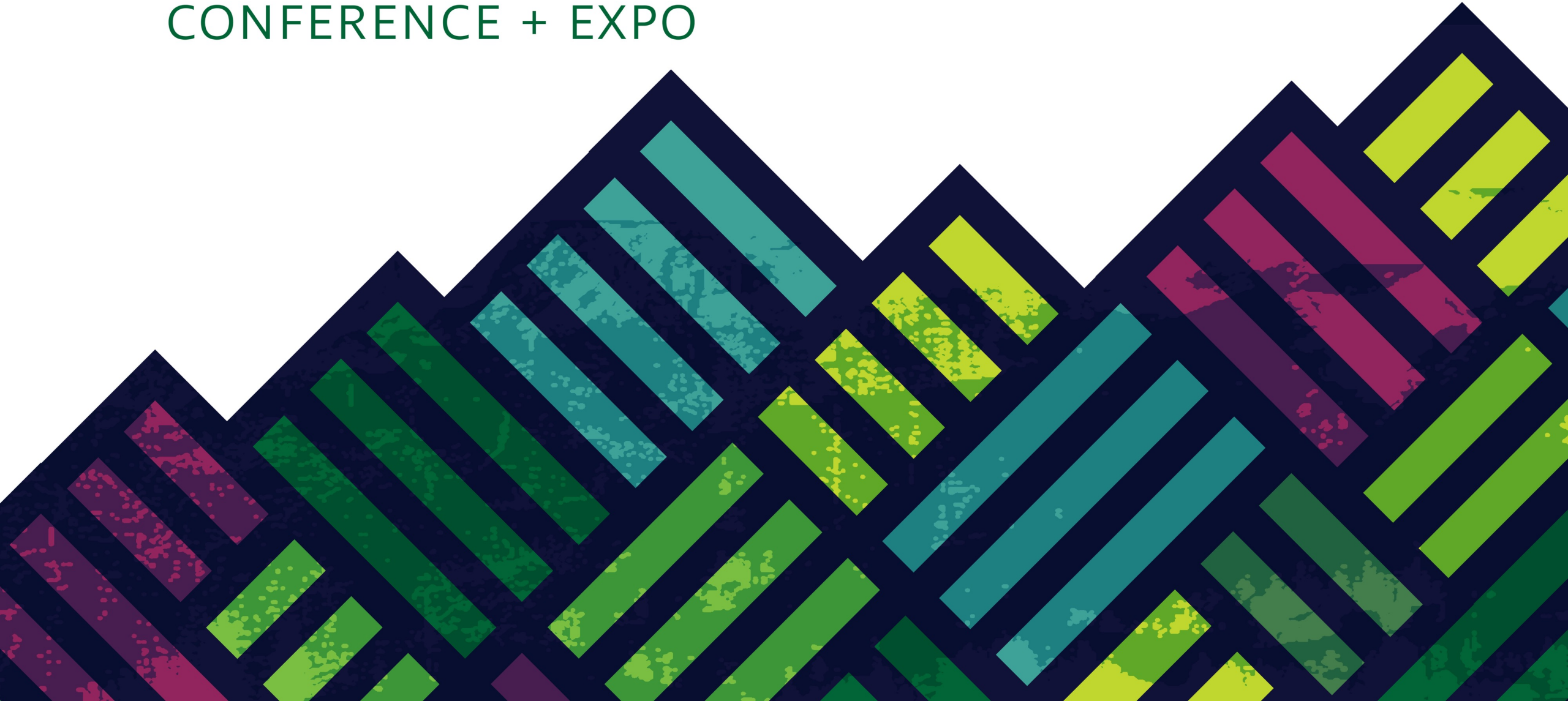
SAFETY24

CONFERENCE + EXPO



AMERICAN SOCIETY OF
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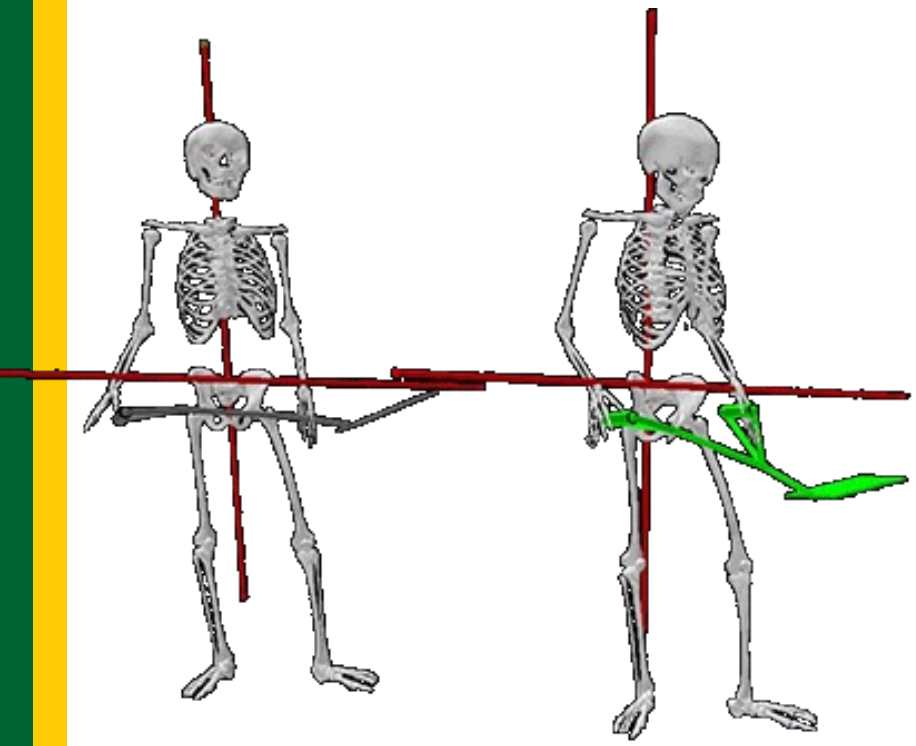
TAKING IT UP A NOTCH: Improving Workplace Ergonomic Assessment Beyond RULA & REBA

Dr. Lito M. Amit, ASP
Assistant Professor
Safety and Occupational Health Applied Sciences
Keene State College, NH



Task: **Shoveling**

Score the MSD risk.
Why that score?

Score	Level of MSD Risk
1	negligible risk, no action required
2-3	low risk, change may be needed
4-7	medium risk, further investigation, change soon
8-10	high risk, investigate and implement change
11+	very high risk, implement change

Contents

- Background
- Advantages & Limitations of RULA & REBA
- Assessment Tools for Posture, Biomechanics & Workload Risks
- Assessment Tools for MSDs Symptoms
- Benefits of Mixed Methods
- Key Takeaways

1. Background

- Musculoskeletal disorders (MSDs) are conditions involving muscles, bones, tendons, ligaments and other soft tissues
- Increasing across industries
- Leading cause of worker disability, high cost on workers' compensation, absenteeism and early retirement (BLS, 2023)
- Absence of Ergonomic Standard
- Ergonomic hazard sources:
  - Physical
  - Biomechanical
  - Psychosocial

Chart 1. Number, incidence rate, and median days away from work of injuries and illnesses involving musculoskeletal disorders, U.S., private sector, 2011-18

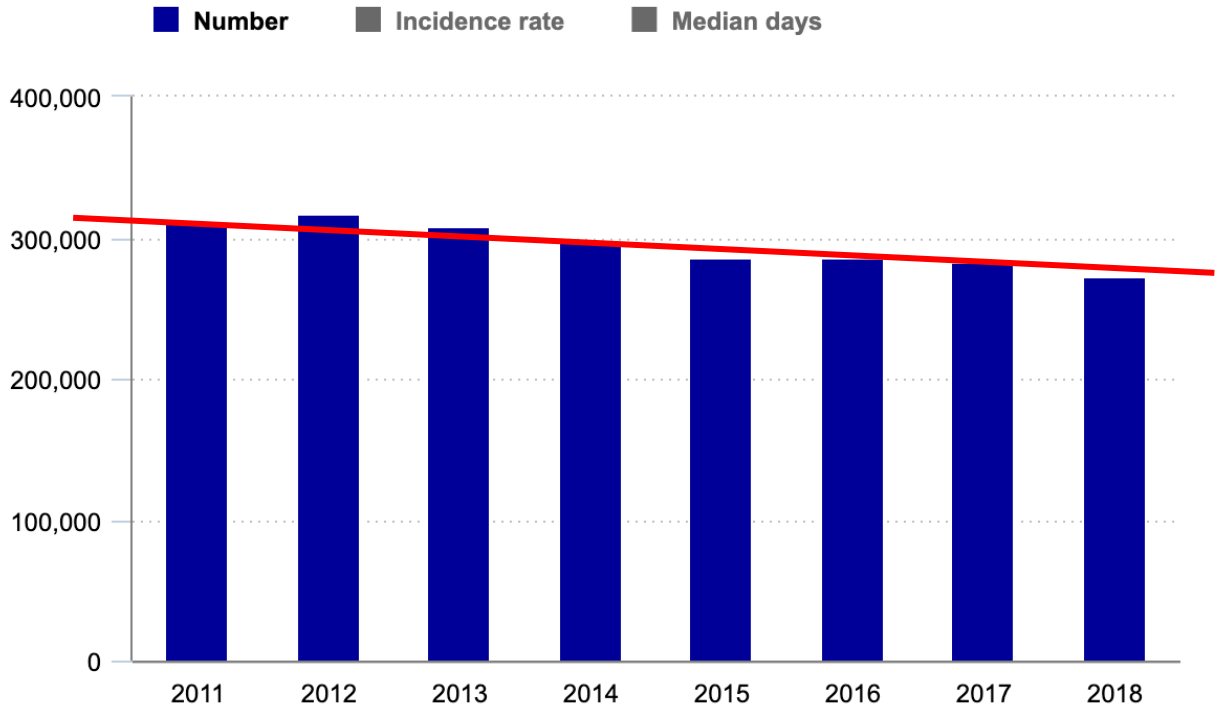
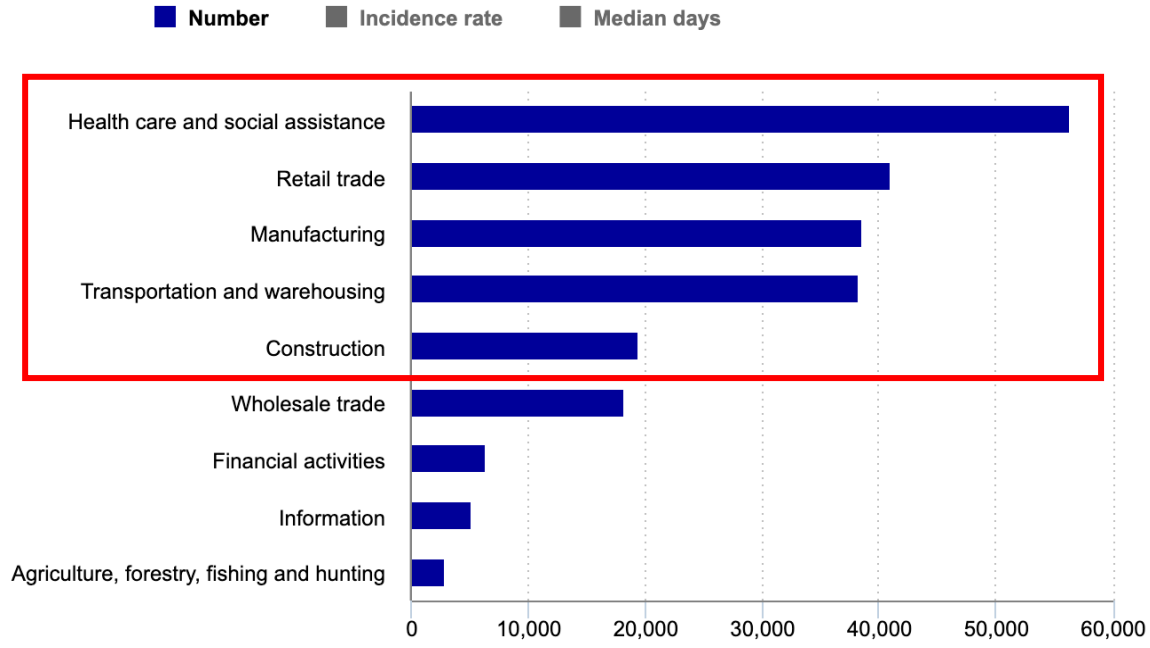


Chart 2. Number, incidence rate, and median days away from work of injuries and illnesses involving musculoskeletal disorders by selected industries, U.S., private sector, 2018



Source: BLS, 2020

Chart 3. Number, median days away from work, and percentage of total injuries involving musculoskeletal disorders by selected occupations, U.S., private sector, 2018

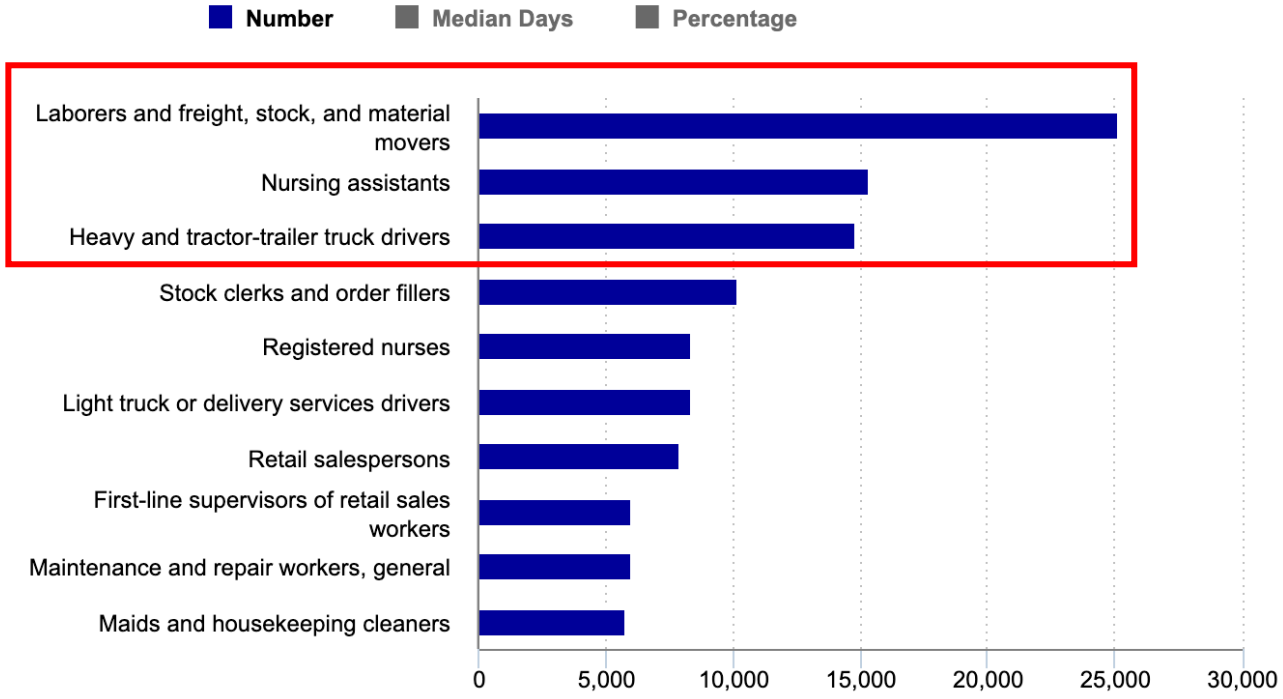
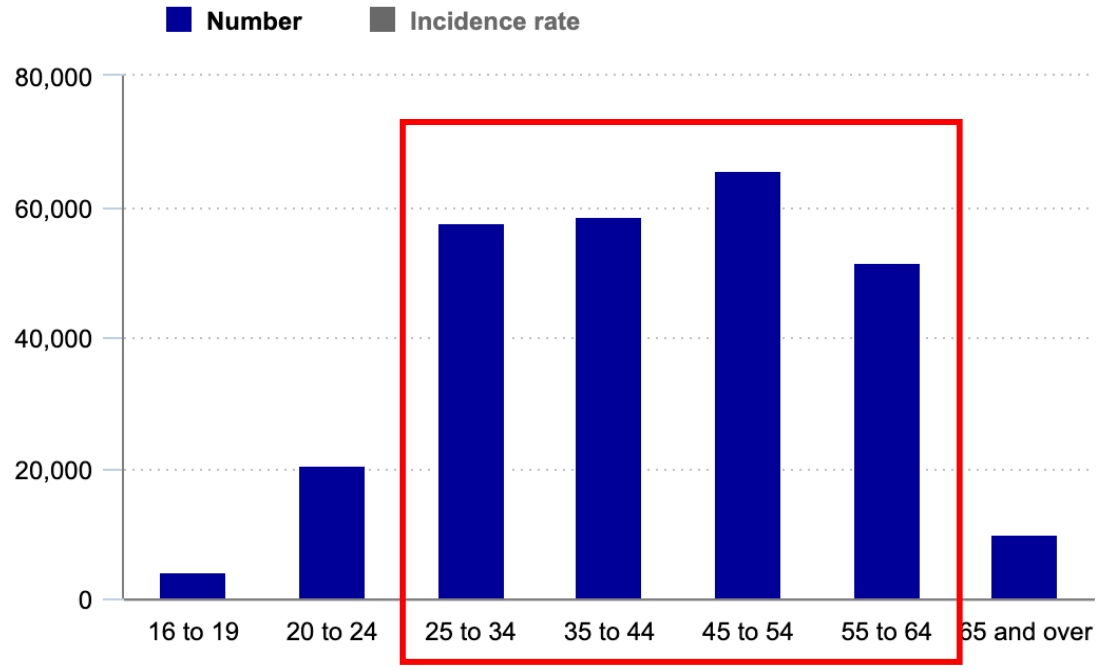


Chart 4. Number and incidence rate of injuries and illnesses involving musculoskeletal disorders, by selected age groups, U.S., private sector, 2018



Source: BLS, 2020

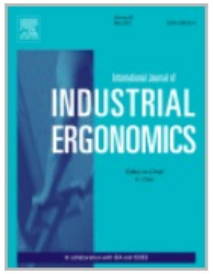
What is your go-to ergonomic hazard assessment tool?

2. RULA and REBA

ELSEVIER

International Journal of Industrial Ergonomics

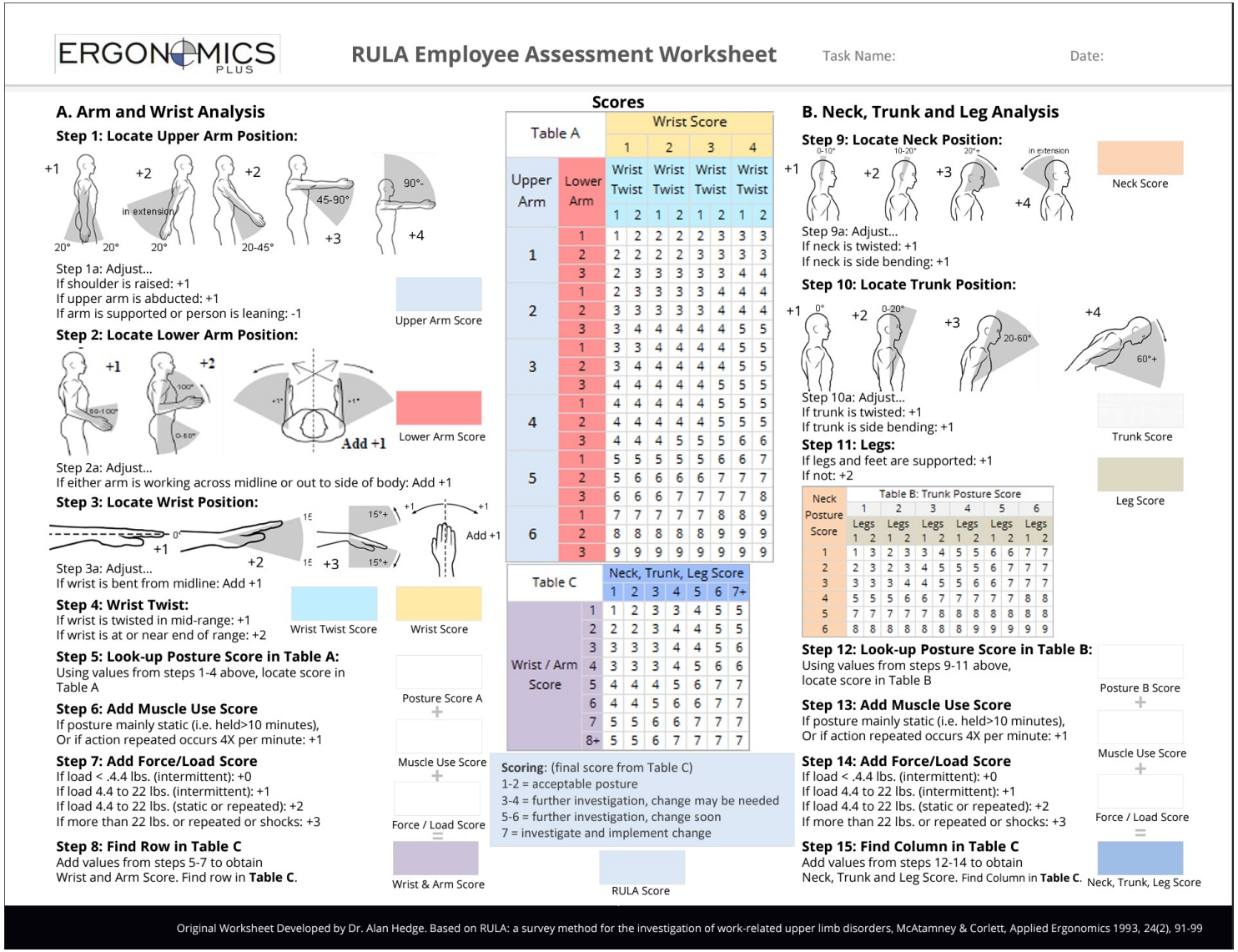
Volume 83, May 2021, 103140



Comparison of OWAS, RULA and REBA for assessing potential work-related musculoskeletal disorders

Dohyung Kee ✉

Rapid Upper Limb Assessment (RULA)



ERGONOMICS PLUS

RULA Employee Assessment Worksheet Task Name: Date:

A. Arm and Wrist Analysis

Step 1: Locate Upper Arm Position:

+1 (20° / 20°) +2 (in extension / 20°) +2 (20°–45°) (45°–90°) +3 (90°+) +4

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:

+1 (60°–100°) +2 (100°+ / 0–60°) Add +1

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:

0° +1 (15°+) +2 +3 (15°+) Add +1

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

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 | Wrist 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

Upper Arm	Lower Arm	Wrist Score 1 Wrist Twist 1	1 2	2 1	2 2	3 1	3 2	4 1	4 2
1	1	1	2	2	2	2	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

Wrist / Arm Score	Neck, Trunk, Leg 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)
1-2 = acceptable posture
3-4 = further investigation, change may be needed
5-6 = further investigation, change soon
7 = investigate and implement change

RULA Score

B. Neck, Trunk and Leg Analysis

Step 9: Locate Neck Position:

+1 (0-10°) +2 (10-20°) +3 (20°+) +4 (in extension)

Neck Score

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

Step 10: Locate Trunk Position:

+1 (0°) +2 (0-20°) +3 (20-60°) +4 (60°+)

Trunk Score

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

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	7	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 B Score

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

Original Worksheet Developed by Dr. Alan Hedge. Based on RULA: a survey method for the investigation of work-related upper limb disorders, McAtamney & Corlett, Applied Ergonomics 1993, 24(2), 91-99

Source: McAtamney & Corlett, 1993

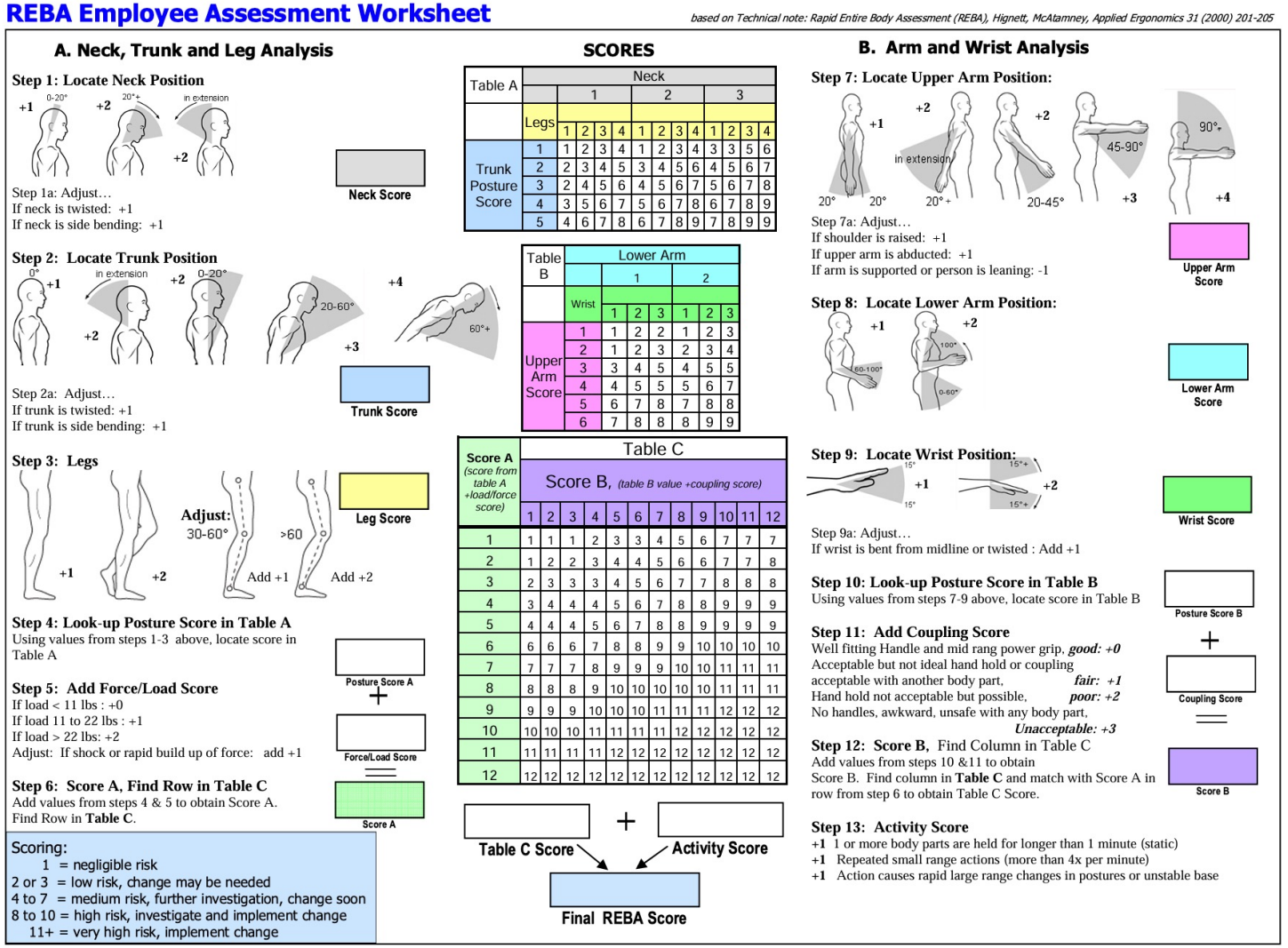
Advantages:

- Better for postural loading assessment
- High work-relatedness
- Applicable Industry: **All**

Disadvantages:

- Based on evaluator's perspective
- Motion, context of the task, weight of load
- Fails to consider individual body part exposure to repetition

Rapid Entire Body Assessment (REBA)



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

Adjust: 30-60° Add +1, >60 Add +2

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	11	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 .

rbarker@ergosmart.com (816) 444-1667

Source: Hignett & McAtamney, 2000

Advantages:

- Evaluates whole-body
- Applicable Industry: **All**

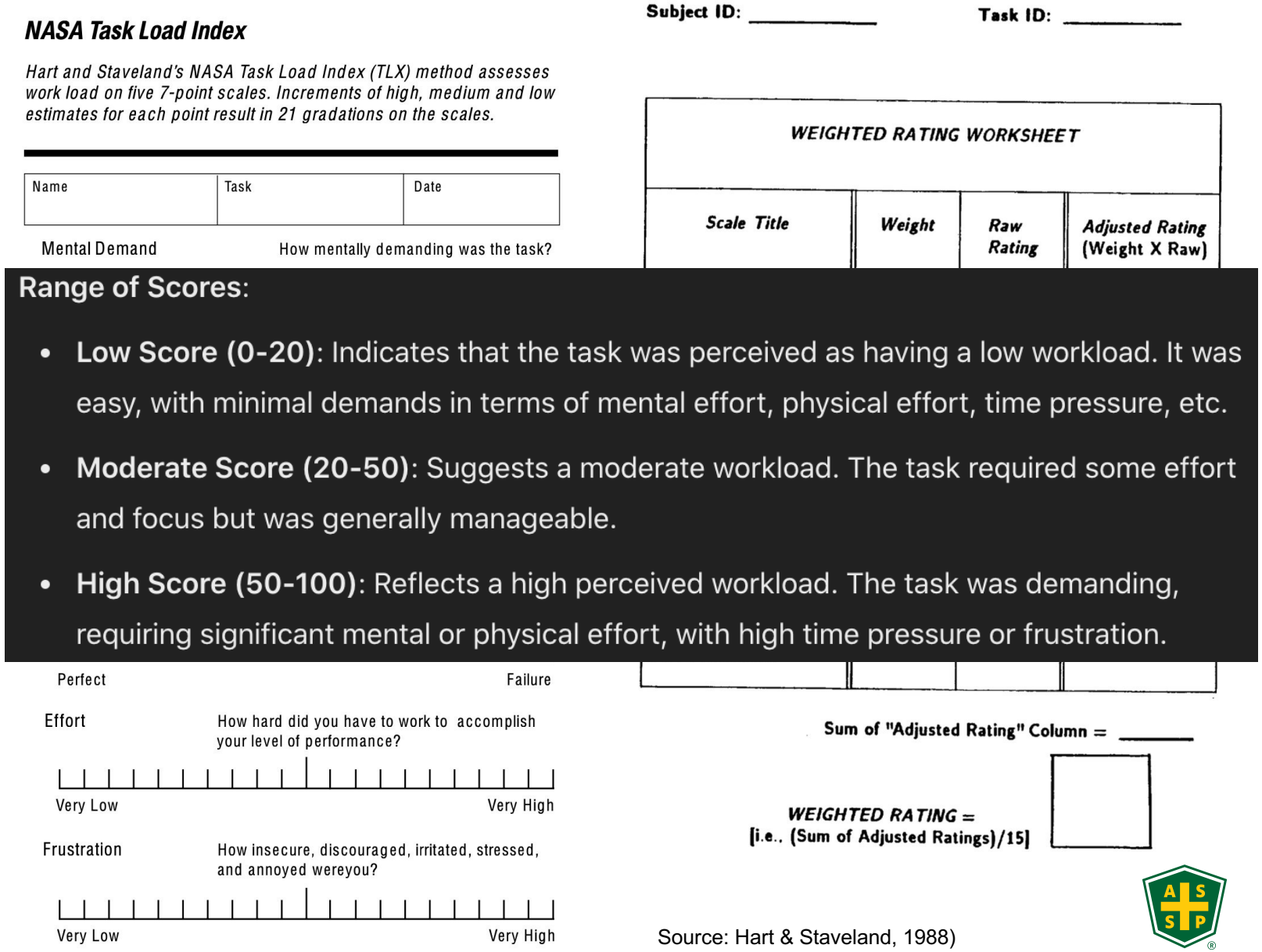
Disadvantages:

- Based on evaluator's perspective
- Motion, context of the task, weight of load
- Fails to consider individual body part exposure to repetition
- Inferior to RULA (Kee, 2021)

3. Assessment Tools for Posture, Biomechanics & Workload Risks

1. NASA Task Load Index (TLX)

- Evaluates mental, physical, temporal, performance, effort, and frustration
- Low cost
- Simple methods
- Generic subscales (generaliz ability)
- Software support
- Non-intrusive to primary task
- Applicable Industry: **All**



NASA Task Load Index

Hart and Staveland's NASA Task Load Index (TLX) method assesses work load on five 7-point scales. Increments of high, medium and low estimates for each point result in 21 gradations on the scales.

Name	Task	Date

Mental Demand — How mentally demanding was the task?

Perfect — Failure

Effort — How hard did you have to work to accomplish your level of performance?

Very Low — Very High

Frustration — How insecure, discouraged, irritated, stressed, and annoyed wereyou?

Very Low — Very High

Subject ID: _____ Task ID: _____

WEIGHTED RATING WORKSHEET

Scale Title	Weight	Raw Rating	Adjusted Rating (Weight X Raw)

Sum of "Adjusted Rating" Column = _____

WEIGHTED RATING =
[i.e., (Sum of Adjusted Ratings)/15]

Range of Scores:

- **Low Score (0-20)**: Indicates that the task was perceived as having a low workload. It was easy, with minimal demands in terms of mental effort, physical effort, time pressure, etc.
- **Moderate Score (20-50)**: Suggests a moderate workload. The task required some effort and focus but was generally manageable.
- **High Score (50-100)**: Reflects a high perceived workload. The task was demanding, requiring significant mental or physical effort, with high time pressure or frustration.

Source: Hart & Staveland, 1988)

Cognitive and Muscular Demands of a Passive Shoulder Exoskeleton

Patrick Boland, Reed Parker Miller, Scott Philibert Jr. and Lito Amit
Safety and Occupational Health Applied Sciences, Sustainable Product Design, Exercise Science
Keene State College, NH, USA 03435

Figure 1. Cognitive demand of female (left) and male (right) participants during Task 1, N=26

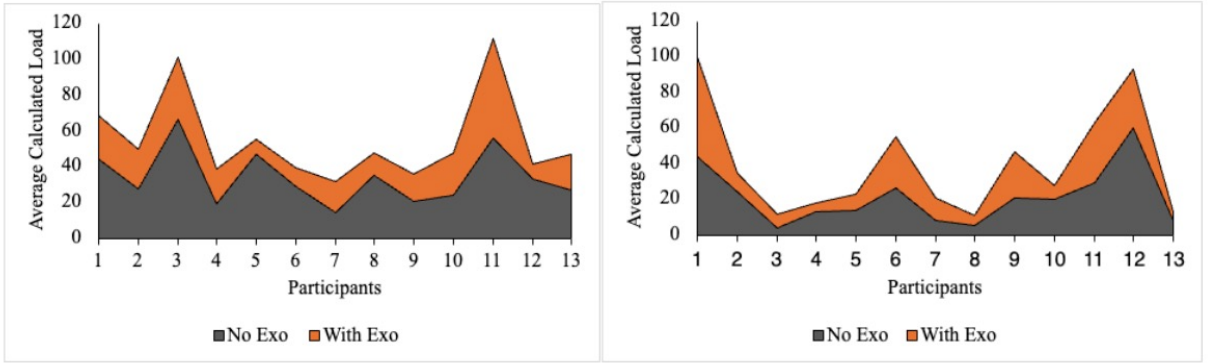
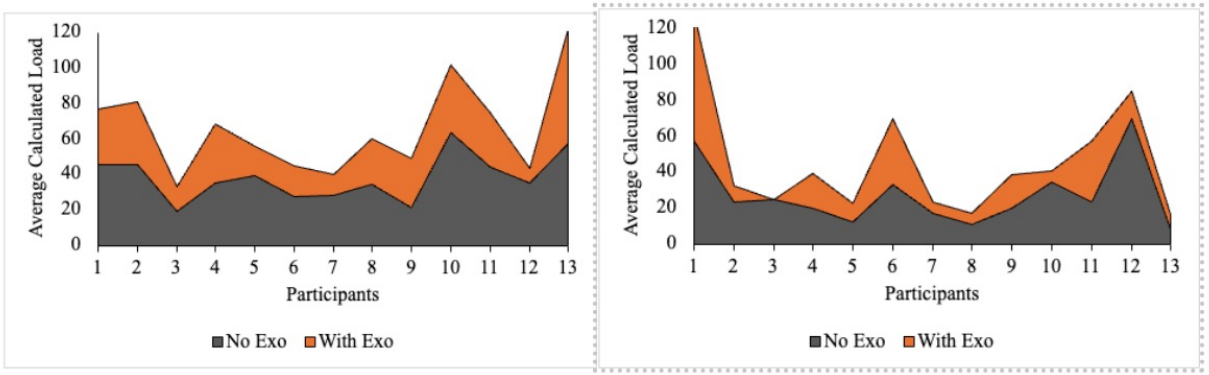


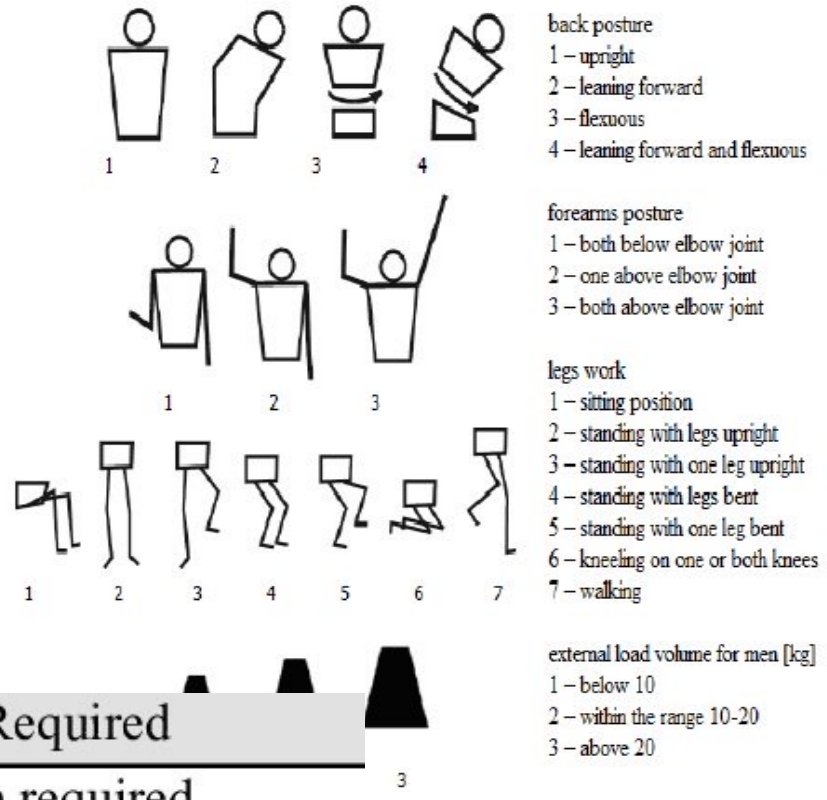
Figure 3. Cognitive demand of female (left) and male (right) participants during Task 3, N=26



2. Ovako Working posture Assessment System (OWAS)

- Classification system based on the risk of MSDs and physical load on the musculoskeletal syst em
- Focuses on 3 body parts; back arms, and legs
- Action Category (AC) indicates urgency and priority of corrective measures
- Applicable Industry: **All**

Back	Arms	1			2			3			4			5			6	
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2
1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	1	1
	2	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	1	1
	3	1	1	1	1	1	1	1	1	1	2	2	3	2	2	3	1	1
2	1	2	2	3	2	2	3	2	2	3	3	3	3	3	3	3	2	2
	2	2	2	3	2	2	3	2	3	3	3	4	4	3	4	4	3	3
	3	3	3	4	2	2	3	3	3	3	3	4	4	4	4	4	4	4
3	1	1	1	1	1	1	1	1	1	2	3	3	3	4	4	4	1	1
	2	2	2	3	1	1	1	1	1	2	4	4	4	4	4	4	3	3
	3	2	2	3	1	1	1	2	3	3	4	4	4	4	4	4	4	4
4	1	2	3	3	2	2	3	2	2	3	4	4	4	4	4	4	4	4
	2	3	3	4	2	3	4	3	3	4	4	4	4	4	4	4	4	4

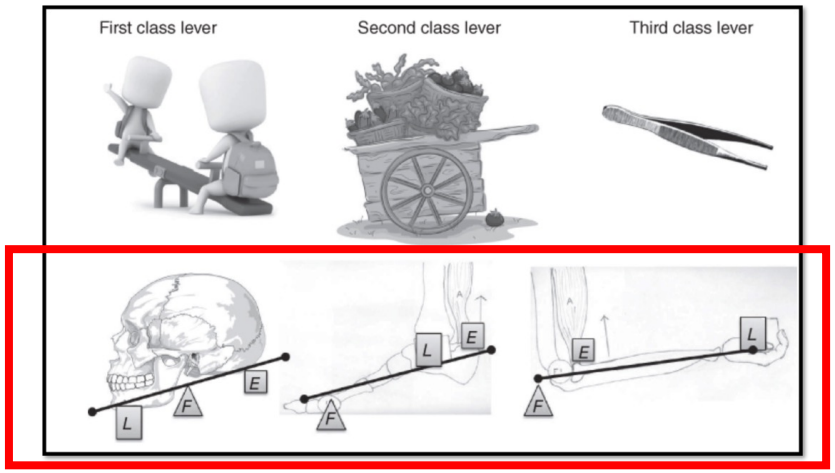


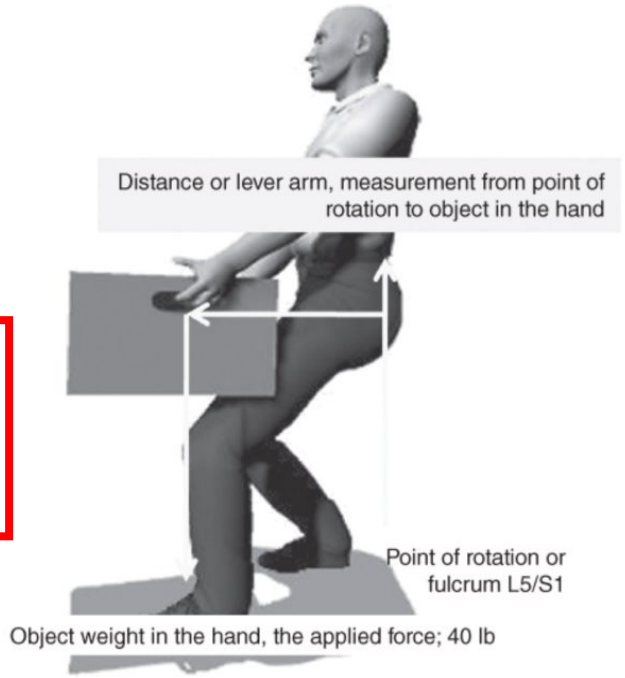
Action Category	Action Required
AC1	No action required
AC2	Action required in the near future
AC3	Action required as soon as possible
AC4	Action required immediately

position	legs work code	external load volume code

Source: Karhu et al., 1977

3. Biomechanical Formula:
Moment = Weight x Distance





- **Lever systems** are the coordination of our bones and muscles to create motion
- Two Main Functions
  - Generate muscular effort to overcome a given load
  - Increase the speed of a given movement
- Body is required to meet rotational force or **Moment**
- Applicable Industry: **All**

Source: Stack et al., 2016 (crossref)

Question:

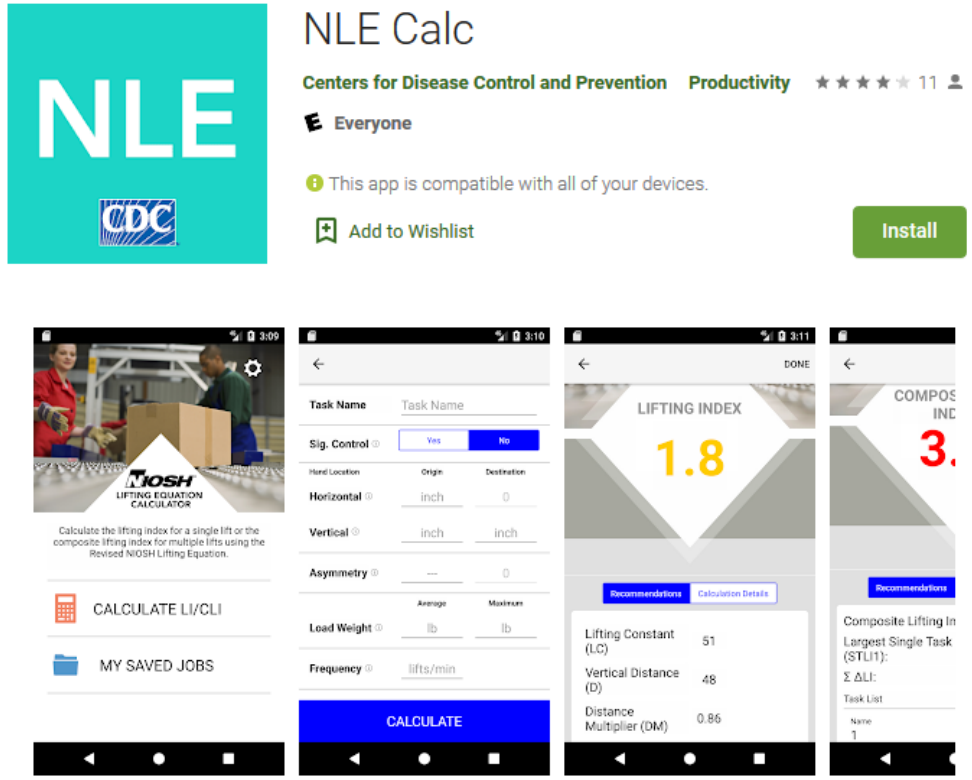
*If rotational force or **moment = weight x distance**, how much rotational force or moment is generated on L5/S1 spinal unit when the **40-lb** weight is lifted?*

Answer: **It depends on the Distance!**

- Holding 40 lbs, **20”** from the L5/S1 results in **800 in.lb** of rotational force
- Holding 40 lbs, **15”** from L5/S1 results in **600 in.lb** of rotational force
- Holding 40 lbs, **10”** from the L5/S1 results in **400 in.lb** of rotational force

Other Important Tools for Posture, Biomechanics & Workload Risk

1. Rapid Office Strain Assessment (ROSA)
2. NIOSH Lifting Equation (NLE)
3. MSD Online Assessment (U.K. Health and Safety Executive)
4. Arbouw Method for Construction (Dutch version of NLE)



4. Assessment Tools for MSDs Symptoms

1. Nordic Musculoskeletal Questionnaire (NMQ)

Musculoskeletal Discomfort Form (Based on the Nordic Questionnaire (Kourinka et al. 1987)) **Employee ID:**_____

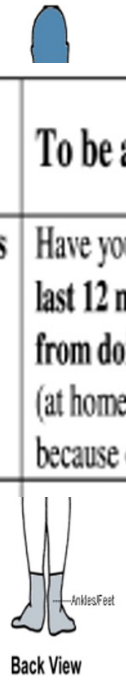
Job/Position: _____ Gender: M F Age: _____ Height: ___ ft.___ in. Weight: _____
How long have you been doing this job? __years __ months How many hours do you work each week? ____

How to answer the questionnaire:

Picture: In this picture you can see the approximate position of the parts of the body referred to in the table. Limits are not sharply defined, and certain parts overlap. You should decide for yourself in which part you have or have had your trouble (if any).

Table: Please answer by putting an "X" in the appropriate box - one "X" for each question. You may be in doubt as to how to answer, but please do your best anyway. Note that column 1 of the questionnaire is to be answered even if you have never had trouble in any part of your body; columns 2 and 3 are to be answered if you answered yes in column 1.

To be answered by everyone	To be answered by those who have had trouble	
Have you at any time during **the last 12 months** had trouble (ache, pain, discomfort, numbness) in:	Have you at any time during the **last 12 months been prevented from doing your normal work** (at home or away from home) because of the trouble?	Have you had trouble at any time during **the last 7 days?**
	☐No ☐Yes	☐No ☐Yes ☐No ☐Yes
Lower Back (small of back)	☐No ☐Yes	☐No ☐Yes ☐No ☐Yes
One or Both Hips/Thighs	☐No ☐Yes	☐No ☐Yes ☐No ☐Yes
One or Both Knees	☐No ☐Yes	☐No ☐Yes ☐No ☐Yes
One or Both Ankles/Feet	☐No ☐Yes	☐No ☐Yes ☐No ☐Yes



Back View

Source: Kuorinka et al., 1987

- Standardized MSDs questionnaire used in epidemiological studies
- Made for the occupational context
- Compares low back, neck, shoulder, and general complaints
- Assesses past 12 months and 7 days symptoms
- Applicable Industry: **All**

2. Back Pain Functional Scale (BPFS)

Responses	Points
unable to perform activity	0
extreme difficulty	1
quite a bit of difficulty	2
moderate difficulty	3
a little bit of difficulty	4
no difficulty	5

total score = SUM(points for all 12 measures)

adjusted total score = (total score) / 60

Interpretation:

• minimum score: 0

• maximum score: 60

• maximum adjusted score: 1 (100%)

• The higher the score the greater the patient's functional ability.

Total Score (Adjusted)	Interpretation
0 (0%)	unable to perform any activity
60 (100%)	no difficulty in any activity

Source: Stratford et al., 2000

- Subjective scale to measure patient's physical function after a low back pain
- Measures 12 items:
  - Any usual work or school activities
  - Hobbies or sports
  - Heavy activities at home
  - Bending or stooping
  - Putting shoes or socks
  - Lifting a box
  - Standing, sitting or driving for 1 hours, etc.
- Applicable Industry: **All**

3. Body Part Discomfort (BPD) Questionnaire

Participant No. _____ Name: _____ *Date:* _____

Instructions:
If you have at any time during the last 7 days had trouble (ache, pain, or discomfort) in each body part, then please check its severity (0: no symptom, 1: just noticeable, 2, 3, 4, 5: intolerable).

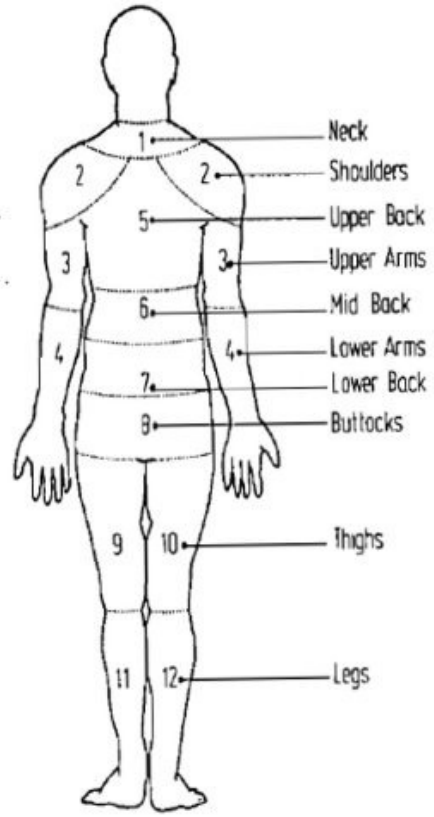


Figure 3. Body regions.

Body regions	0	1	2	3	4	5
Neck						
Shoulders						
Upper back						
Upper arms						
Mid back						
Lower Arms						
Lower back						
Buttocks						
Left thigh						
Right thigh						
Left leg						
Right leg						

Source: Corlett & Bishop, 1976

- Subjective symptom survey
- Respondent's direct experience of discomfort at different body parts
- Comfort versus discomfort
- Easy and quick to use
- Applicable Industry: **All**

Other Important Tools for Posture, Biomechanics & Workload Risk

1. Short musculoskeletal function assessment
2. Quick DASH (disabilities of the arm, shoulder and hand score
3. Northwick Neck Pain Questionnaire MSD Severity and Frequency Questionnaire

QuickDASH

Please rate your ability to do the following activities in the last week by circling the number below the appropriate response.

	NO DIFFICULTY	MILD DIFFICULTY	MODERATE DIFFICULTY	SEVERE DIFFICULTY	UNABLE
1. Open a tight or new jar.	1	2	3	4	5
2. Do heavy household chores (e.g., wash walls, floors).	1	2	3	4	5
3. Carry a shopping bag or briefcase.	1	2	3	4	5
4. Wash your back.	1	2	3	4	5
5. Use a knife to cut food.	1	2	3	4	5
6. Recreational activities in which you take some force or impact through your arm, shoulder or hand (e.g., golf, hammering, tennis, etc.).	1	2	3	4	5

	NOT AT ALL	SLIGHTLY	MODERATELY	QUITE A BIT	EXTREMELY
7. During the past week, *to what extent* has your arm, shoulder or hand problem interfered with your normal social activities with family, friends, neighbours or groups?	1	2	3	4	5

5. Benefits of Mixed Methods

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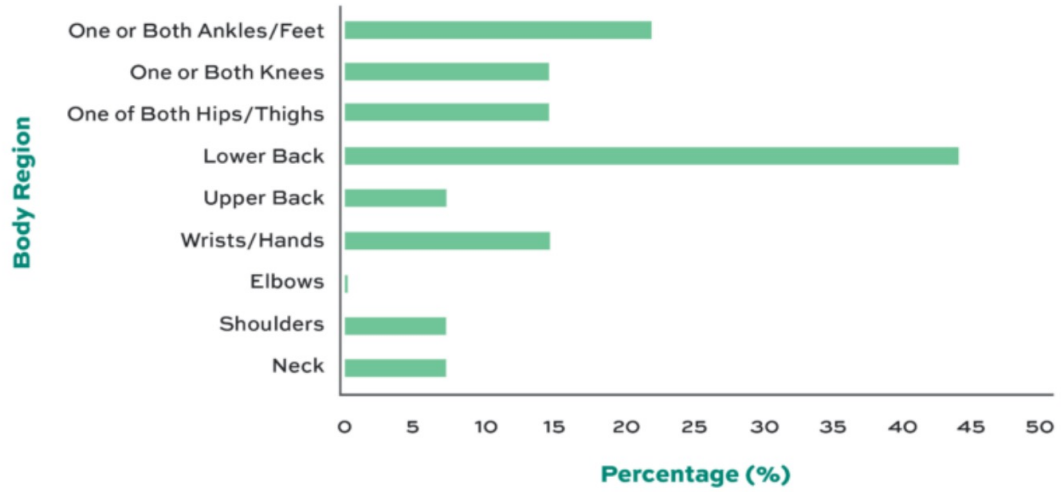
SHIFT
GLOBAL EHS RESEARCH TO PRACTICE

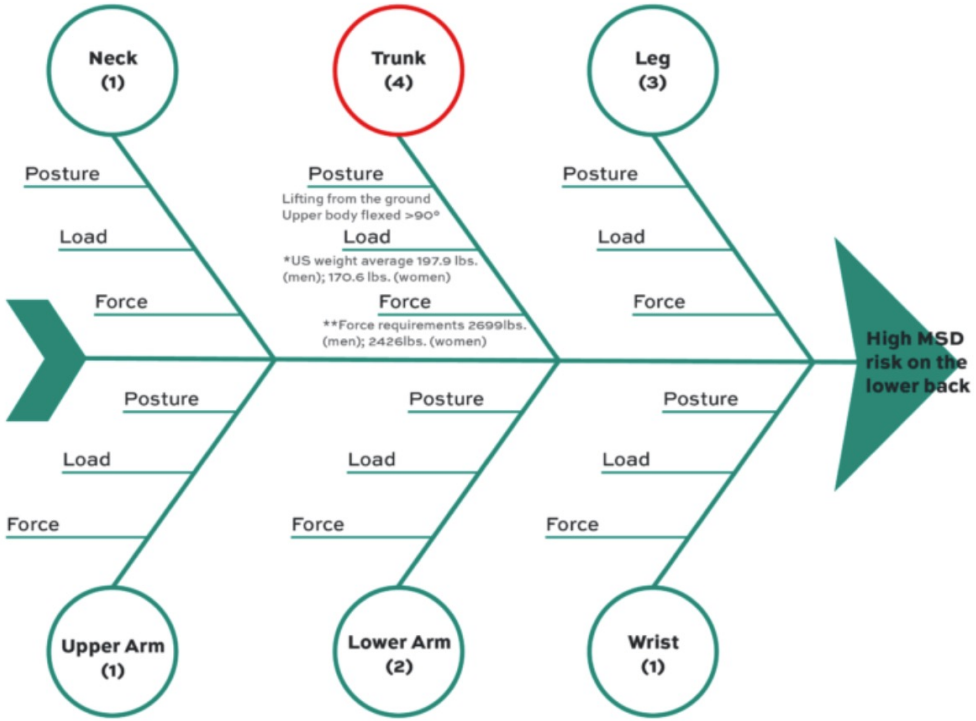
Analyses of Postures and Musculoskeletal Disorders of Emergency Medical Technicians in the United States

Lito M. Amit, Doctor of Health Science in Public Health (Ergonomics)
Keene State College, Department of Safety and Occupational Health Applied Sciences

Calvin S. Hunter, SOHAS
Keene State College, Department of Safety and Occupational Health Applied Sciences



- Allows cross-validation of findings of one or multiple assessment tools
- Minimizes bias on data



Source: Amit & Hunter, 2023

Key Takeaways

- MSDs impact employees' morale and productivity
- RULA & REBA alone may provide weak and shortsighted outcomes
- Safety professionals must explore other standardized, reliable and valid ergonomic assessment tools
- Use of mixed methods yields better outcomes

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Q&A

Thank You!

lito.amit@keene.edu