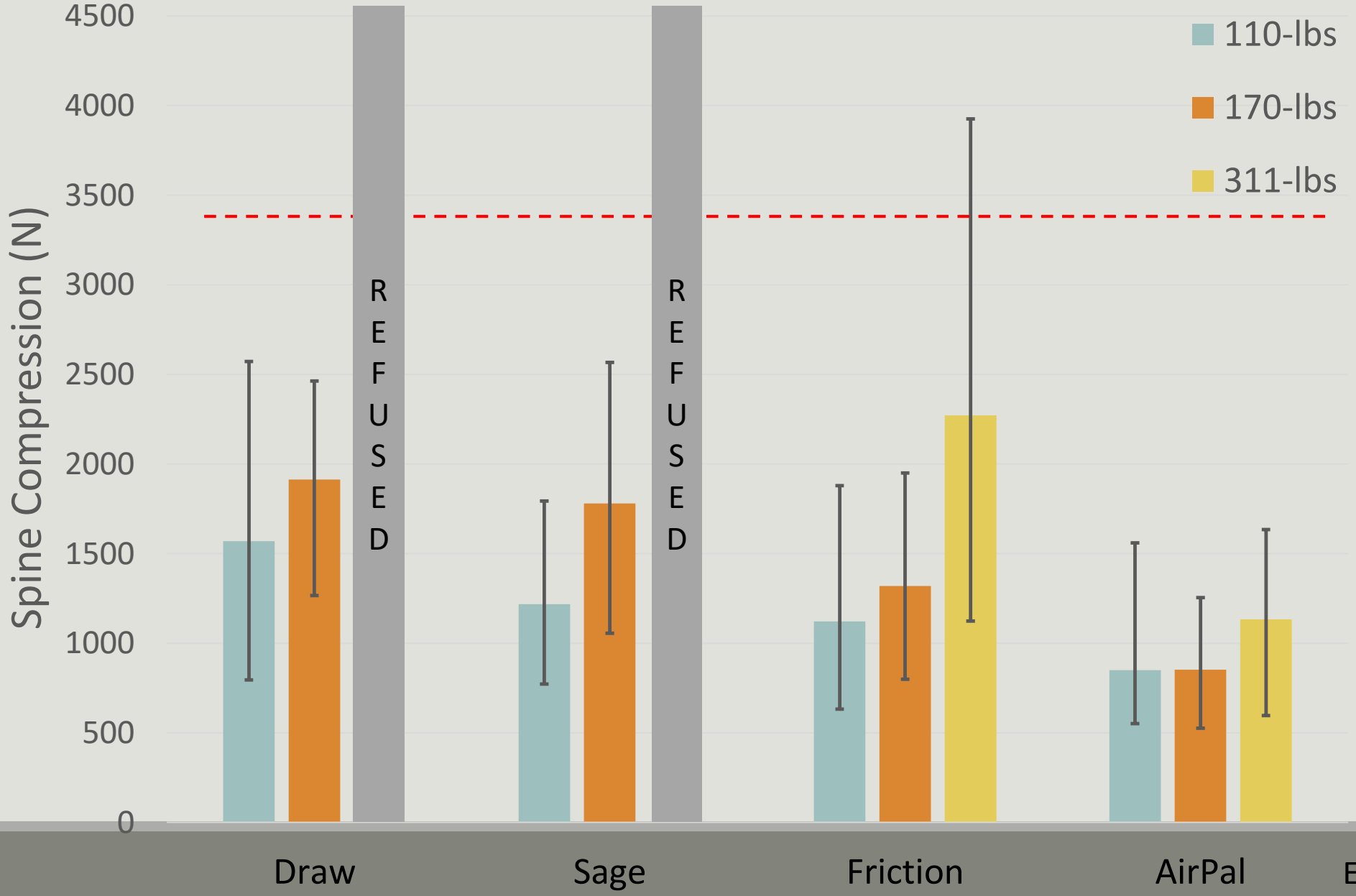
Lateral Transfer – Spine Compression vs. Pull Force



Lateral Reposition – L5/S1 Compression





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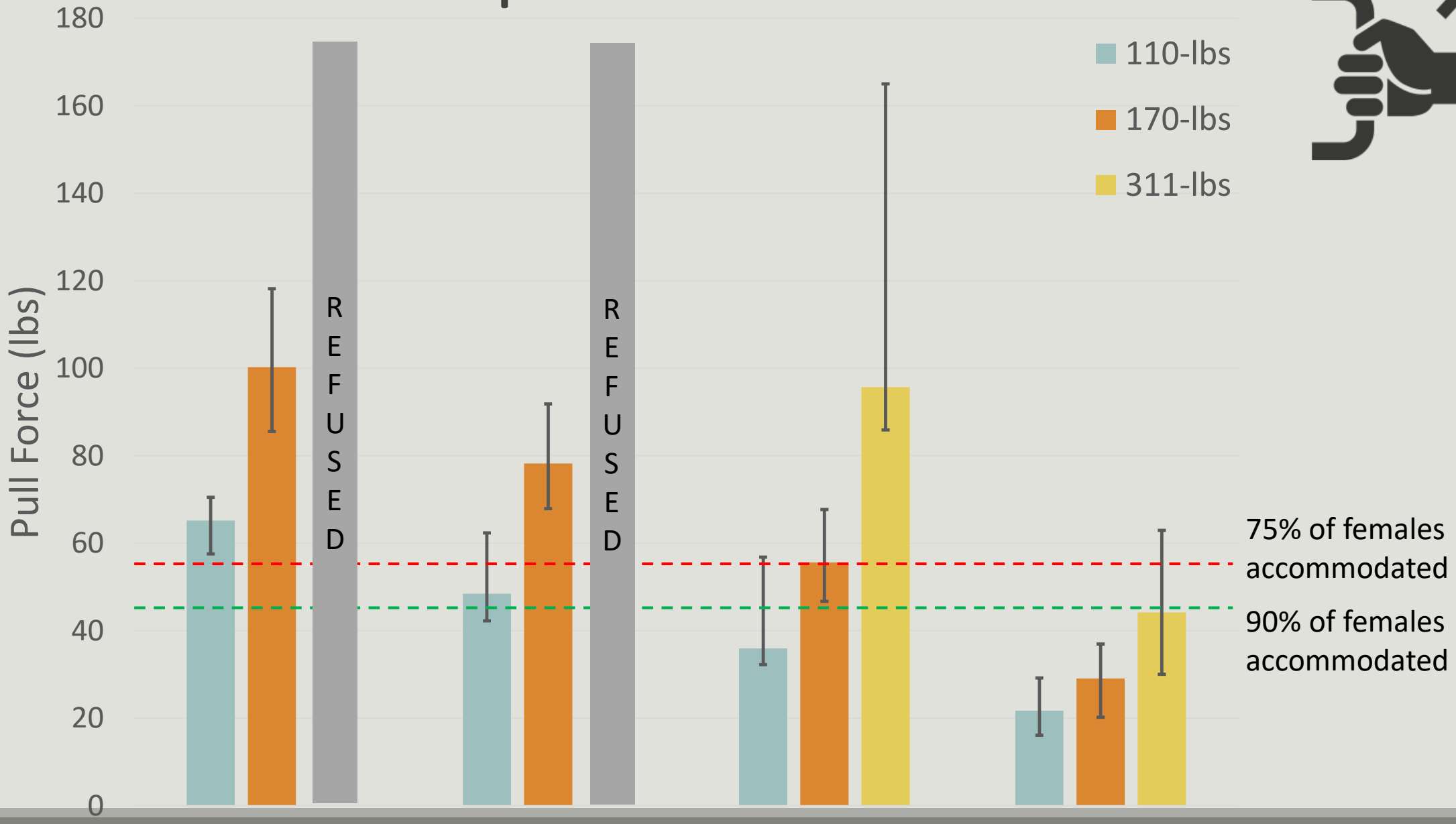
Lateral Reposition – Pull Force



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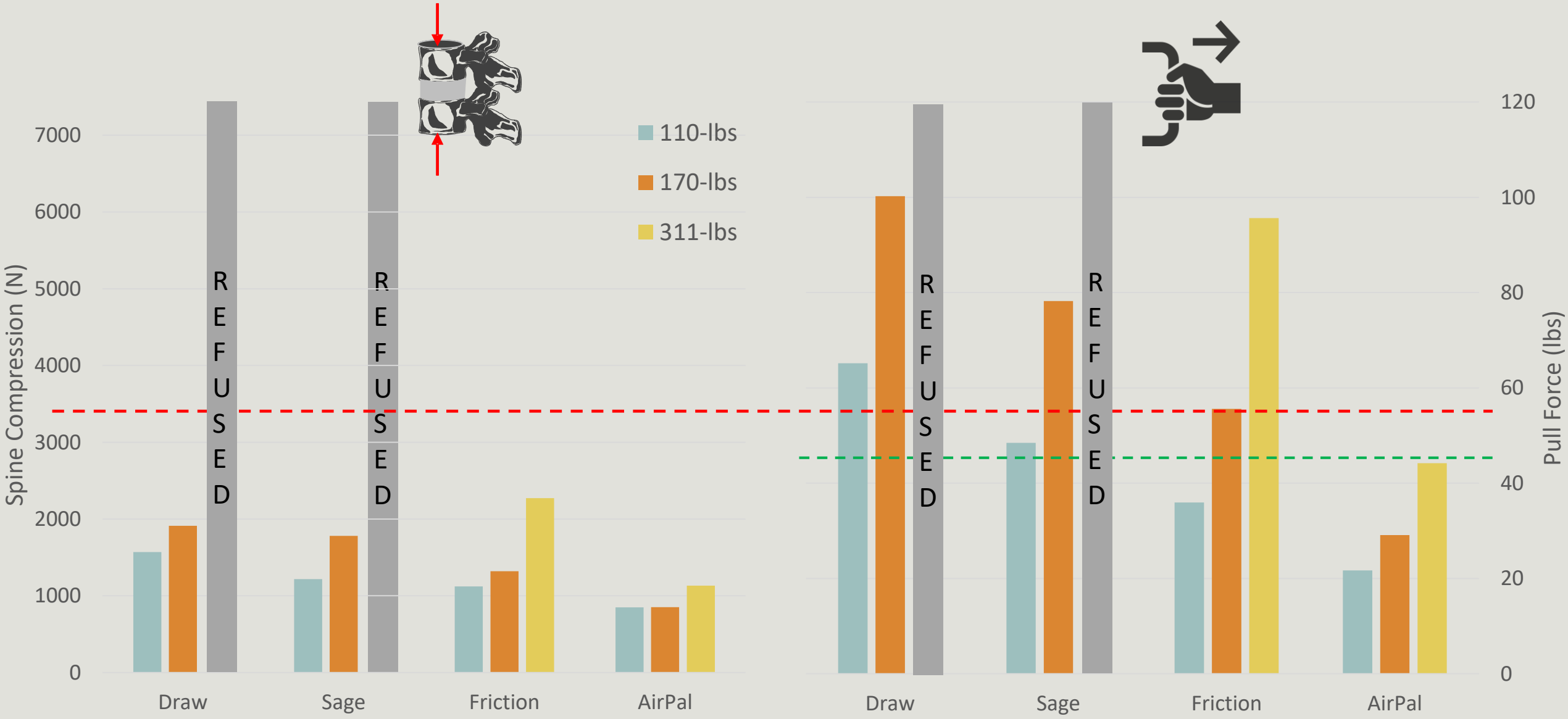
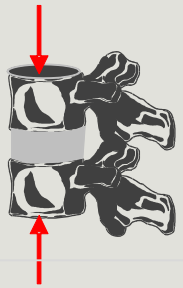
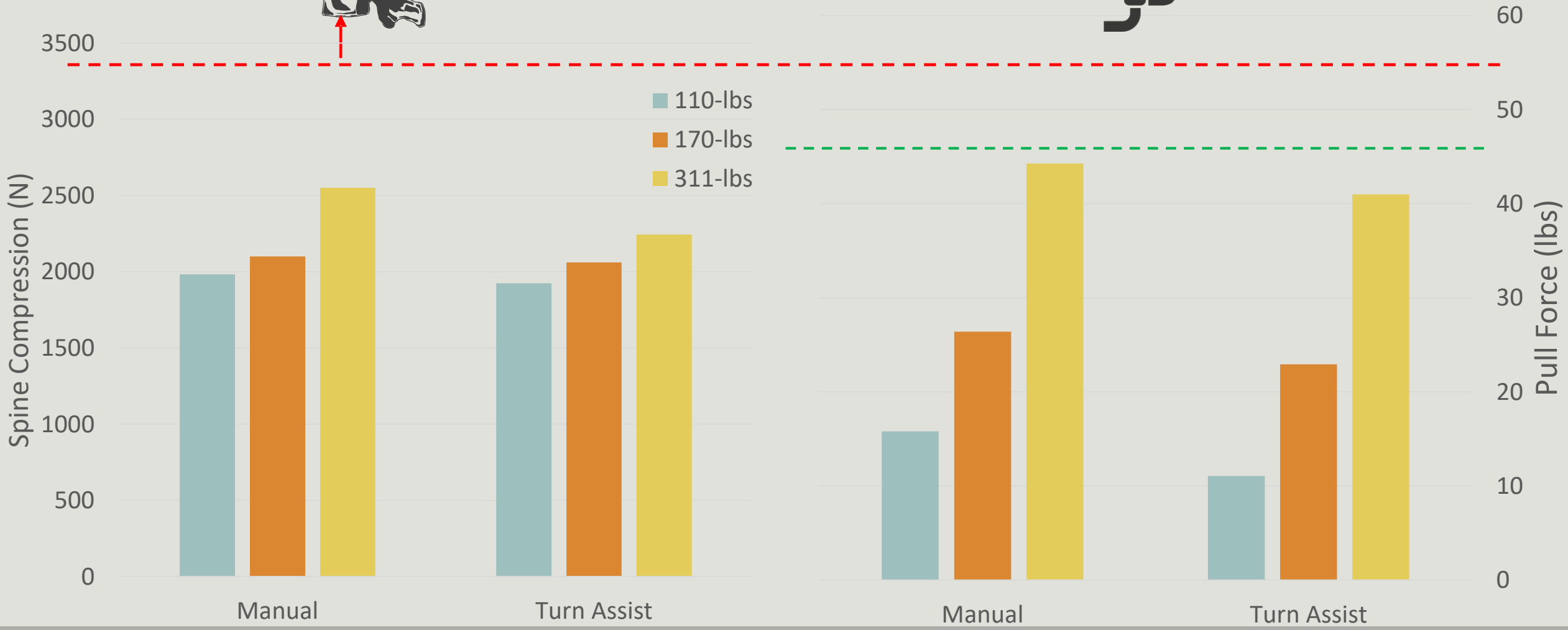
Lateral Reposition – Spine Compression vs. Pull Force

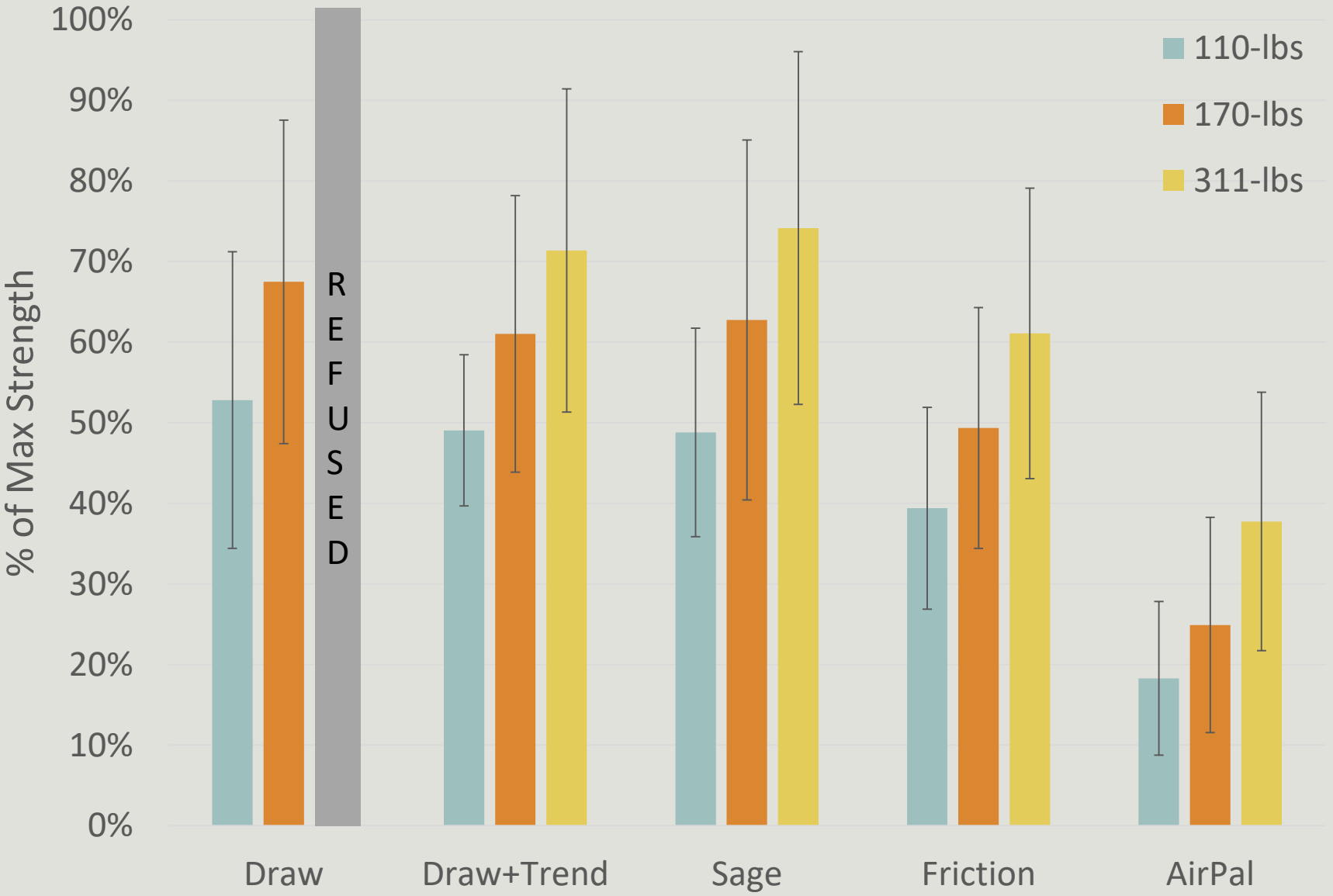


Turning – Spine Compression vs. Pull Force



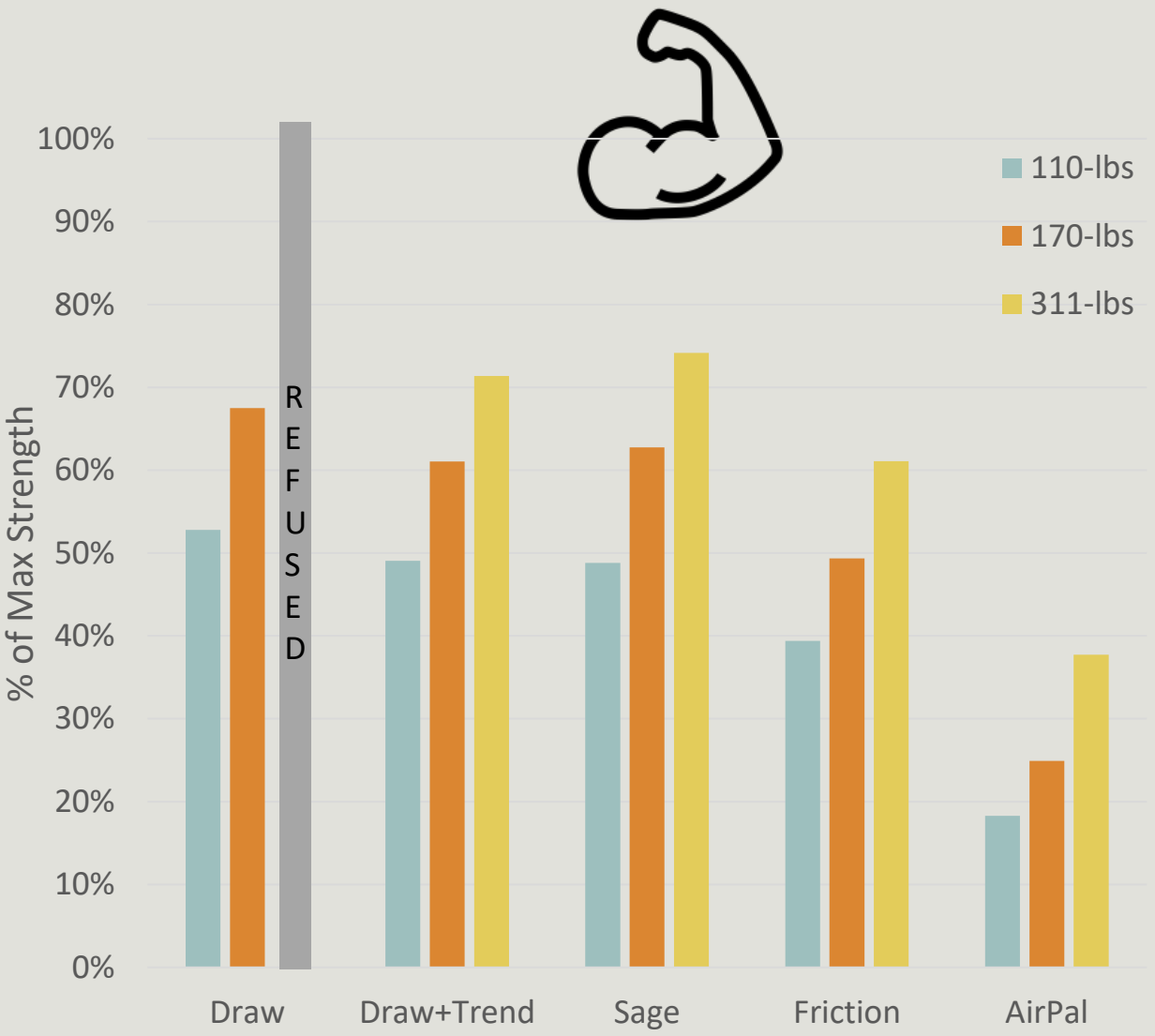


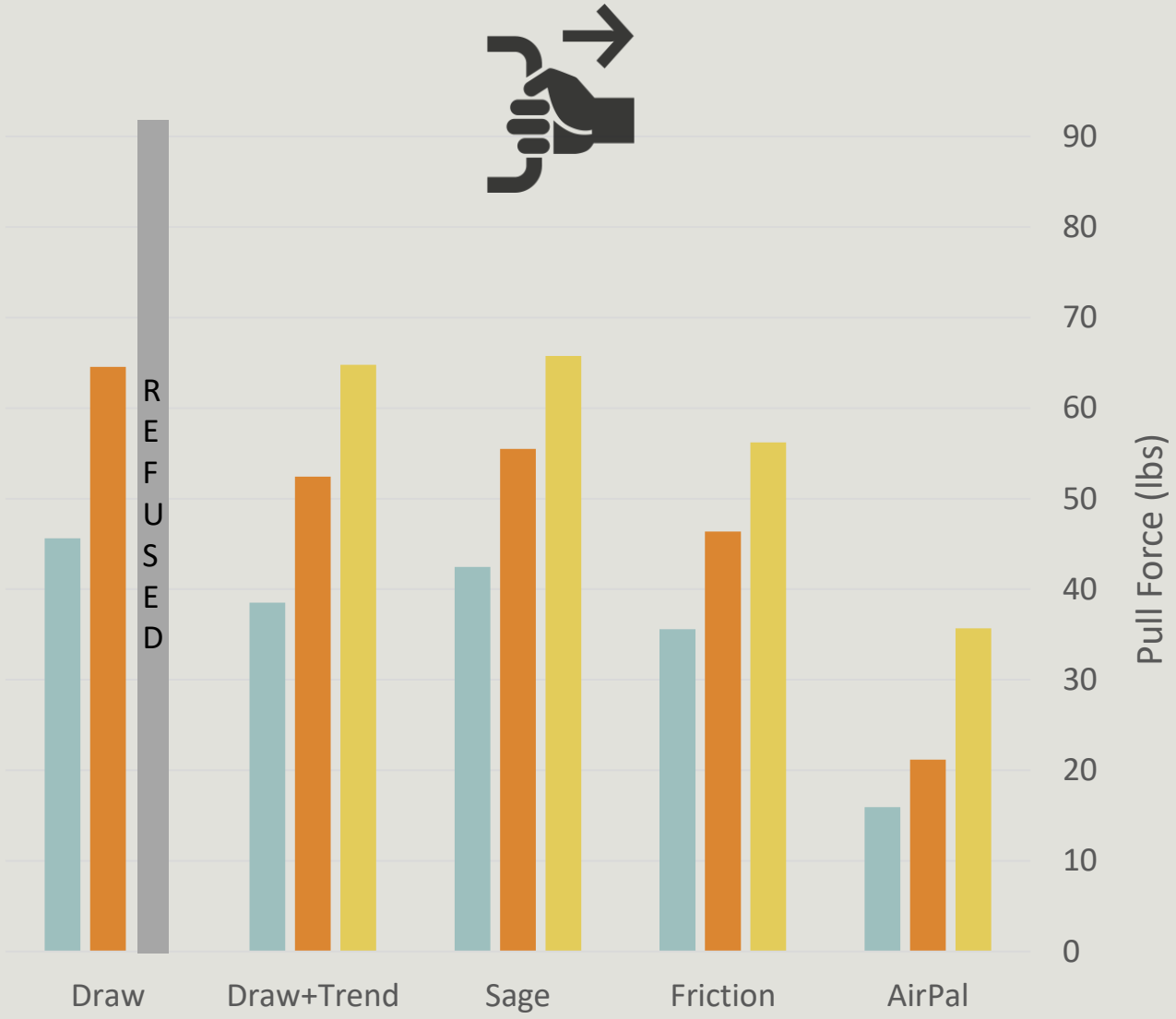
Pull up in Bed – Biceps Muscle Activity



Error Bars = +/- Std Deviation

Pull up in bed – Biceps Muscle Activation vs. Pull Force





Recommendations

		Patient						
Activity	**Condition**	<110 lb	**110 lb**	110-170 lb	**170 lb**	170-311 lb	**311 lb**	>311 lb
Turning	Draw sheet							
	Turn Assist (Centrella)							
Boosting	Draw sheet							
	Draw sheet + Trend							
	FRS							
	Sage TAP							
	AirPal							
Lateral Trans.	Draw sheet							
	FRS							
	AirPal							
Lateral Reposition	Draw sheet							
	FRS							
	Sage TAP							
	AirPal							
All	Ceiling Lift							

Implications for Care
(for most healthy caregivers)

Turning

- May be acceptable to perform manually for average patients when taking into account disc compression and pull forces.
- However, healthcare worker injury data and patient safety risk factors must be considered.
- Turn assist reduces physical stress, especially recommended for heavy patients

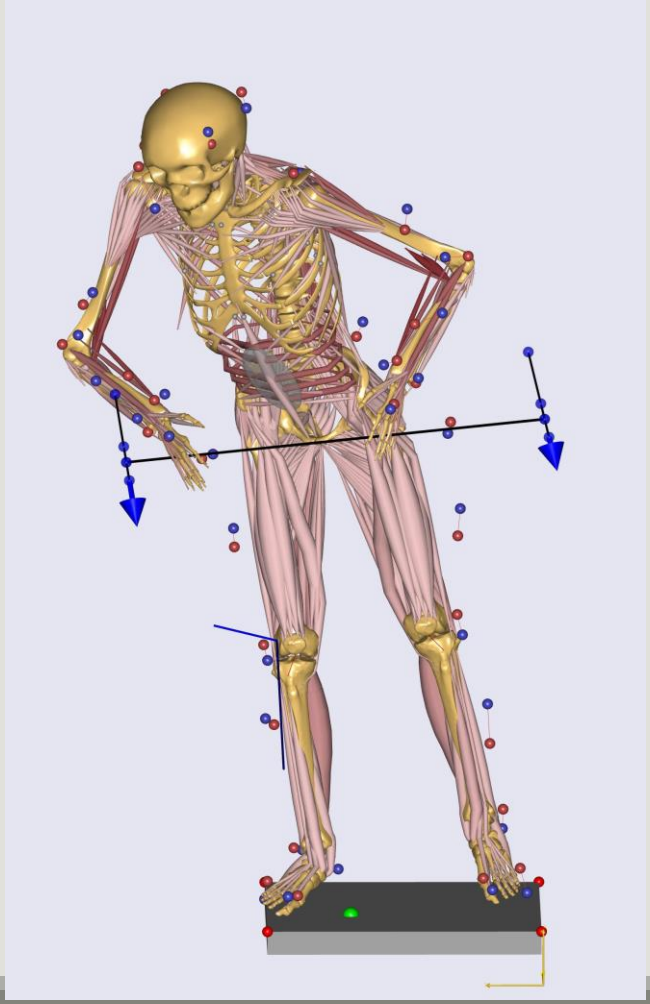
Implications for Care
(for most healthy caregivers)

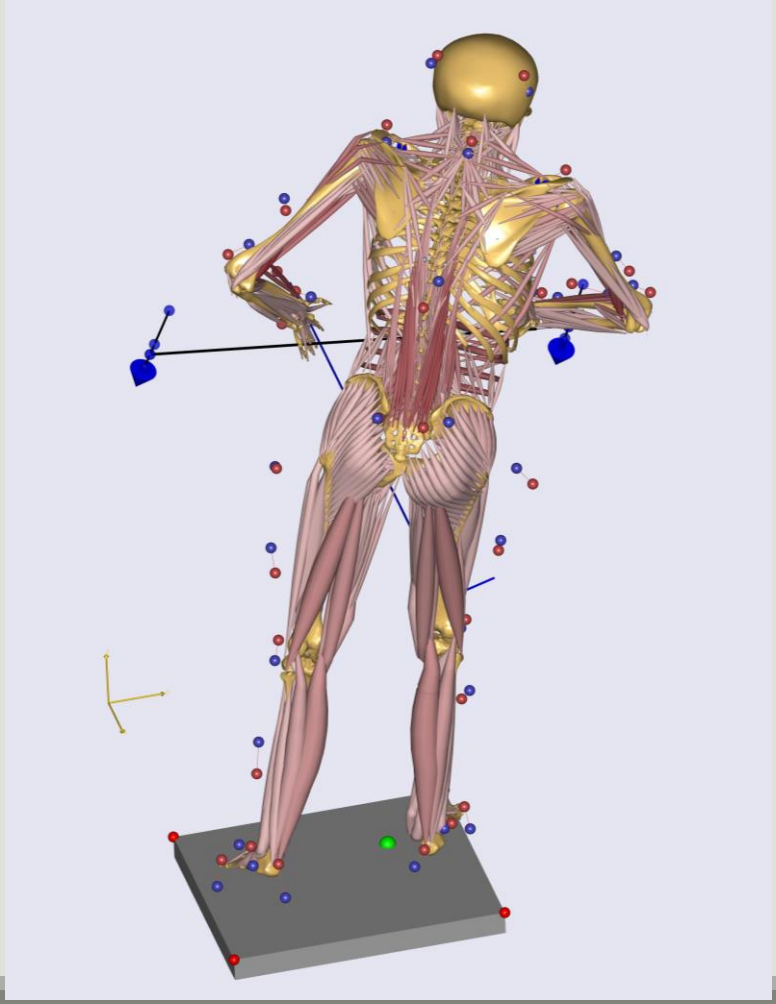
Lateral Repositioning, Pull up in bed, Lateral Transfer

- Unacceptable to perform manually (with draw sheet) for any size patient
- Friction Reducing Sheets acceptable for lighter patients
- Lift equipment required for patients with average to above average weight
- Air Assisted Transfer devices suitable alternative, at least up to 311 lbs
- Ceiling lifts with reposition slings will remain the lowest risk as air assisted devices require manual handling to roll under and off of each patient. Reposition slings may remain under the patient.

Compensatory Strategies

How do we perform tasks that our muscles do not have the strength to perform?





Staff Education: “What NOT to do”

Staff Education:
Proper Repositioning of a Patient

Conclusions

- For repositioning, pull force appears to drive injuries more than spinal compression due to high muscle activation and therefore compensation
- Repositioning aids reduce physical stress on caregivers. However, these aids are only appropriate for lighter patients
- Lift equipment or air assisted transfer devices are needed to safely reposition most patients.
- Due to the need to turn patients on and off of most air-assisted devices, a reposition sling and ceiling lift are most ideal.
- Most patients can be safely turned to place slings when considering disc compression forces and hand forces. However, caution should remain due to patient risk factors and employee injury data.