BEYOND TRADITIONAL ERGONOMICS

Identifying, Understanding, and Addressing Injury Risks

April 16, 2024

IHS
Industry Health Solutions

ERGONOMICS

- Derived from the Greek: ***ergon*** (work) and ***nomos*** (laws)

- Literally the ***“the laws or study of work.”***

“The Science of Work”

HIERARCHY OF CONTROLS

THE VALUE OF ERGONOMICS

- **Optimization of job performance** - safety, quality and productivity
- **Enhance effectiveness and efficiency**
- **Enhance desired human values**
  - improved safety
  - reduced fatigue
  - increased comfort
  - increased job satisfaction
  - improved quality of life
- **Fit the "work" to the individual** - decrease stress on the body

Decreased stress = decreased injury/illness

ERGONOMICS IN MEAT PROCESSING

1986 – "MET Program" was released

- "The **M**edical **E**rgonomics **T**raining Program: A Guide for the Poultry Industry"
- Guidance on
  - Training
  - Ergonomics
  - Medical Intervention
- Specific steps on implementing the three key points

1993 – "Ergonomics Guidelines for the Meatpacking Industry"

- Published by OSHA and the meat industry instituted industry wide programs to address high rate of MSD's

ERGONOMICS IN MEAT PROCESSING

Program Elements

- Worksite Analysis
- Hazard Prevention and Control
- Medical Management
- Training and Education

LOOKING DEEPER

Examine jobs/tasks critically

Framework for assessing the needs of your worksite.

- **Process**
- **Posture**
- **Workstations**
- **Equipment**
- **Material Handling**
- **Training**
- **Environment**
- **Administrative Controls**
- **Employee Feedback**

PROCESS

Process and Analysis is the First Step

Expectations for the position

- Pace of work
- Repetitions
    - Time per repetition / cycle rate
    - Efficiency of task
    - Quality of product

WHY?

- Understand effects of fatigue - how it contributes to soft tissue failure and injury
- Understand the effects of heavy single loads and failure
- Can occur in workstations that are designed correctly under ergonomics guidelines if process is not evaluated correctly

EFFECTS OF FATIGUE

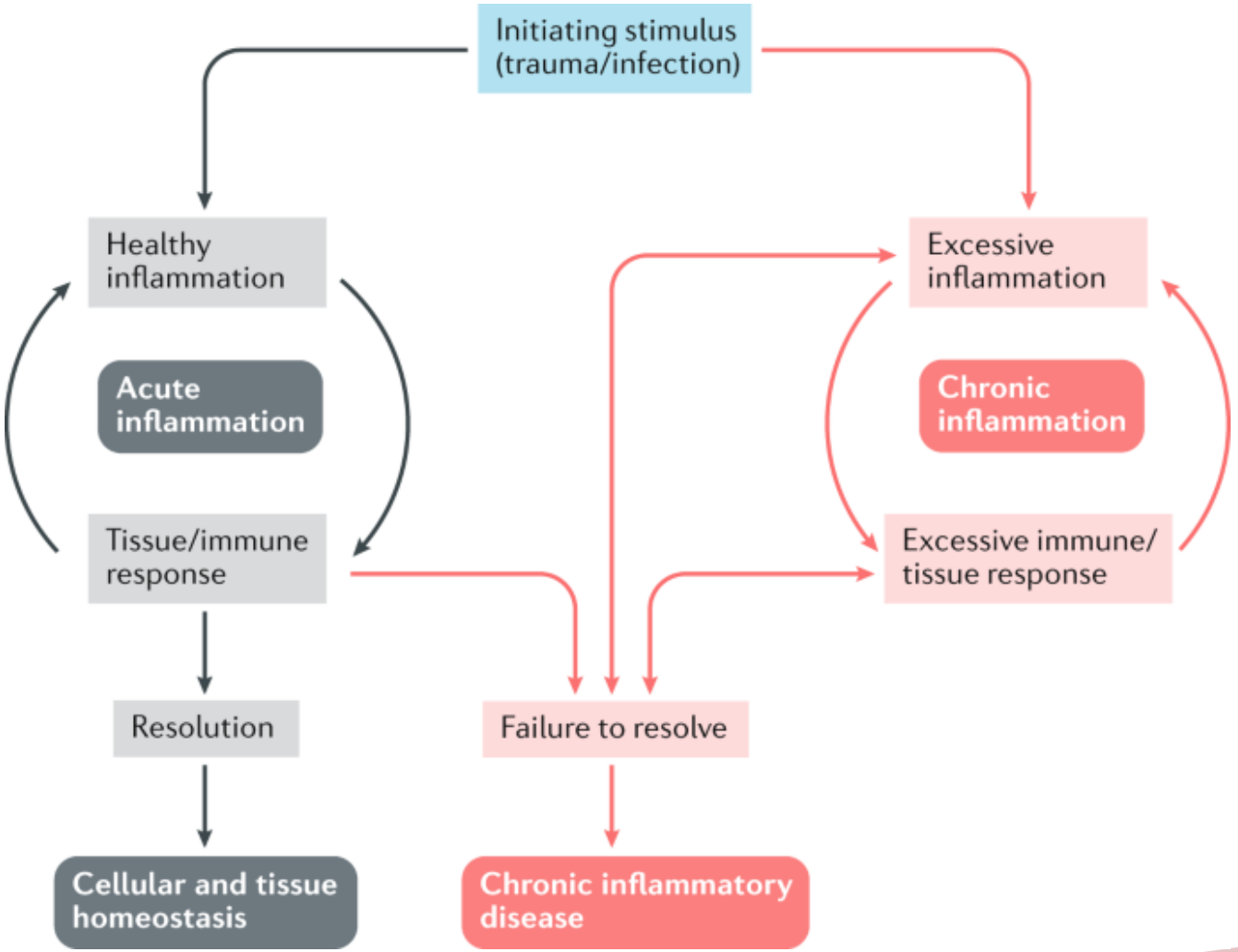
FATIGUE

Muscle Fatigue → Bundle Failure → Fibrile Disruption →

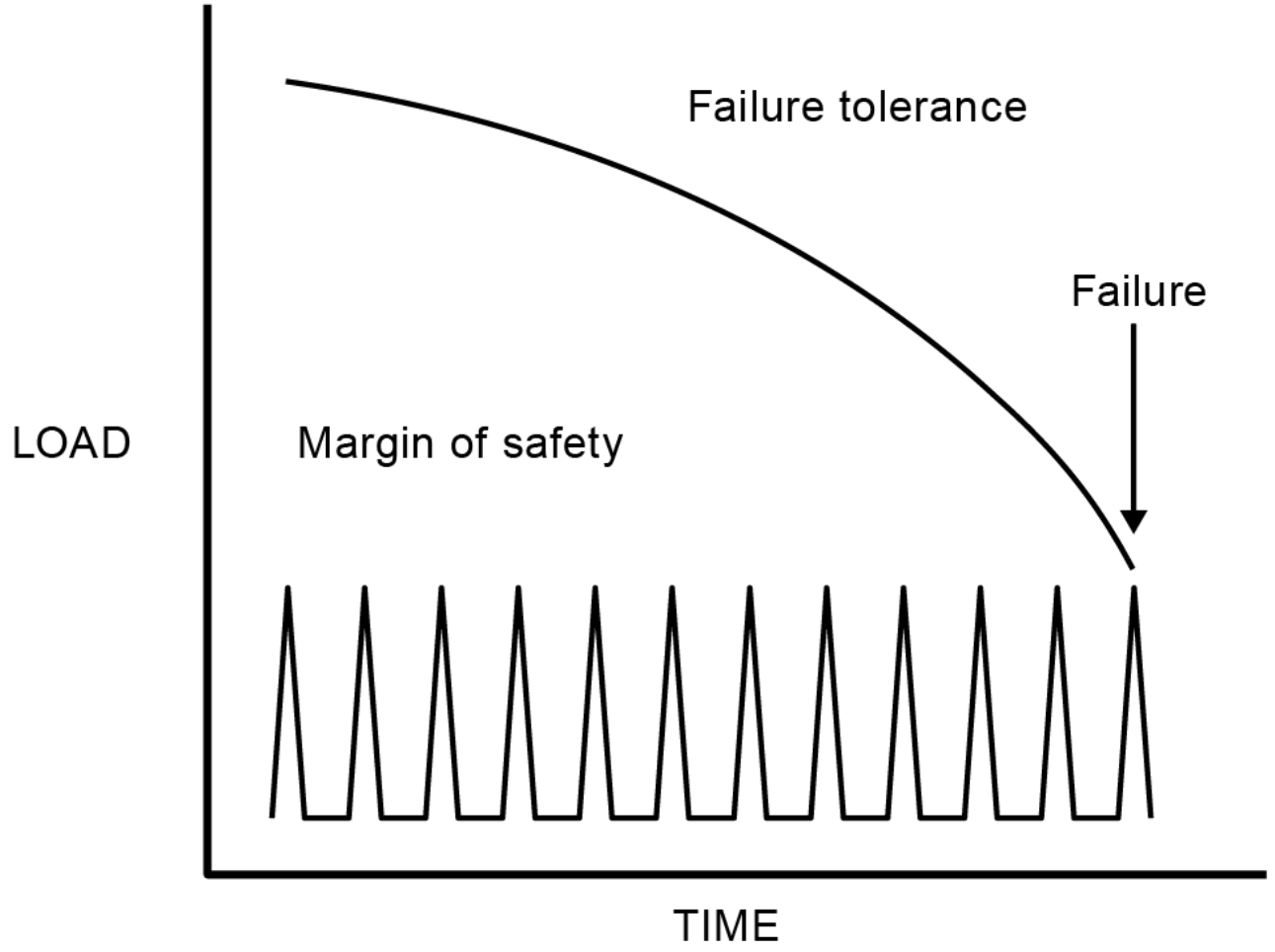
Inflammation → Impairment → Injury

INFLAMMATION CYCLE

Microtearing of Motor Units

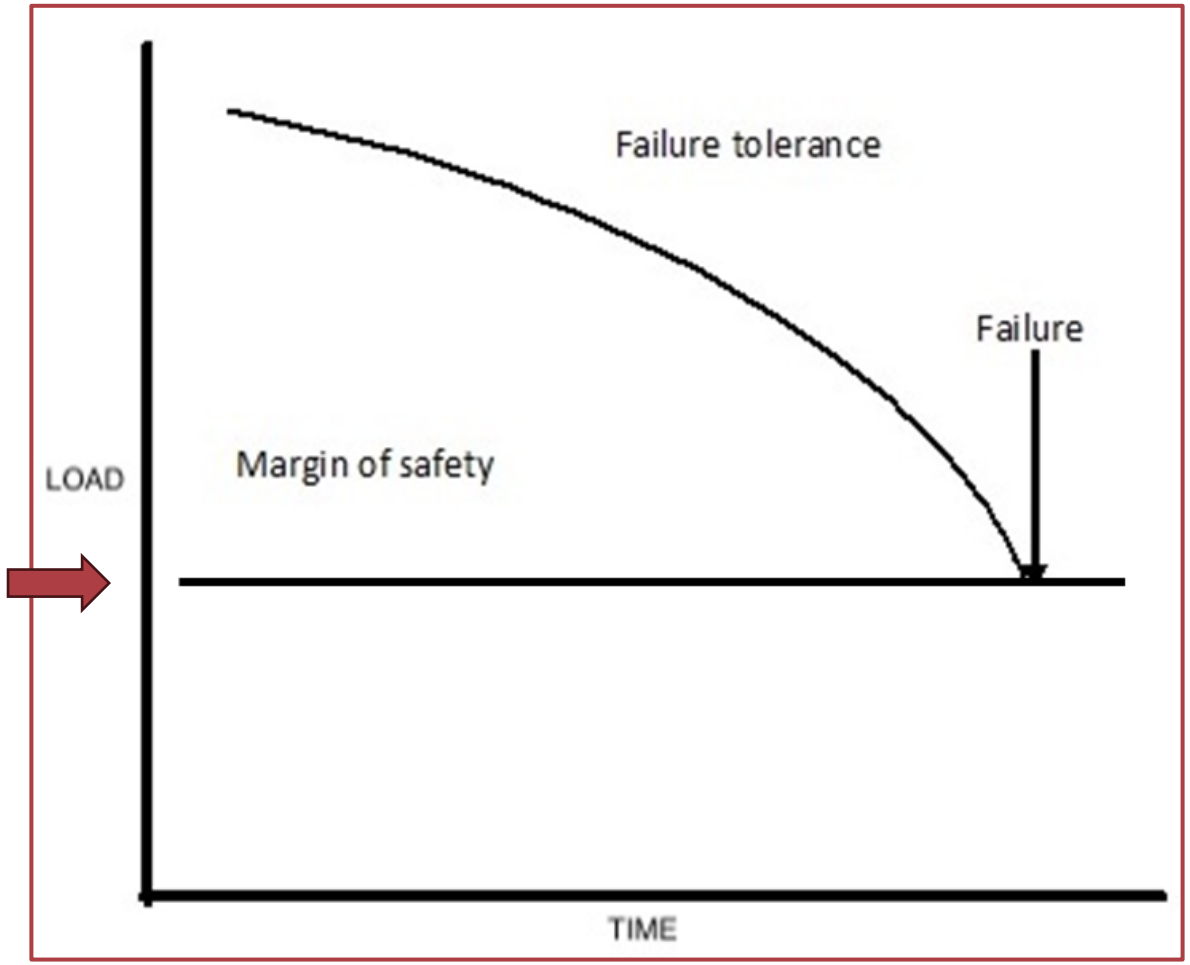


PROCESS

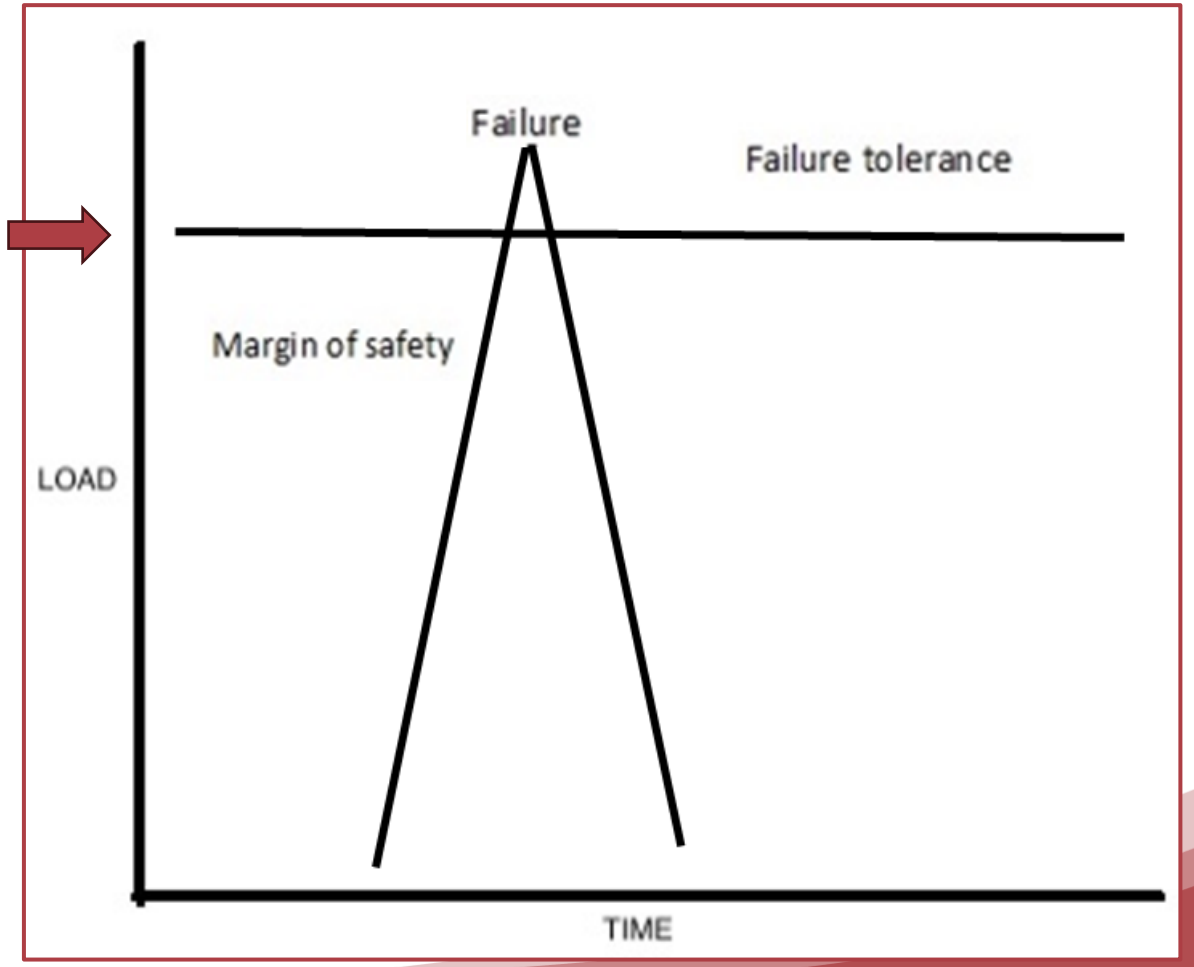


PROCESS

Sustained Load: Static flexion



High Single Load: Heavy Lift, Slip/Fall



PROCESS

Understanding the big picture

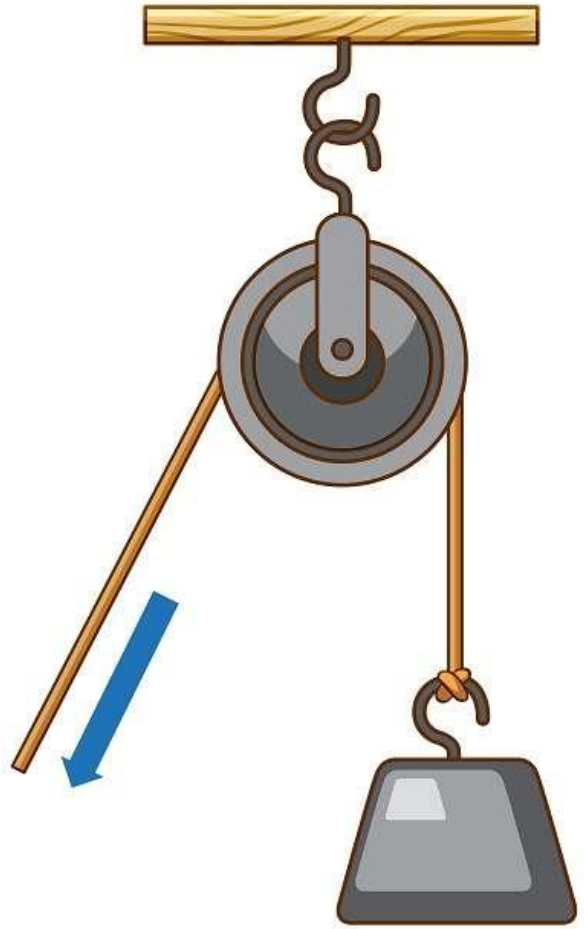
WHY?

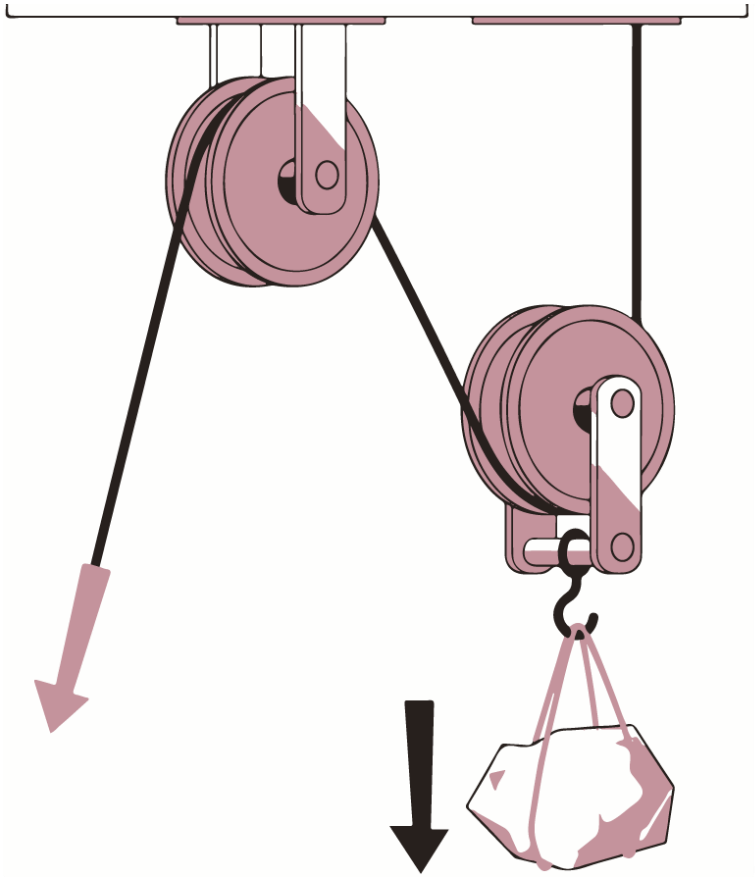
- **Develop contingency plans for process failures**
- **Prioritize issues**

POSTURE

- What is "awkward posture"?
- Why do we focus on posture/joint position?
- What to look for

EFFECTS OF PULLEYS





EFFECTS OF PULLEYS

LOAD: weight of object (Ham / Beef Round etc)

EFFORT: amount of force needed to lift or move the object

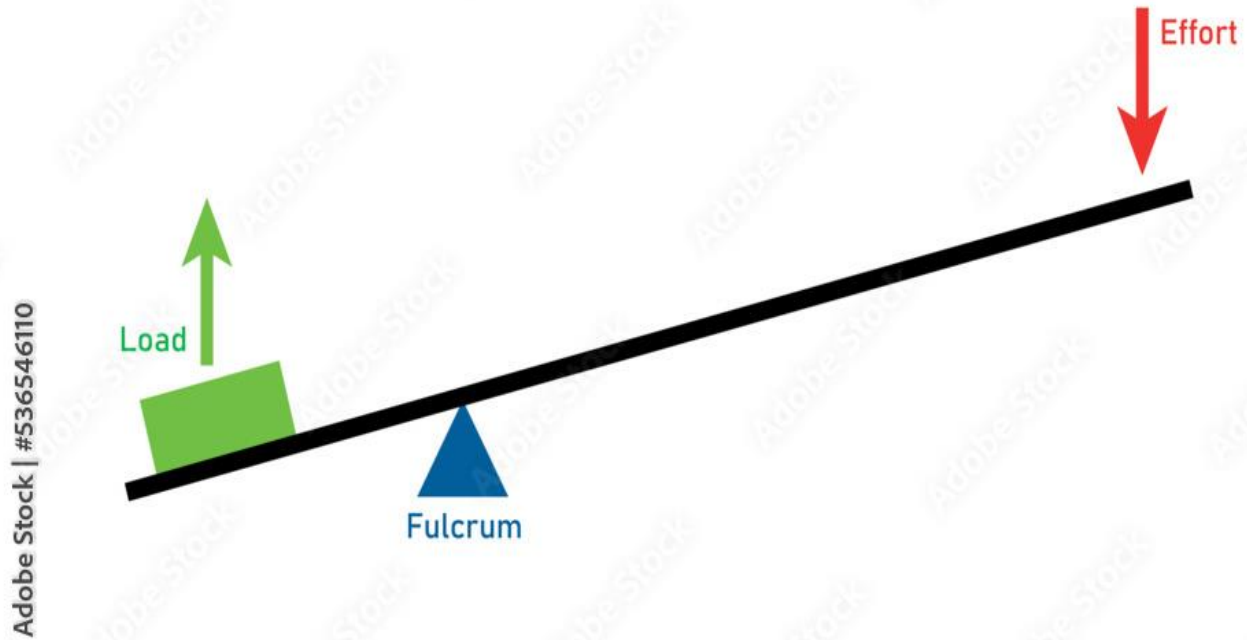
MECHANICAL ADVANTAGE: The factor by which a machine reduces effort (force) alteration when using an external device.

- 1 PULLEY = Mechanical advantage of 2 (40#/2 = 20#)
- 2 PULLEY = Mechanical advantage of 3 (40#/3 = 13#)
- 3 PULLEY = mechanical advantage of 4 (40#/4 = 10#)

The more pulleys, the easier the EFFORT

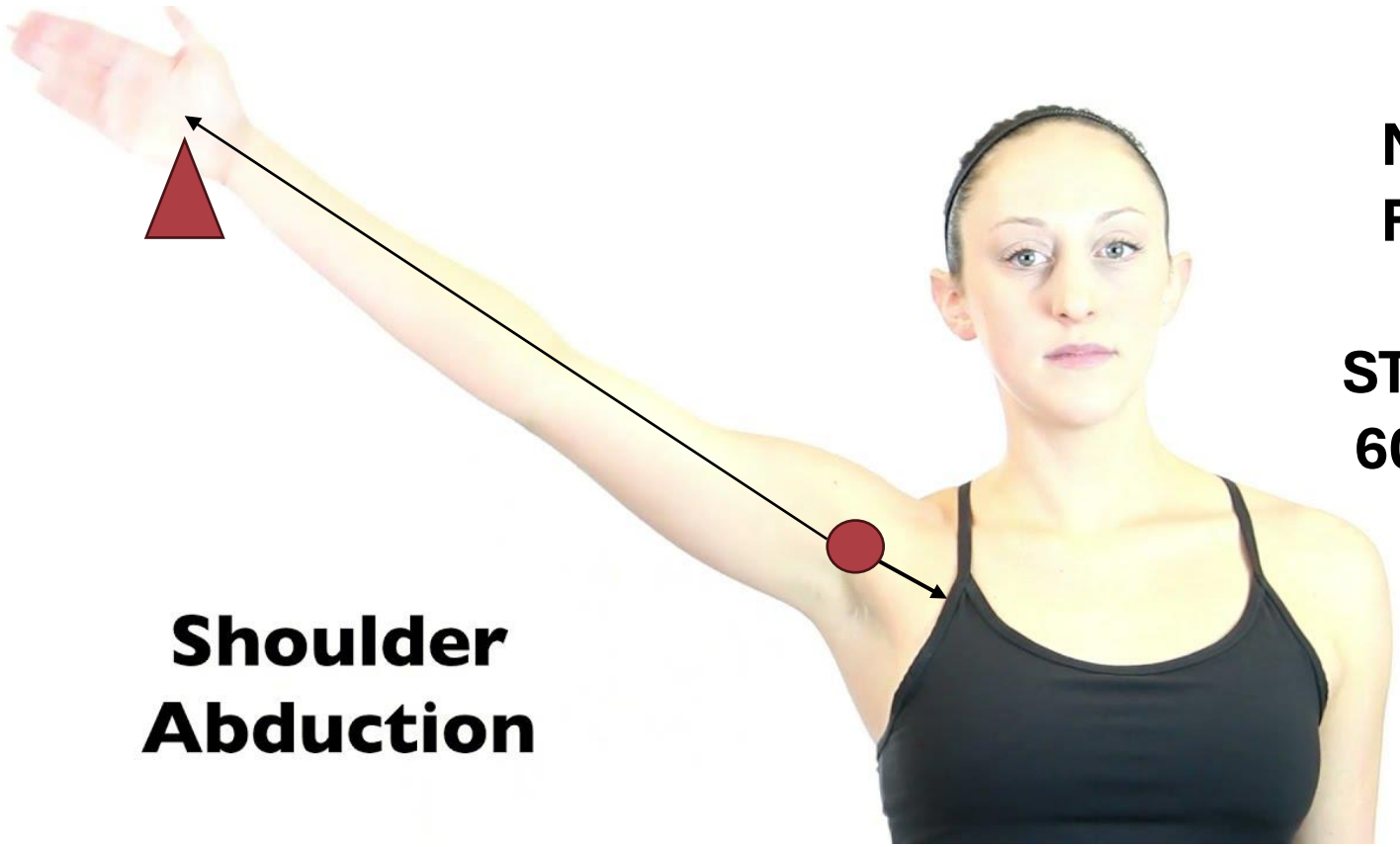
HOWEVER, the human body is not designed with effective pulleys and therefore has poor mechanical advantage at most joints.

EFFECTS OF LEVERS



MOMENT = FORCE X DISTANCE

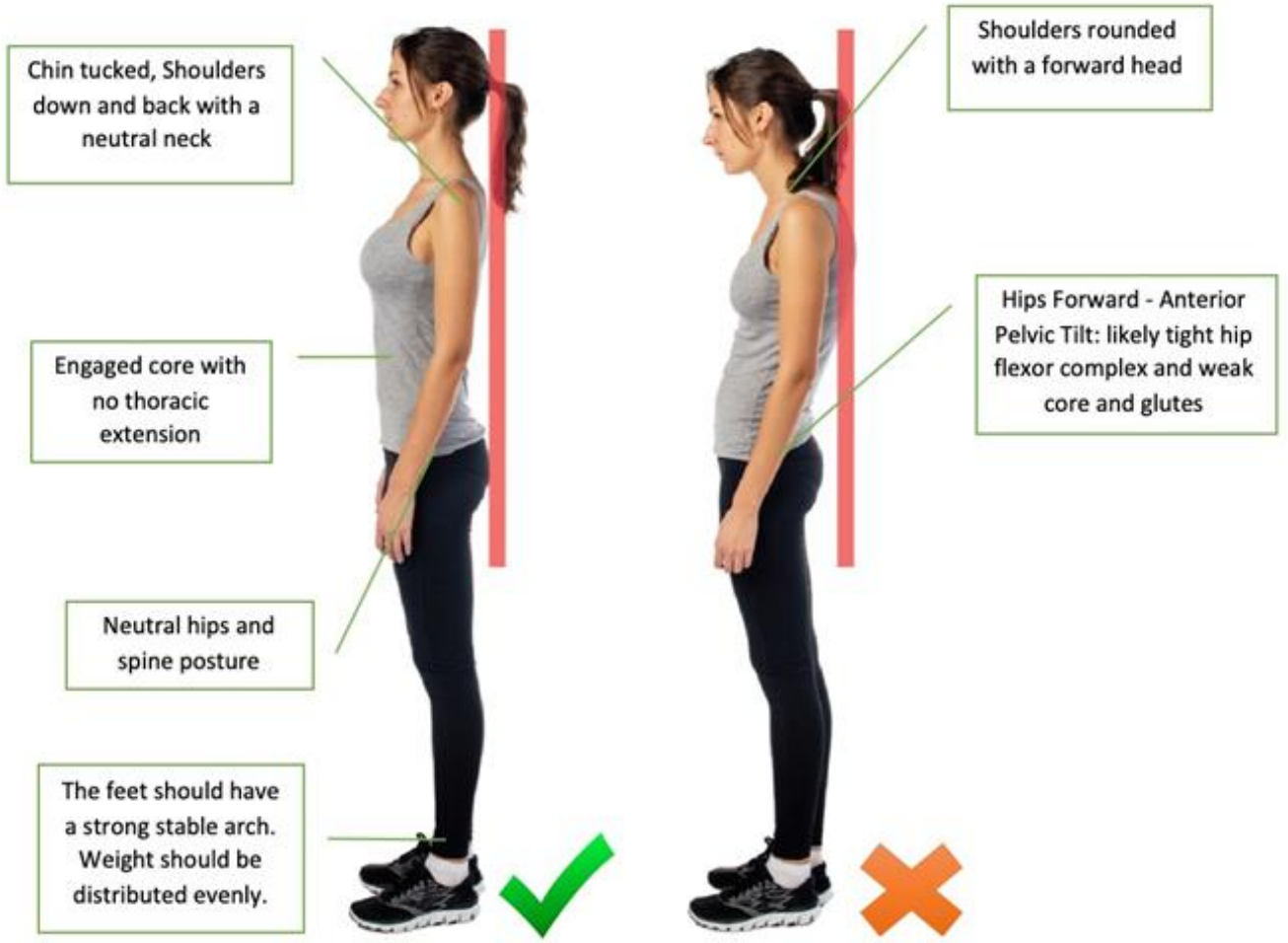
EFFECTS OF LEVERS

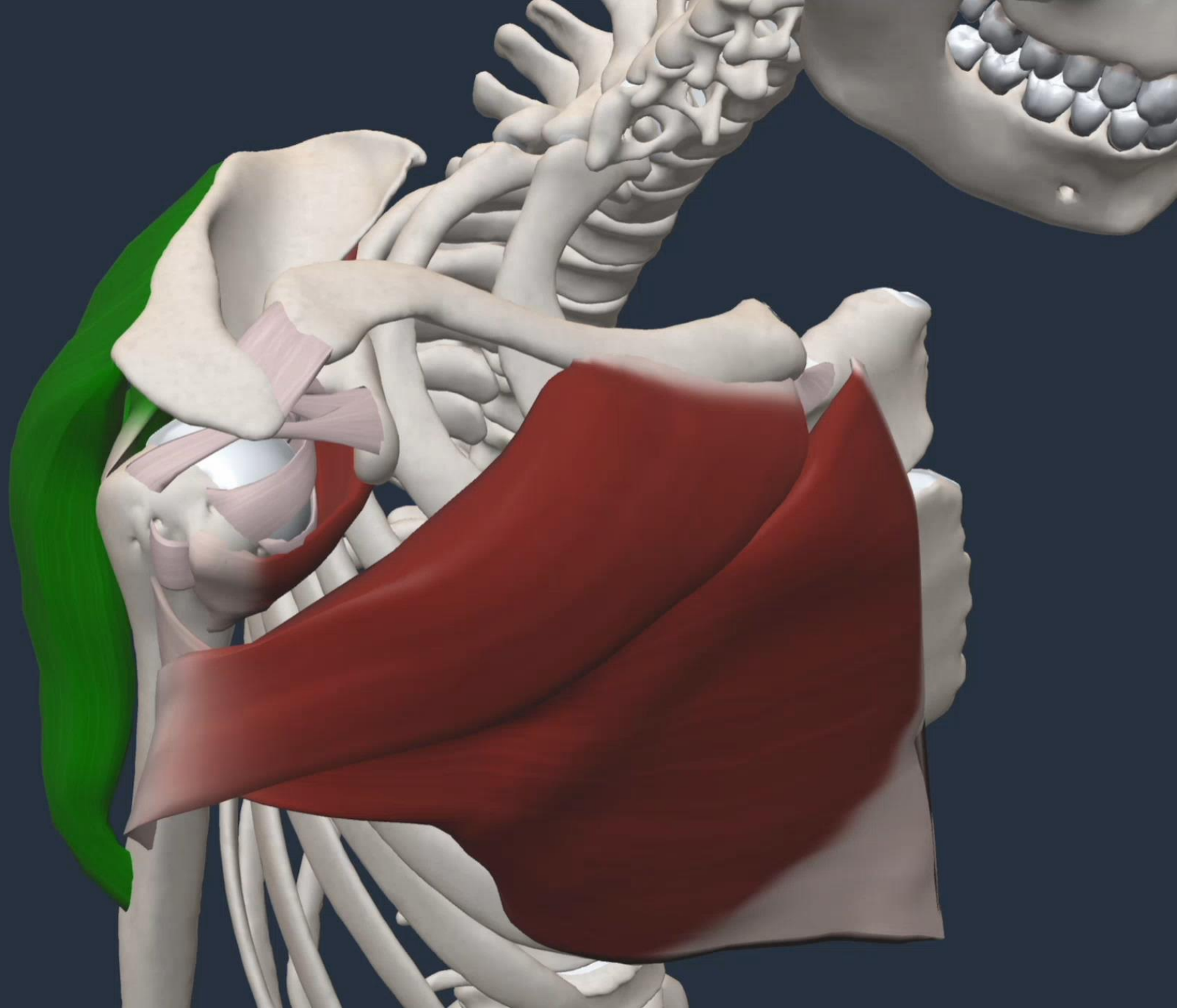


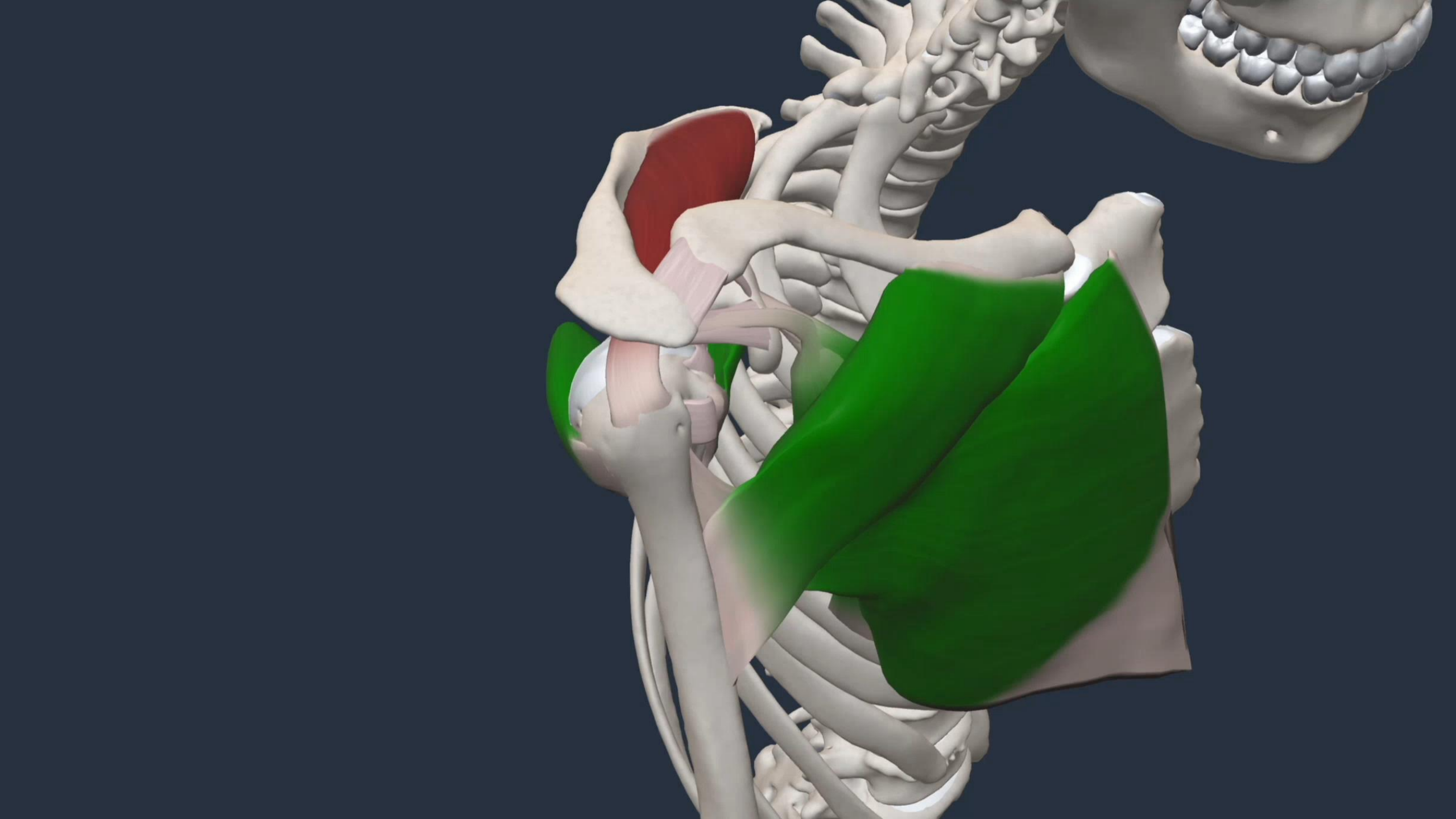
MOMENT =
FORCE X DISTANCE

STRAIN = 20# x 30” = 600 in/lb
600 in/lb ÷ 6” = 100#

POSTURE

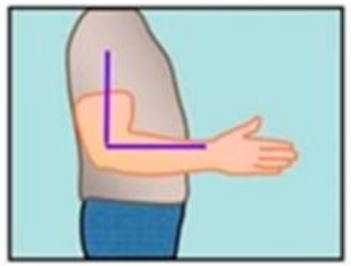

Chin tucked, Shoulders down and back with a neutral neck
Engaged core with no thoracic extension
Neutral hips and spine posture
The feet should have a strong stable arch. Weight should be distributed evenly.
Shoulders rounded with a forward head
Hips Forward - Anterior Pelvic Tilt: likely tight hip flexor complex and weak core and glutes

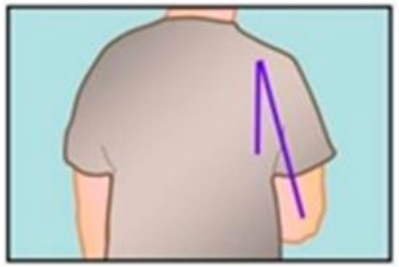




POSTURE

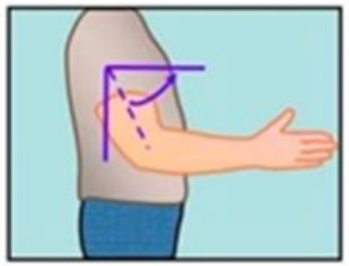
Neutral Posture



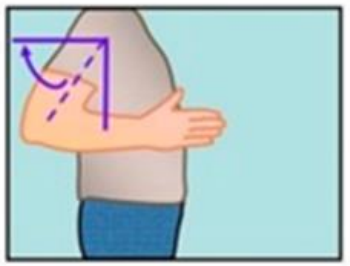


Awkward Postures

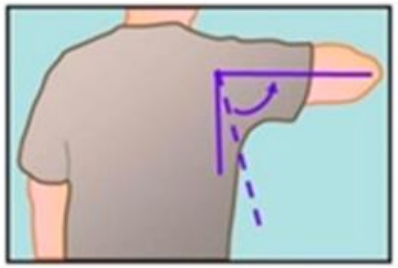
Shoulder Flexion



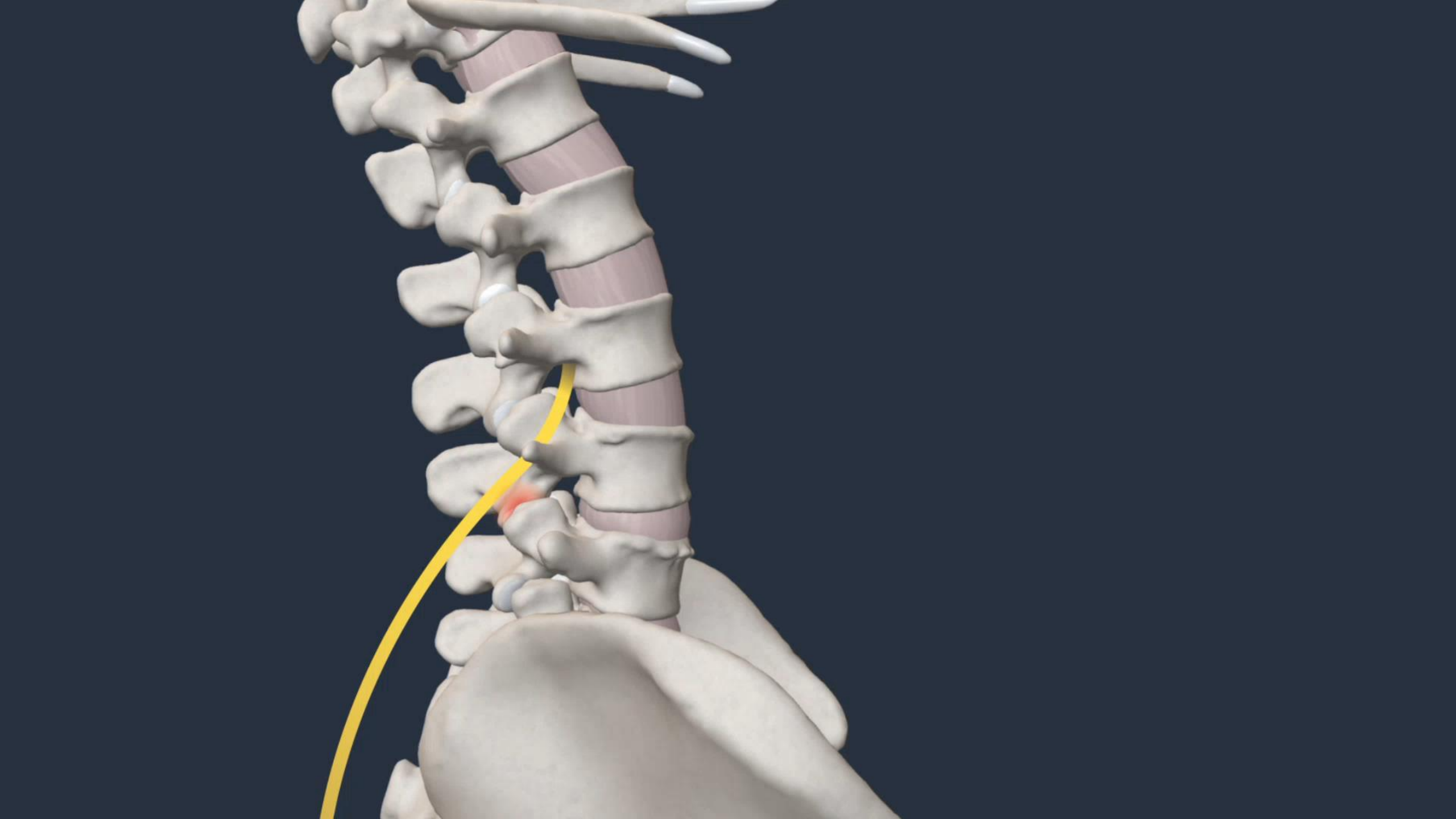
Shoulder Extension

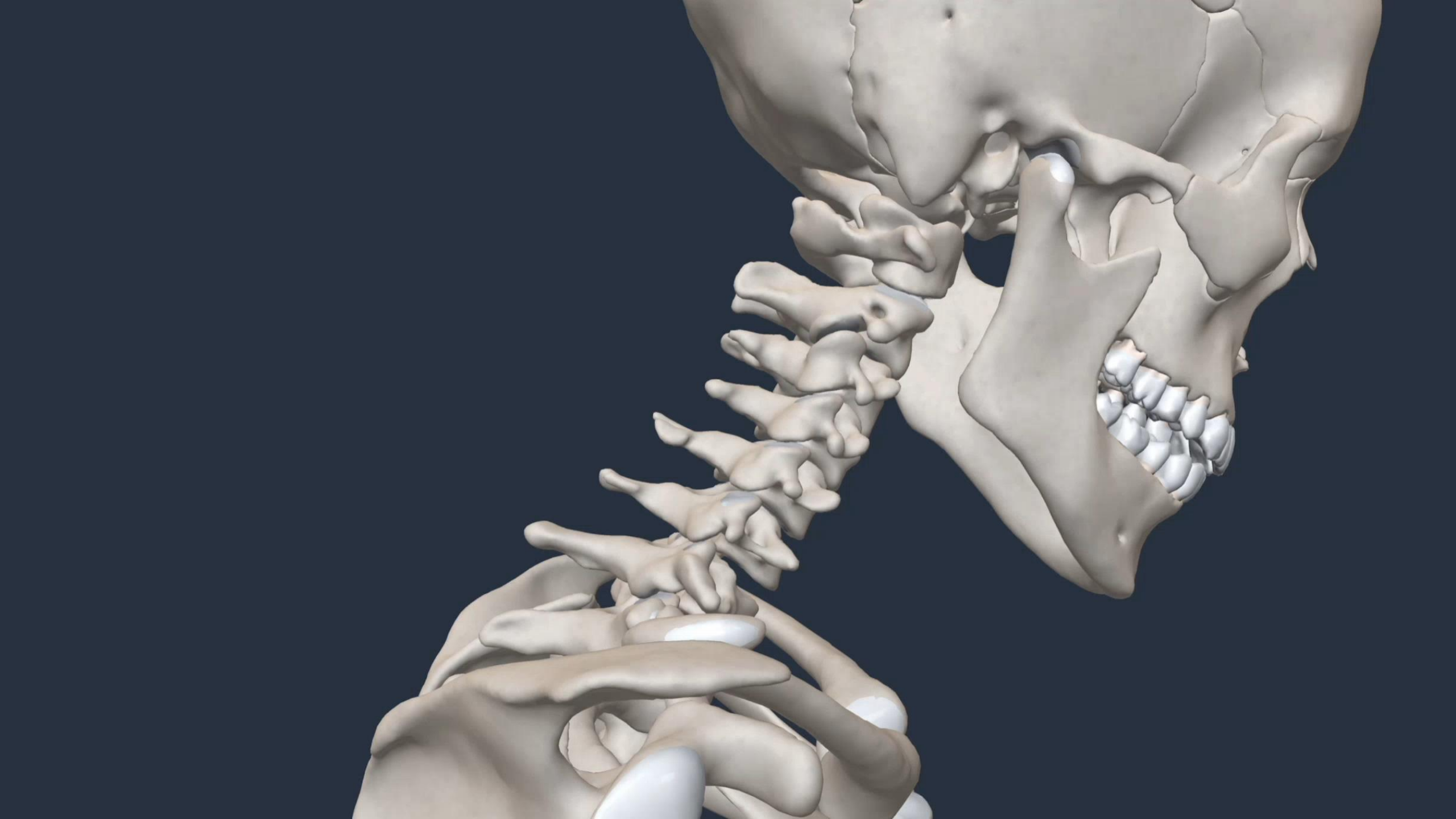


Shoulder Abduction



Shoulder Abduction & Extension





Posture

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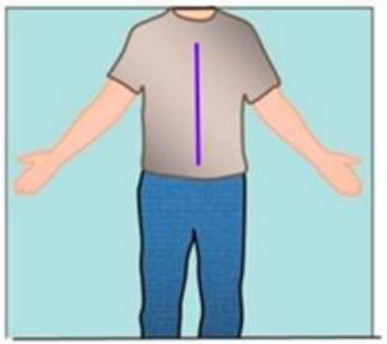
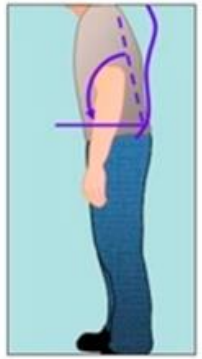
Neutral Posture

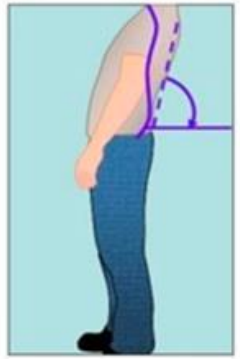


Awkward Postures

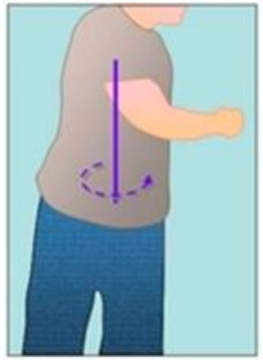
Back Flexion



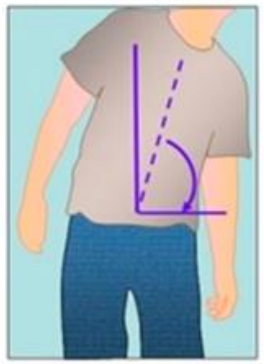
Back Extension

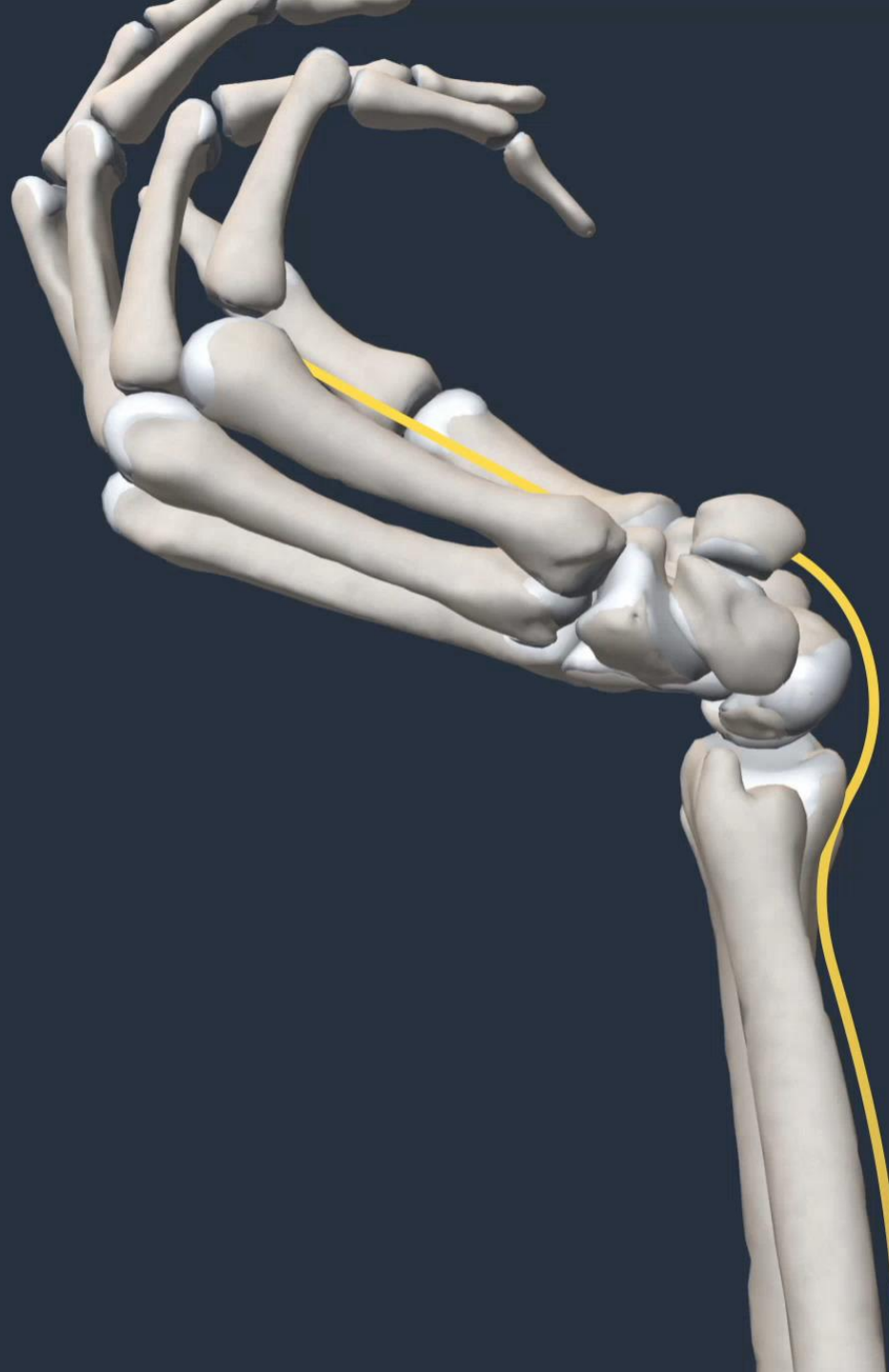


Twisting about Waist



Lateral Bending

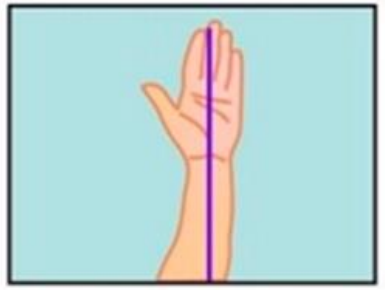




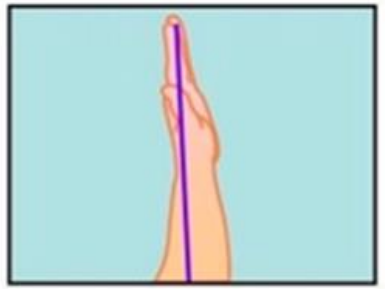
POSTURE

Neutral Posture

View #1
(minimal radial/ulnar deviation)

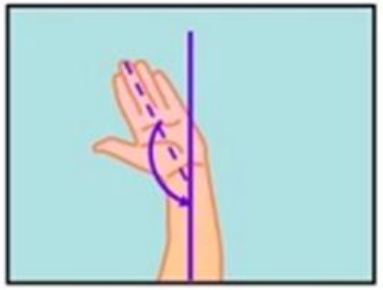


View #2
(minimal flexion/extension)

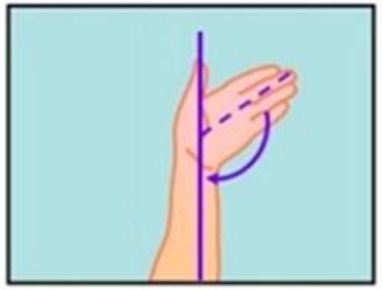


Awkward Postures

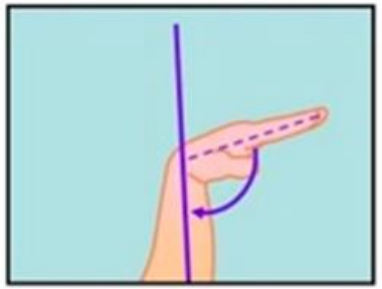
Radial Deviation



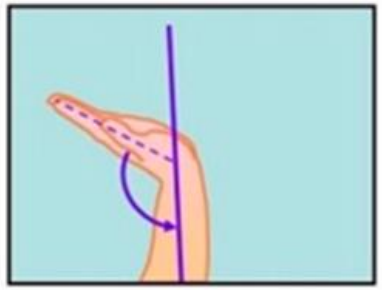
Ulnar Deviation



Flexion

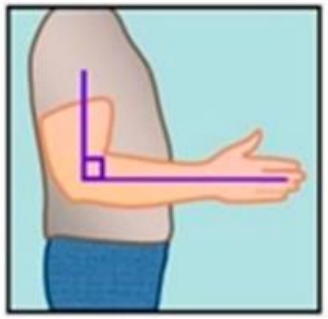


Extension



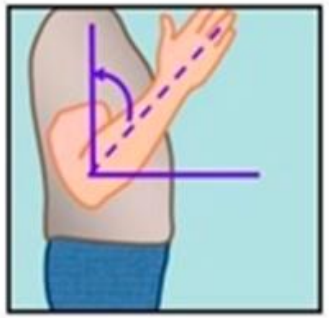
POSTURE

Neutral Posture



Awkward Postures

Elbow Flexion



Elbow Extension

WORKSTATION

- Guidelines
  - Power zone

- Anthropometrics and adapting your demographic

WORKSTATION

Power Zones

40-Pound box

Strain on Low Back from the weight of the load:

- 40 [lbs] x 6 [in] = 240 [in-lbs] **+** 960 [in-lbs] upper body = 1,200 [in-lbs] or **<u>400-600 POUNDS</u>**

- 40 # @ 18” = **560-840 POUNDS**
- 40 # @ 24” = **640-960 POUNDS**

40# box in Green zone vs Red Zone = 560 pounds

WORKSTATION

WORKSTATION

Understanding a workstation

- Demographics/Anthropometrics
- Hand-working height, not table height
- Adjustability
- Space to move
- Reach

WORKSTATION

- Age
- Gender
- Hand Dominance
- Health and Wellness

EQUIPMENT

EQUIPMENT

- Fit
- Application
- Maintenance

MATERIAL HANDLING

- Tools for handling
- “Proper” lifting mechanics
- Box Weight/Size guidelines

MATERIAL HANDLING

Scissor lift or load table

MATERIAL HANDLING

Hand cart/product rack design

MATERIAL HANDLING

The Squat – is it practical in most environments?

- **No.** Based on simple and impractical mechanics not designed for lifting in repetitive industrial settings

- Freestyle lifting mechanics and reduced physiological tax

MATERIAL HANDLING

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Box design

- Dimensions
- Weight
- Coupling
- Pallet Size

TRAINING

- Training program guidelines
- Work Hardening Programs

TRAINING

“Practice doesn’t make perfect…

Perfect practice makes perfect.”

TRAINING

Training program recommendation

- Controlled environment limiting paced work
- Technique driven and evaluated vs pace
- Documentation
- Trained trainers vs. experienced employees

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Work Hardening

TRAINING

Practice best job method

- SOP’s
- Proper guidelines and documentation of process
- Review SOP’s and expectations with trainee and do it consistently
- Use operations and safety resources available to review identified
- hazards of the workplace

TRAINING

Weeks 1-4

- Work limited to 40 hours/week

Weeks 5-6

- Work limited to 5 days/week

Weeks 7+

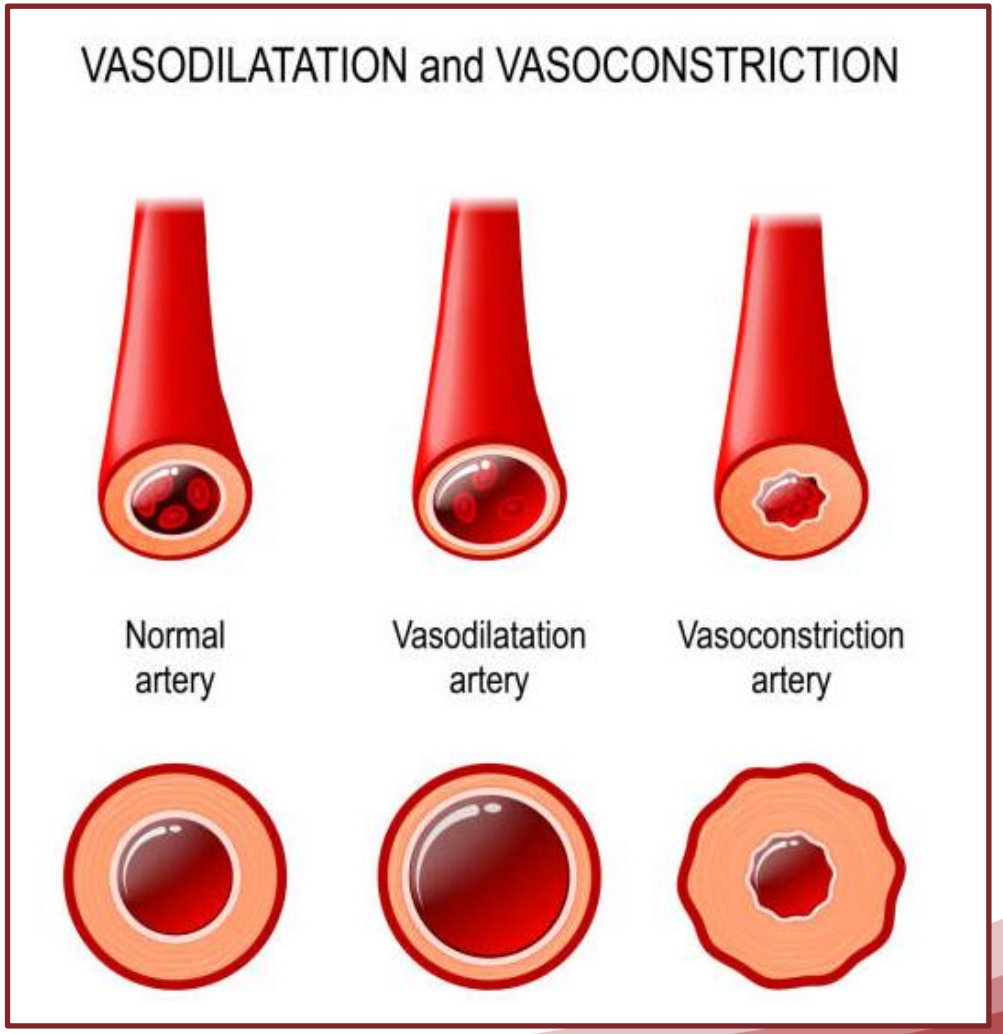
- Work all regular department hours and days
- Continue to monitor through touchpoints

ENVIRONMENT

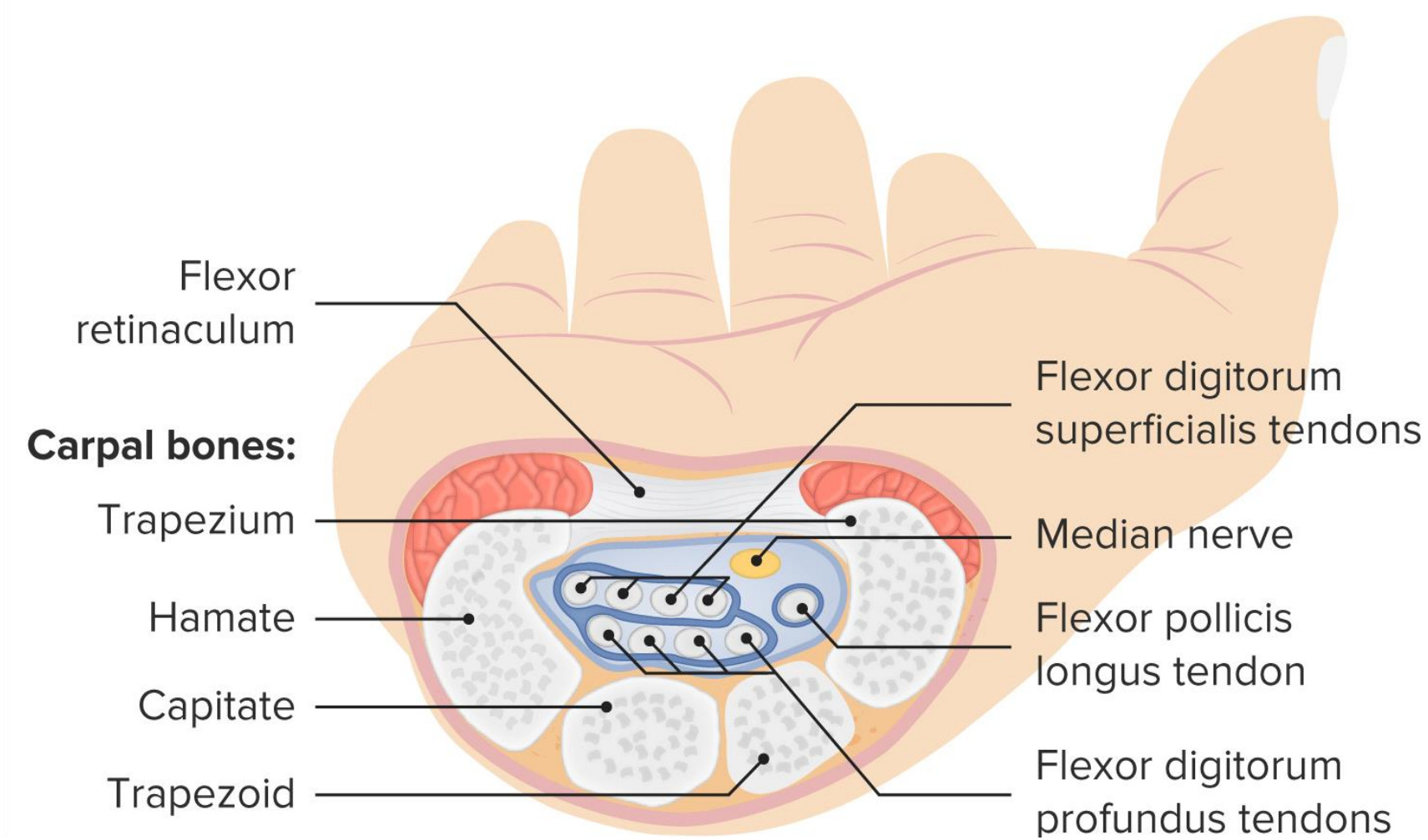
- Cold
- Wet
- Circulating airflow (convection)

Blood vessels constrict and chemical changes occur in the muscles.

Sensation, proprioception, and motor function in hands diminishes



ENVIRONMENT



ENVIRONMENT

- **Proper glove wear**
  - **Wool, polyester, nylon**
  - **Avoid cotton gloves**
    - Ineffective insulator
    - Absorbs moisture and becomes counterproductive immediately
  - **Layers**
    - Inspect layers - ensure workers are not wearing additional gloves that further **restrict blood flow** and **limit motion**

ADMINISTRATIVE CONTROLS

- **Controls - establish work practices that reduce duration, frequency, or intensity of exposure to hazards**
  - Job rotation
  - Breaks
  - Stretching programs

ADMINISTRATIVE CONTROLS

Rotations

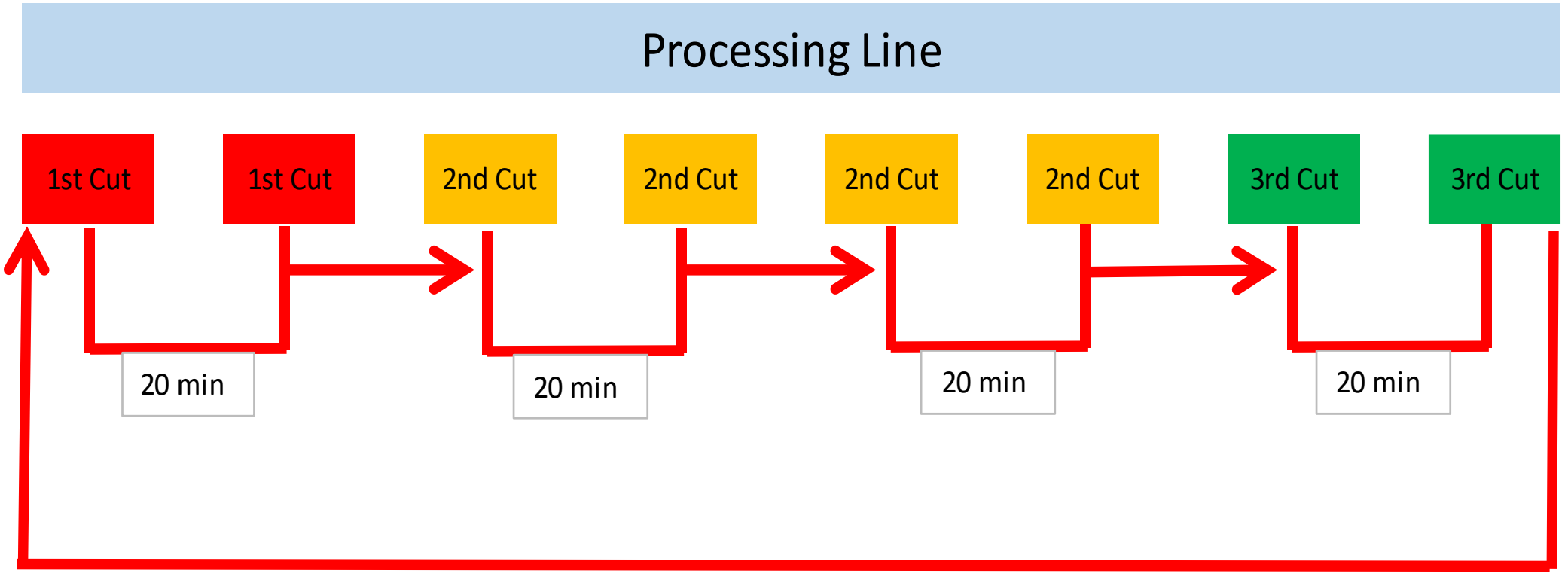
- Balancing risk
- Breaking monotony of positions
- Cross-training

Effective?

ADMINISTRATIVE CONTROLS

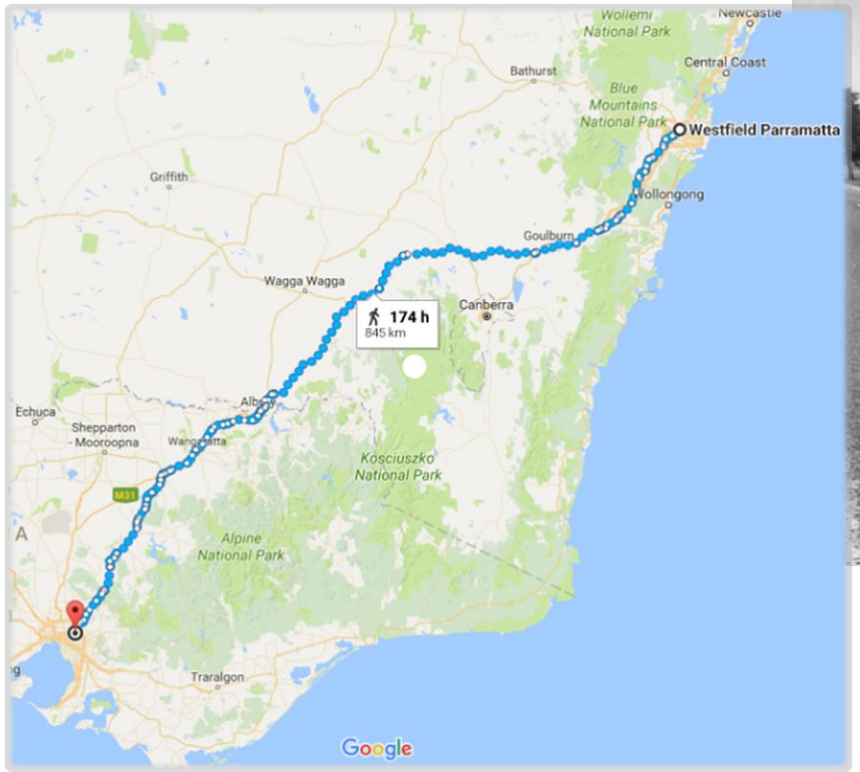
- 30 minute to 1 hour rotation
- Limit repeated body part exposure
- Job training
- Job enlargement

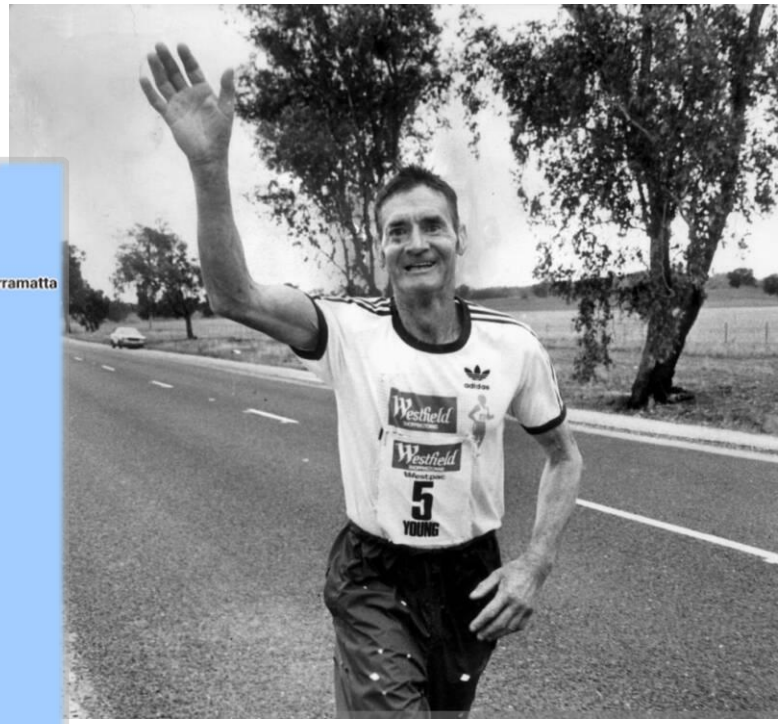
ADMINISTRATIVE CONTROLS



CONSERVING ENERGY

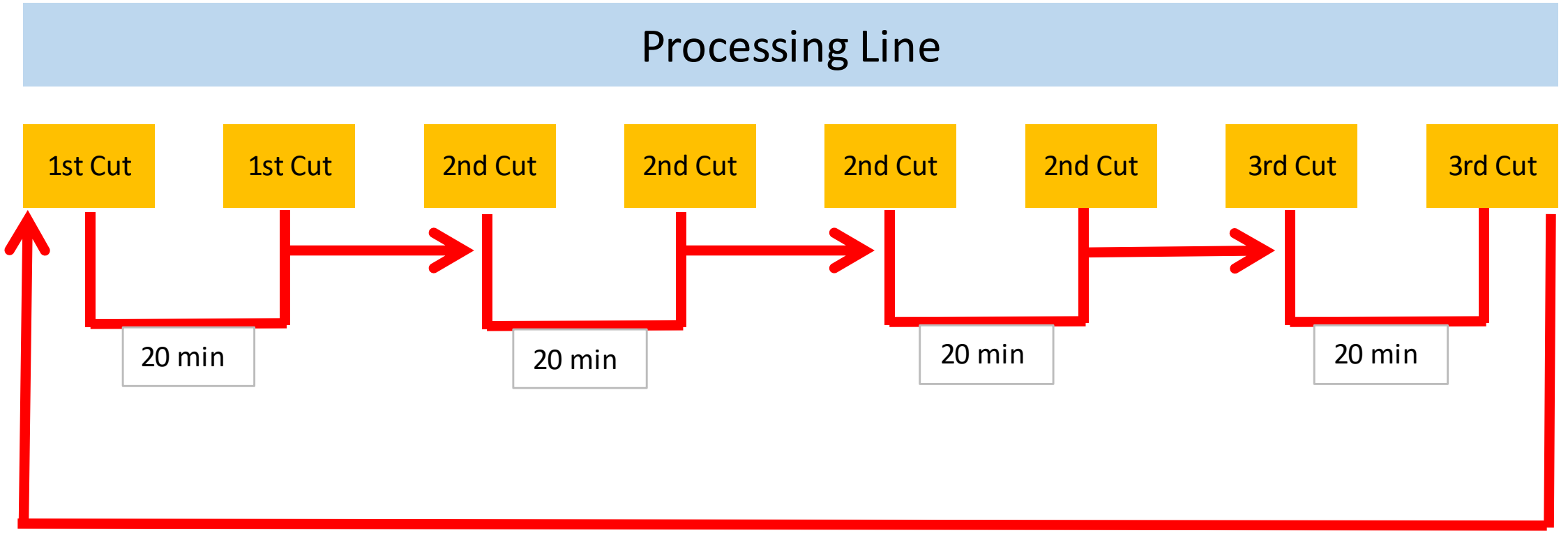
How a Potato Farmer won a 544 mile Marathon at age 61





Cliff Young

ADMINISTRATIVE CONTROLS



ERGONOMIC APPROACH

Employee Feedback

Feedback from people performing the job

- Utilize your most important asset
- Create a platform to allow employees to be involved in ergonomics programs
- Surveys

*RE*ACTIVE VS *PRO*ACTIVE APPROACH

Ergonomics programs start in the *reactive*

- Review OSHA log for high injury/Illness rates
- Prioritize areas for assessment and intervention
- Tackle the low cost/high impact solutions
  - "Low hanging fruit"

Sustain the program, but how?

Modify your approach to be *Proactive*

LOOK BELOW THE SURFACE

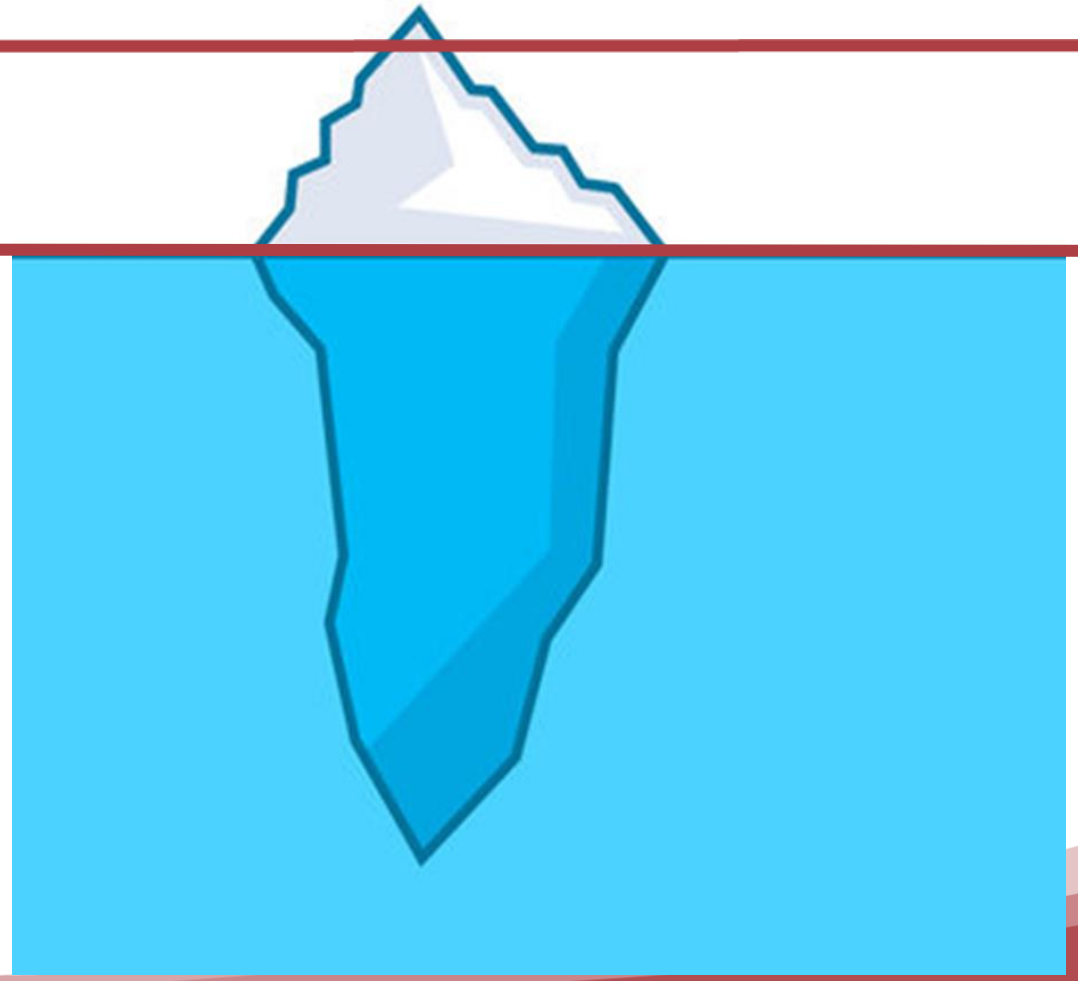
Recordable

First Aid

Discomfort

Near Misses

Employee Feedback



ERGONOMIC ASSESSMENT INSTRUMENTS

- **REBA** - Rapid Entire Body Assessment
- **RULA** - Rapid Upper Limbs Assessment
- Strain Index
- **NIOSH** lifting equations
- Liberty Mutual Material Handling Equations

REBA

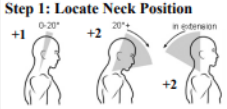
Rapid Entire Body Assessment

REBA Employee Assessment Worksheet

based on Technical note: Rapid Entire Body Assessment (REBA), Hignett, McAtamney, Applied Ergonomics 31 (2000) 201-205

A. Neck, Trunk and Leg Analysis

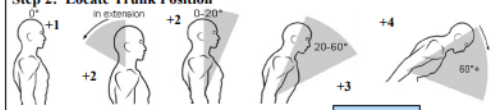
Step 1: Locate Neck Position



Step 1a: Adjust…
If neck is twisted: +1
If neck is side bending: +1

Neck Score

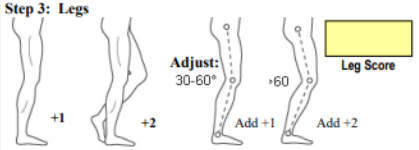
Step 2: Locate Trunk Position



Step 2a: Adjust…
If trunk is twisted: +1
If trunk is side bending: +1

Trunk Score

Step 3: Legs



Leg Score

Step 4: Look-up Posture Score in Table A
Using values from steps 1-3 above, locate score in Table A

Posture Score A

Step 5: Add Force/Load Score
If load < 11 lbs : +0
If load 11 to 22 lbs : +1
If load > 22 lbs: +2
Adjust: If shock or rapid build up of force: add +1

Force/Load Score

Step 6: Score A, Find Row in Table C
Add values from steps 4 & 5 to obtain Score A.
Find Row in **Table C**.

Score A

Scoring:
1 = negligible risk
2 or 3 = low risk, change may be needed
4 to 7 = medium risk, further investigation, change soon
8 to 10 = high risk, investigate and implement change
11+ = very high risk, implement change

SCORES

Table A

Trunk Posture Score	Legs	Neck 1				Neck 2				Neck 3			
		1	2	3	4	1	2	3	4	1	2	3	4
1		1	2	3	4	1	2	3	4	3	3	5	6
2		2	3	4	5	3	4	5	6	4	5	6	7
3		2	4	5	6	4	5	6	7	5	6	7	8
4		3	5	6	7	5	6	7	8	6	7	8	9
5		4	6	7	8	6	7	8	9	7	8	9	9

Table B

Upper Arm Score	Wrist	Lower Arm 1			Lower Arm 2		
		1	2	3	1	2	3
1		1	2	2	1	2	3
2		1	2	3	2	3	4
3		3	4	5	4	5	5
4		4	5	5	5	6	7
5		6	7	8	7	8	8
6		7	8	8	8	9	9

Table C

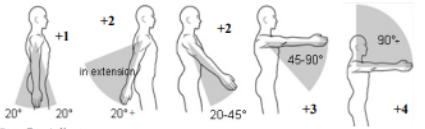
Score A (score from table A +load/force score)	Score B, (table B value +coupling score) 1	2	3	4	5	6	7	8	9	10	11	12
1	1	1	1	2	3	3	4	5	6	7	7	7
2	1	2	2	3	4	4	5	6	6	7	7	8
3	2	3	3	3	4	5	6	7	7	8	8	8
4	3	4	4	4	5	6	7	8	8	9	9	9
5	4	4	4	5	6	7	8	8	9	9	9	9
6	6	6	6	7	8	8	9	9	10	10	10	10
7	7	7	7	8	9	9	9	10	10	11	11	11
8	8	8	8	9	10	10	10	10	10	11	11	11
9	9	9	9	10	10	10	11	11	11	12	12	12
10	10	10	10	11	11	11	11	12	12	12	12	12
11	11	11	11	11	12	12	12	12	12	12	12	12
12	12	12	12	12	12	12	12	12	12	12	12	12

Table C Score + Activity Score

Final REBA Score

B. Arm and Wrist Analysis

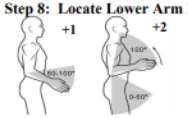
Step 7: Locate Upper Arm Position:



Step 7a: Adjust…
If shoulder is raised: +1
If upper arm is abducted: +1
If arm is supported or person is leaning: -1

Upper Arm Score

Step 8: Locate Lower Arm Position:



Lower Arm Score

Step 9: Locate Wrist Position:

Step 9a: Adjust…
If wrist is bent from midline or twisted : Add +1

Wrist Score

Step 10: Look-up Posture Score in Table B
Using values from steps 7-9 above, locate score in Table B

Posture Score B

Step 11: Add Coupling Score
Well fitting Handle and mid rang power grip, ***good: +0***
Acceptable but not ideal hand hold or coupling acceptable with another body part, ***fair: +1***
Hand hold not acceptable but possible, ***poor: +2***
No handles, awkward, unsafe with any body part, ***Unacceptable: +3***

Coupling Score

Step 12: Score B, Find Column in Table C
Add values from steps 10 &11 to obtain Score B. Find column in **Table C** and match with Score A in row from step 6 to obtain Table C Score.

Score B

Step 13: Activity Score
+1 1 or more body parts are held for longer than 1 minute (static)
+1 Repeated small range actions (more than 4x per minute)
+1 Action causes rapid large range changes in postures or unstable base

Task name: _____ Reviewer: _____ Date: _____/_____/_____

provided by Practical Ergonomics

This tool is provided without warranty. The author has provided this tool as a simple means for applying the concepts provided in REBA .

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REBA

Rapid Entire Body Assessment

Used to "rapidly" evaluate the risk of developing MSDs associated with certain job tasks

Pros

- Simple postural analysis
- Divides body into segments with reference to postures and movement planes
- Provides a scoring system for static, dynamic, rapid changing, and unstable postures
- Considers coupling with handling loads
- Simple; user friendly

Cons

- Does not consider duration, recovery time, or hand/arm vibration
- Only evaluates are worst case posture

Tools

- Goniometer
- Camera; photos and videos

REBA

Rapid Entire Body Assessment

Looks at

- Neck, Trunk, Legs
  - Neck position
  - Trunk position
  - Leg position
  - Force/Load score
- Arm and Wrist
  - Upper arm position
  - Lower arm position
  - Wrist position
  - Coupling score
  - Activity score

This assessment is good for

- Any job that uses the entire body
- Packers/Palletizers
- PIT OPs
- Warehouse Ops
- In conjunction with a lifting assessment like NIOSH

RULA

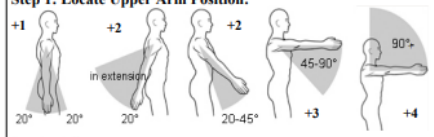
Rapid Upper Limb Assessment

RULA Employee Assessment Worksheet

based on RULA: a survey method for the investigation of work-related upper limb disorders, McAtamney & Corlett, Applied Ergonomics 1993, 24(2), 91-99

A. Arm and Wrist Analysis

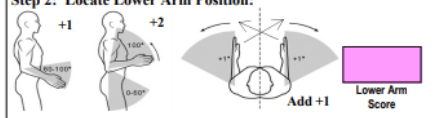
Step 1: Locate Upper Arm Position:



Step 1a: Adjust…
If shoulder is raised: +1
If upper arm is abducted: +1
If arm is supported or person is leaning: -1

Upper Arm Score

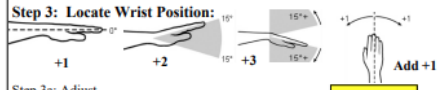
Step 2: Locate Lower Arm Position:



Lower Arm Score

Step 2a: Adjust…
If either arm is working across midline or out to side of body: Add +1

Step 3: Locate Wrist Position:



Step 3a: Adjust…
If wrist is bent from midline: Add +1

Wrist Score

Step 4: Wrist Twist:
If wrist is twisted in mid-range: +1
If wrist is at or near end of range: +2

Wrist Twist Score

Step 5: Look-up Posture Score in Table A:
Using values from steps 1-4 above, locate score in Table A

Posture Score A

+

Step 6: Add Muscle Use Score
If posture mainly static (i.e. held>10 minutes),
Or if action repeated occurs 4X per minute: +1

Muscle Use Score

+

Step 7: Add Force/Load Score
If load < .4.4 lbs (intermittent): +0
If load 4.4 to 22 lbs (intermittent): +1
If load 4.4 to 22 lbs (static or repeated): +2
If more than 22 lbs or repeated or shocks: +3

Force/Load Score

=

Step 8: Find Row in Table C
Add values from steps 5-7 to obtain
Wrist and Arm Score. Find row in **Table C**.

Wrist & Arm Score

SCORES

Table A: Wrist Posture Score

Upper Arm	Lower Arm	1 Wrist Twist 1	1 Wrist Twist 2	2 Wrist Twist 1	2 Wrist Twist 2	3 Wrist Twist 1	3 Wrist Twist 2	4 Wrist Twist 1	4 Wrist Twist 2
1	1	1	2	2	2	3	3	3	3
	2	2	2	2	2	3	3	3	3
	3	2	3	3	3	3	3	4	4
2	1	2	3	3	3	3	4	4	4
	2	3	3	3	3	3	4	4	4
	3	3	4	4	4	4	4	5	5
3	1	3	3	4	4	4	4	5	5
	2	3	4	4	4	4	4	5	5
	3	4	4	4	4	4	5	5	5
4	1	4	4	4	4	4	5	5	5
	2	4	4	4	4	4	5	5	5
	3	4	4	4	5	5	5	6	6
5	1	5	5	5	5	5	6	6	7
	2	5	6	6	6	6	7	7	7
	3	6	6	6	7	7	7	7	8
6	1	7	7	7	7	7	8	8	9
	2	8	8	8	8	8	9	9	9
	3	9	9	9	9	9	9	9	9

Table C: Neck, trunk and leg score

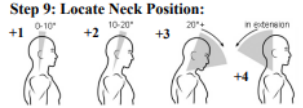
Wrist and Arm Score	1	2	3	4	5	6	7+
1	1	2	3	3	4	5	5
2	2	2	3	4	4	5	5
3	3	3	3	4	4	5	6
4	3	3	3	4	5	6	6
5	4	4	4	5	6	7	7
6	4	4	5	6	6	7	7
7	5	5	6	6	7	7	7
8+	5	5	6	7	7	7	7

Scoring: (final score from Table C)
1 or 2 = acceptable posture
3 or 4 = further investigation, change may be needed
5 or 6 = further investigation, change soon
7 = investigate and implement change

Final Score

B. Neck, Trunk and Leg Analysis

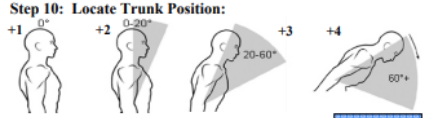
Step 9: Locate Neck Position:



Step 9a: Adjust…
If neck is twisted: +1
If neck is side bending: +1

Neck Score

Step 10: Locate Trunk Position:



Step 10a: Adjust…
If trunk is twisted: +1
If trunk is side bending: +1

Trunk Score

Step 11: Legs:
If legs and feet are supported: +1
If not: +2

Leg Score

Table B: Trunk Posture Score

Neck Posture Score	1 Legs 1	1 Legs 2	2 Legs 1	2 Legs 2	3 Legs 1	3 Legs 2	4 Legs 1	4 Legs 2	5 Legs 1	5 Legs 2	6 Legs 1	6 Legs 2
1	1	3	2	3	3	4	5	5	6	6	7	7
2	2	3	2	3	4	5	5	5	6	7	7	7
3	3	3	3	4	4	5	5	6	6	7	7	7
4	5	5	5	6	6	7	7	7	7	8	8	
5	7	7	7	7	8	8	8	8	8	8	8	
6	8	8	8	8	8	8	9	9	9	9	9	

Step 12: Look-up Posture Score in Table B:
Using values from steps 9-11 above,
locate score in Table B

Posture Score B

+

Step 13: Add Muscle Use Score
If posture mainly static (i.e. held>10 minutes),
Or if action repeated occurs 4X per minute: +1

Muscle Use Score

+

Step 14: Add Force/Load Score
If load < .4.4 lbs (intermittent): +0
If load 4.4 to 22 lbs (intermittent): +1
If load 4.4 to 22 lbs (static or repeated): +2
If more than 22 lbs or repeated or shocks: +3

Force/Load Score

=

Step 15: Find Column in Table C
Add values from steps 12-14 to obtain
Neck, Trunk and Leg Score. Find Column in **Table C**.

Neck, Trunk & Leg Score

Task name: _____ Reviewer: _____ Date: ____/____/____

provided by Practical Ergonomics

This tool is provided without warranty. The author has provided this tool as a simple means for applying the concepts provided in RULA .

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RULA

Rapid Upper Limb Assessment

Used to "rapidly" evaluate the exposure of an individual worker, for risk of developing upper limb MSD

Pros

- Provides a method of screening to assess exposure to risk factors leading to upper extremity "illnesses"
- Evaluates factors that contribute to muscle fatigue (postures, excessive forces, static or repetitive, etc.)
- Simple end score and user friendly

Cons

- Duration, available recovery time, and hand/arm vibration not considered

Tools

- Goniometer
- Camera (photos and videos)

RULA

Rapid Upper Limb Assessment

Looks at

- Arm and Wrist
  - Upper arm position
  - Lower arm
  - Wrist
  - Muscle score (static or repetitive)
  - Force/load
- Neck, Trunk, Legs
  - Neck position
  - Trunk position
  - Legs supported
  - Muscle score
  - Force/load

This assessment is good for

- Hand intensive/repetitive tasks
- Anyone that uses scissors/knives
- Assemblers
- Packers
- In conjunction with RULA

Strain Index

Moore-Garg

APPENDIX A – A USER'S GUIDE FOR THE STRAIN INDEX

This guide describes how to perform the five steps associated with using the Strain Index. Page 1 describes the rating criteria and the measurements and calculations for the six task variables. The numerical ranges for assigning rating criteria for the subjective variables are only guidelines. Page 2 includes a table for entering your data and guides you through calculating an SI score.

Step 1: Data Collection

1. Intensity of Exertion is an estimate of the strength required to perform the task one time. Guidelines for assigning a rating criterion are presented in the following table. Write the most appropriate rating criterion into the data table.

Rating Criterion	*%MS*[A]	*Borg Scale*[B]	*Perceived Effort*
Light	<10%	≤2	Barely noticeable or relaxed effort
Somewhat Hard	10%-29%	2	Noticeable or definite effort
Hard	30%-49%	4-5	Obvious effort; unchanged facial expression
Very Hard	50%-79%	6-7	Substantial effort; changes facial expression
Near Maximal	≥80%	>7	Uses shoulder or trunk to generate force

[A] Percentage of maximal strength

[B] Compared to the Borg CR-10 scale[76]

2. Duration of Exertion is calculated by measuring the duration of all exertions during an observation period, then dividing the measured duration of exertion by the total observation time and multiplying by 100.

$$\%\ \text{Duration of Exertion} = 100\ X\ \frac{\text{duration of all exertions (sec)}}{\text{total observation time (sec)}} = 100\ X\ \frac{\quad}{\quad} = \quad$$

3. Efforts per Minute are measured by counting the numbers of exertions that occur during an observation period, then dividing the number of exertions by the duration of the observation period, measured in minutes.

$$\text{Efforts per Minute} = \frac{\text{number of exertions}}{\text{total observation time (min)}} = \frac{\quad}{\quad} = \quad$$

4. Hand/Wrist Posture is an estimate of the position of the hand or wrist relative to neutral position. Guidelines for assigning a rating criterion are presented in the following table. Enter the results in the data table.

Rating Criterion	***Wrist Extension***[A]	***Wrist Flexion***[A]	***Ulnar Deviation***[A]	***Perceived Posture***
Very Good	0° - 10°	0° - 5°	0° - 10°	Perfectly neutral
Good	11° - 25°	6° - 15°	11 - 15°	Near neutral
Fair	26° - 40°	16° - 30°	16° - 20°	Nonneutral
Bad	41° - 55°	31° - 50°	21° - 25°	Marked deviation
Very Bad	>60°	>50°	>25°	Near extreme

[A] Derived from data presented in Stetson et al.[20]

5. Speed of work is an estimate of how fast the worker is working. Guidelines for assigning a rating criterion are presented in the following table Enter the result in the data table.

Rating Criterion	***Compared to MTM-1***[A]	***Perceived Speed***
Very Good	≤ 80%	Extremely relaxed pace
Good	81 - 90%	"taking one's own time"
Fair	91 – 100%	"normal" speed of motion
Bad	101 – 115%	Rushed, but able to keep up
Very Bad	> 115%	Rushed and barely or unable to keep up

[A] The observed pace is divided by MTM-1's predicted pace and expressed as a percentage of predicted. See Barnes.[85]

6. Duration of Task per Day is either measured or obtained from plant personnel. Enter the result in the data table.

Step 2: Assign Ratings Values

Use the table below to find the rating values for each task variable. Select the appropriate entry for each variable, then find the corresponding rating value on the same row at the far left.

Rating Values	*Intensity of Exertion*	*Duration of Exertion*	*Efforts/ Minute*	*Hand/Wrist Posture*	*Speed of Work*	*Duration per Day*
1	Light	<10	<4	Very good	Very slow	≤1
2	Somewhat hard	10 – 29	4 – 8	Good	Slow	1 – 2
3	Hard	30 – 49	9 – 14	Fair	Fair	2 – 4
4	Very hard	50 – 79	15 – 19	Bad	Fast	4 – 8
5	Near maximal	≥ 80	≥20	Very bad	Very fast	≥8

Step 3: Determine the Multipliers

Rating Values	Intensity of Exertion	Duration of Exertion	Efforts/ Minute	Hand/Wrist Posture	Speed of Word	Duration per Day
1	1	0.5	0.5	1.0	1.0	0.25
2	3	1.0	1.0	1.0	1.0	0.50
3	6	1.5	1.5	1.5	1.0	0.75
4	9	2.0	2.0	2.0	1.5	1.00
5	13	3.0[A]	3.0[A]	3.0	2.0	1.50

[A] If duration of exertion is 100%, then efforts/minute multiplier should be set to 3.0

Enter your data here:

	Intensity of Exertion	*Duration of Exertion*	*Efforts/ Minute*	*Hand/Wrist Posture*	*Speed of Work*	*Duration per Day*
Step 1: Rating Criterion or Measured Result						
Step 2: Rating Value						
Step 3: Multiplier						

Step 4: Calculate Score

Intensity of Exertion	X	Duration of Exertion	X	Efforts per Minute	X	Hand/ Wrist Posture	X	Speed of Work	X	Duration of Task	=	SI Score
	X		X		X		X		X		=	

Step 5: Interpret the Result

Preliminary testing has revealed that jobs associated with distal upper extremity disorders had SI Scores greater than 5. SI Scores less than or equal to 3 are probable safe. SI Scores greater than or equal to 7 are probably hazardous. The Strain Index does not consider stresses related to localized mechanical compression. The risk factor should be considered separately.

Strain Index

Moore-Garg

Used to evaluate hand intensive and repetitive tasks for the risk of developing hand/wrist/elbow MSDs

Pros

- More in depth than the RULA
- Better prediction accuracy for developing MSDs
- Considers duration, recovery time, and speed

Cons

- Time consuming
- Does not evaluate hand/wrist vibration

Tools

- Stopwatch
- Counter
- Camera (videos)

Strain Index

Moore-Garg

IHS Industry Health Solutions

Looks at

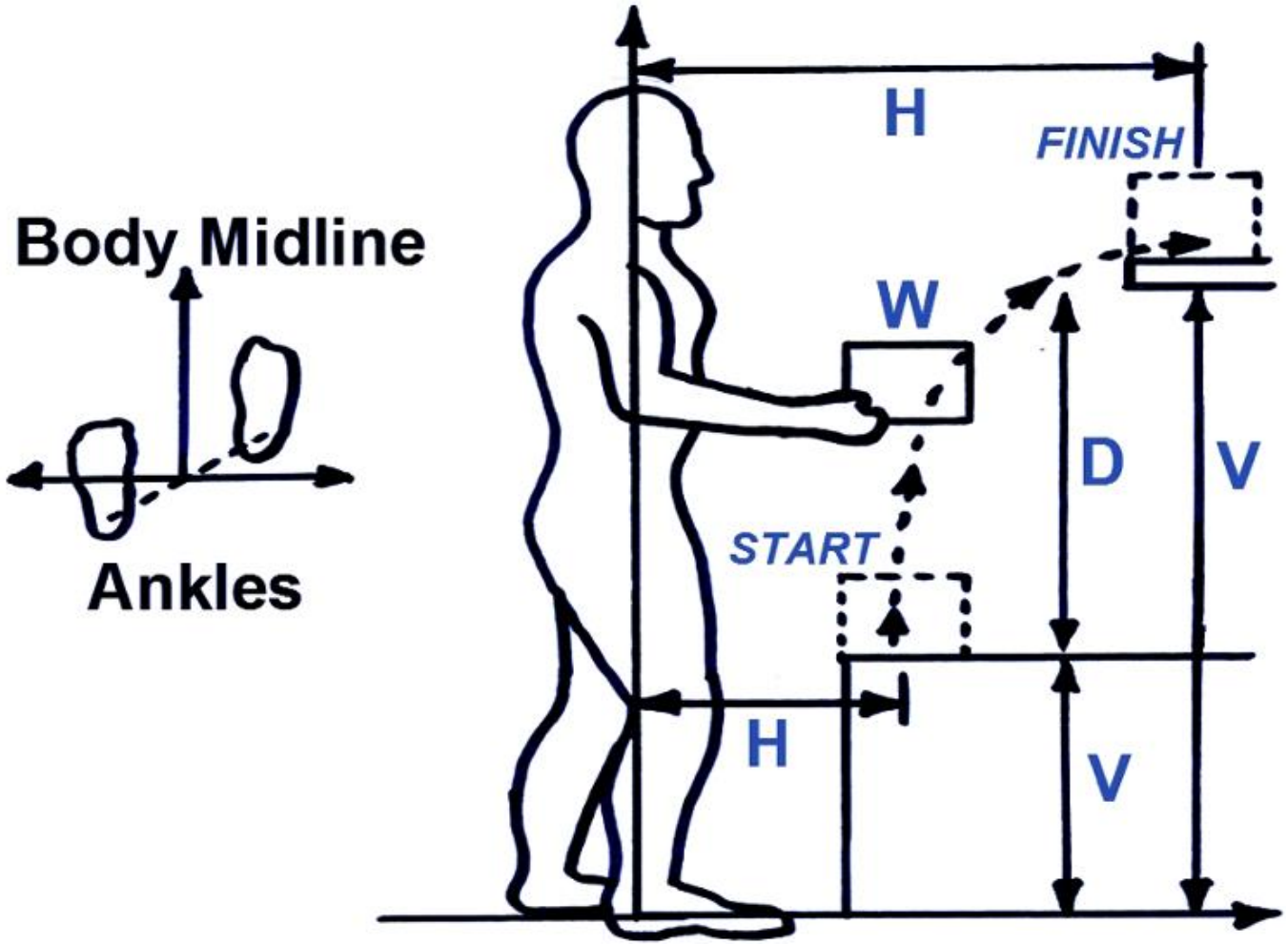
- Intensity of work
- Duration of exertion
- Efforts per minute
- Hand/Wrist posture
- Speed of work
- Duration of task

This assessment is good for

- Hand intensive/repetitive tasks
- Anyone that uses scissors/knives
- Assemblers
- Packers
- In conjunction with RULA

NIOSH Lifting Equation

National Institute for Occupational Safety & Health Lifting Equation



NIOSH Lifting Equation

National Institute for Occupational Safety & Health Lifting Equation

Created to determine whether a lift can be performed safely over the duration of a workday without causing a lower back injury for the average employee.

Pros

- Equation that calculates the Risk Index for two handed lifts at the origin and destination of the lift
- Provides a recommended weight of the object being moved within the parameters of the lift being performed
- Factors in other variables other than weight that can contribute to injury and illnesses

Cons

- Cannot be used in one handed lift scenarios or lifts that occur longer than 8 hours
- Cannot adjust for lifts that are carried beyond a few steps
- Unable to factor in unstable loads
- Does not factor in control of object being moved ex. Box is thrown onto pallet and not gently placed would not provide accurate assessment

Avoid testing destination if significant control of the object is not required.

NIOSH Lifting Equation

National Institute for Occupational Safety & Health Lifting Equation

Looks at

- Horizontal location
- Vertical Location
- Vertical Travel Distance
- Asymmetry angle
- Lifting Frequency
- Quality of handles
- Weight of load
- Duration of lift

This assessment is good for

- Palletizers
- Anyone that performs a two-handed lift or lower.

Tools

- Goniometer
- Measuring tape
- Stopwatch
- Counter
- Camera (photos and videos)

Liberty Mutual Manual Material Handling Equations

Liberty Mutual Manual Materials Handling Guidelines

TABLE 11M - MALE POPULATION PERCENTAGES FOR CARRYING TASKS

OBJECT WEIGHT (POUNDS)	HAND HEIGHT (INCHES)	CARRYING DISTANCE	7 FEET					14 FEET					28 FEET				
		FREQUENCY ONE CARRY EVERY	10s	30 s	1m	5m	8h	10s	30 s	1m	5m	8h	10s	30 s	1m	5m	8h
99	43		-	-	-	18	30	-	-	-	-	36	-	-	-	-	22
	33		-	11	22	36	67	-	-	11	21	54	-	-	-	15	47
84	43		-	-	12	33	66	-	-	-	12	42	-	-	-	-	28
	33		-	19	28	42	71	-	-	15	27	60	-	-	11	28	53
69	43		-	-	17	29	62	-	-	-	17	48	-	-	-	-	34
	33		14	23	35	49	75	-	-	21	34	65	-	15	16	28	55
65	43		-	-	22	37	66	-	-	11	21	54	-	-	-	-	40
	33		19	25	40	54	79	-	-	28	39	70	-	19	20	32	64
61	43		-	14	27	41	70	-	-	19	27	60	-	-	-	18	46
	33		23	31	46	59	81	-	13	31	45	73	11	24	25	38	68
77	43		13	19	33	47	74	-	-	20	33	66	-	-	-	19	52
	33		29	37	52	64	84	-	27	39	51	77	15	30	31	44	73
73	43		19	25	40	53	78	-	-	25	39	69	-	13	14	25	58
	33		33	44	58	69	86	11	23	44	57	80	21	37	35	50	76
69	43		24	32	46	60	81	-	13	32	46	74	-	18	19	31	63
	33		42	51	64	74	88	16	29	51	63	83	27	44	45	57	80
65	43		31	39	53	65	84	-	19	40	53	78	-	25	26	38	69
	33		49	57	69	78	+	22	37	58	69	86	34	51	52	63	83
61	43		36	47	60	71	87	13	26	47	60	82	16	32	34	46	74
	33		57	64	74	82	+	29	44	64	74	88	42	58	56	68	86
57	43		47	55	67	76	89	19	34	55	67	90	23	41	42	54	79
	33		64	71	76	85	+	37	52	71	79	+	53	69	66	74	90
53	43		56	62	73	82	+	27	43	63	73	88	31	50	51	62	83
	33		71	75	83	88	+	44	60	76	83	+	58	71	72	79	+
49	43		64	70	78	84	+	37	52	70	78	+	41	58	56	69	86
	33		78	83	86	+	+	53	68	81	86	+	66	77	76	83	+
45	43		71	76	83	88	+	47	61	76	83	+	51	67	66	78	89
	33		81	85	89	+	+	64	75	85	89	+	73	82	82	87	+
41	43		78	82	87	+	+	58	70	82	87	+	61	74	75	82	+
	33		86	88	+	+	+	72	81	88	+	+	80	86	87	+	+
36	43		85	87	+	+	+	70	76	86	+	+	73	82	83	87	+
	33		+	+	+	+	+	81	87	+	+	+	86	+	+	+	+
31	43		+	+	+	+	+	81	87	+	+	+	82	88	86	+	+
	33		+	+	+	+	+	88	+	+	+	+	+	+	+	+	+

+ = GREATER THAN 90% - = LESS THAN 10%

Liberty Mutual Manual Material Handling Equations

Created to determine acceptable loads and forces in lifting, lowering, pushing, pulling, and carrying tasks to prevent injuries. Liberty mutual has more than 40 years of psychophysical research on the tasks mentioned above.

Pros

- Has a lot of great research to back up the results
- Uses predictive equations to allow for more specific inputs for more accurate results
- Designed to prevent injuries not only in the lower back but the entire body
- Easier and more comprehensive than the older liberty mutual tables

Cons

- Designed for tasks performed during an 8-hour day in favorable ambient temperatures
- Limited to conditions and independent variables of the test subjects in the studies
- Lifting and lowering tasks need to be controlled and 2-handed tasks

Liberty Mutual Manual Material Handling Equations

Looks at

- Lifting
- Lowering
- Carrying
- Pushing
  - Initial
  - Sustained
- Pulling
  - Initial
  - Sustained

This assessment is good for

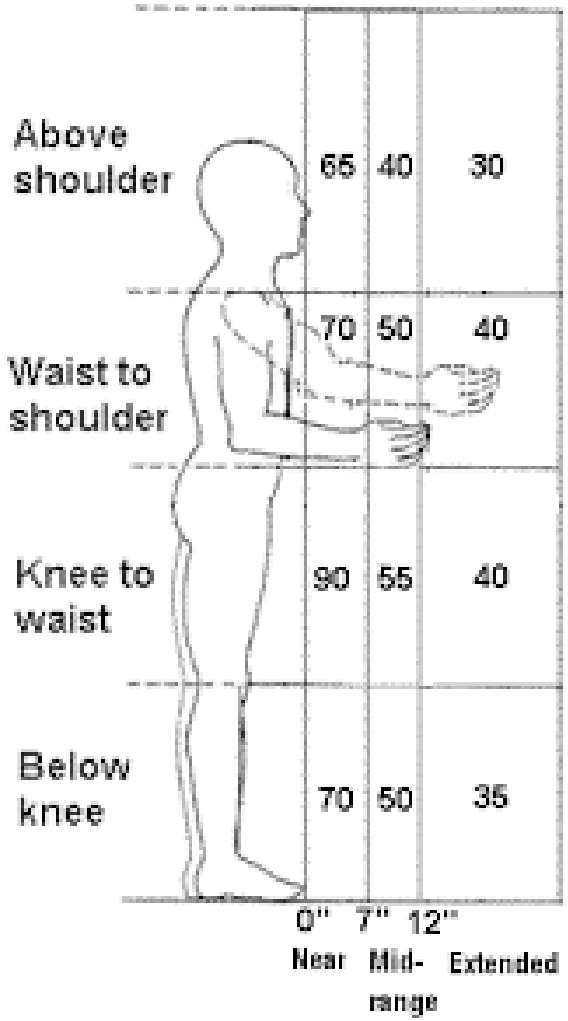
- Palletizers
- Warehouse
- Any job that requires 2-hand manual handling of product
- Development of jobs/products

Tools

- Goniometer
- Measuring tape
- Stopwatch
- Counter
- Camera (photos and videos)
- Dynamometer

WISHA Lifting Calculator

Washington State Department of Labor and Industries Lifting Calculator



WISHA Lifting Calculator

Washington State Department of Labor and Industries Lifting Calculator

Created to be a quick screen on manual lifting tasks to determine if further analysis are needed. This is very similar to the NIOSH calculator with a few measurements removed to make for faster screenings. This calculator is not designed to be a final analysis to determine if a lifting task is unsafe. Considered to be a very liberal test compared to other lifting calculators.

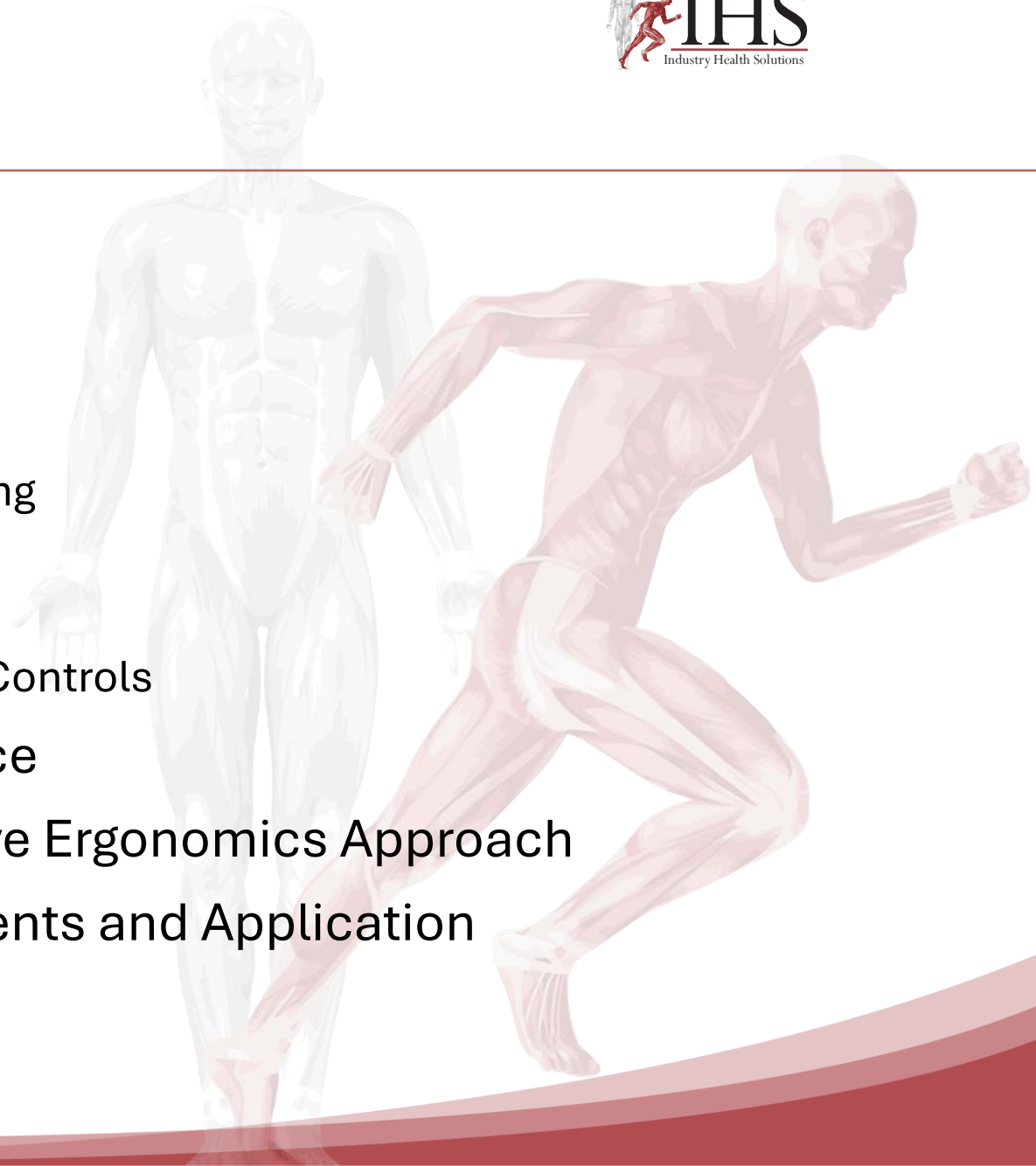
Pros

- Fast and easy with few tools and measurements needed
- Provides a baseline on what lifting tasks may need further testing
- Designed to make sure lifts are safe for all individuals

Cons

- Does not consider many variables during the lifting task

SUMMARY



- Ergonomics
  - Process
  - Posture
  - Workstation
  - Material Handling
  - Training
  - Environment
  - Administrative Controls
- Consider the Science
- Reactive vs Proactive Ergonomics Approach
- Ergonomic Instruments and Application
- Prioritization