



AMERICAN SOCIETY OF
SAFETY PROFESSIONALS

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

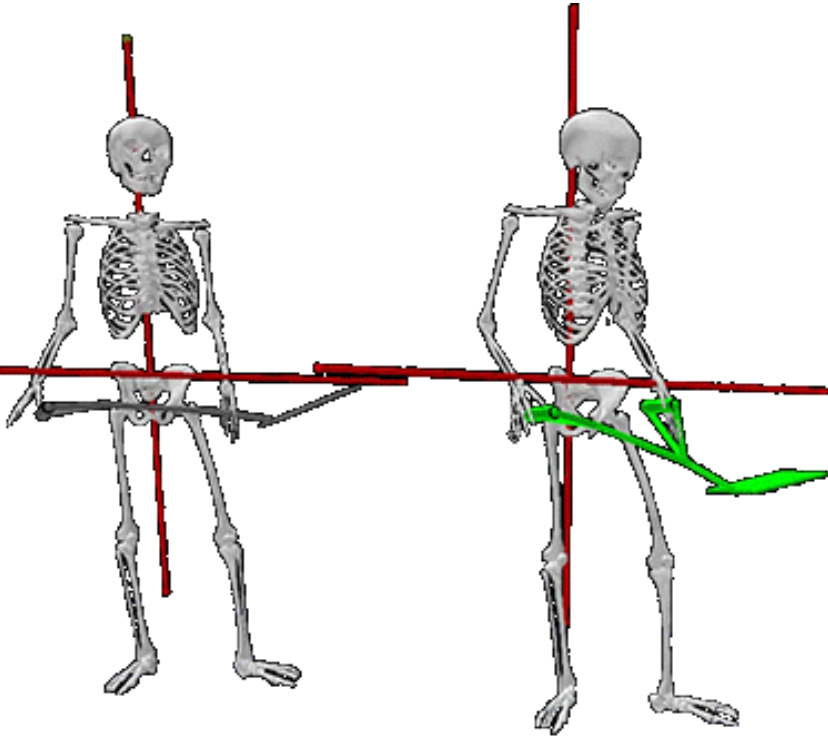
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*Score the MSD risk.
Why that score?*



Task: Shoveling

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

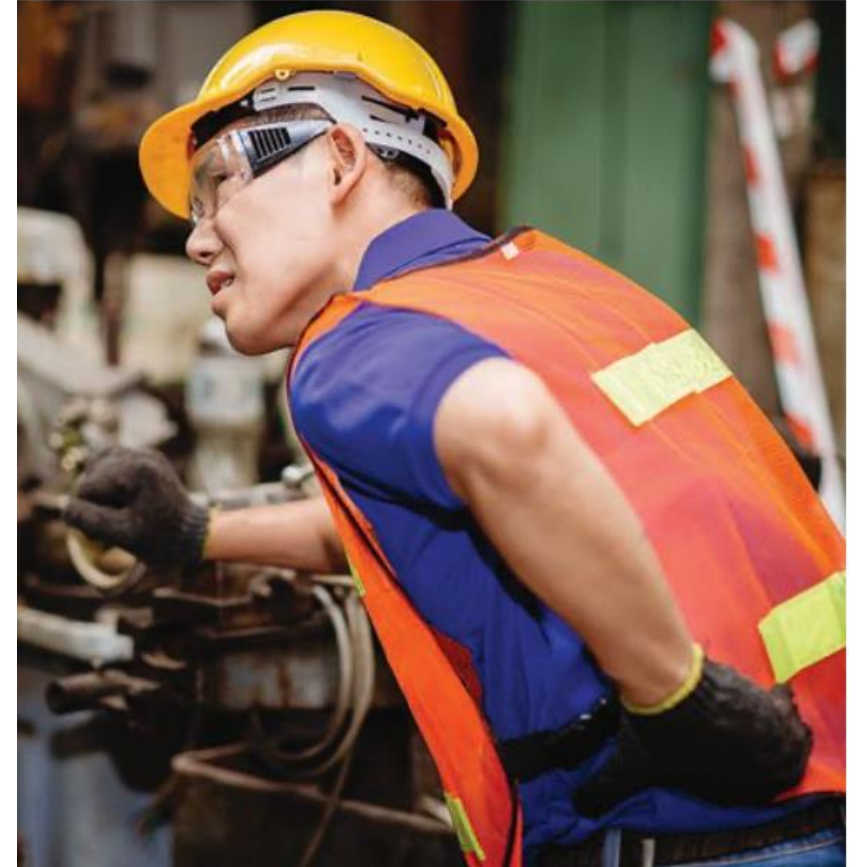


Chart 1. Number, incidence rate, and median days away from work of injuries and illnesses involving musculoskeletal disorders, U.S., private sector, 2011-18

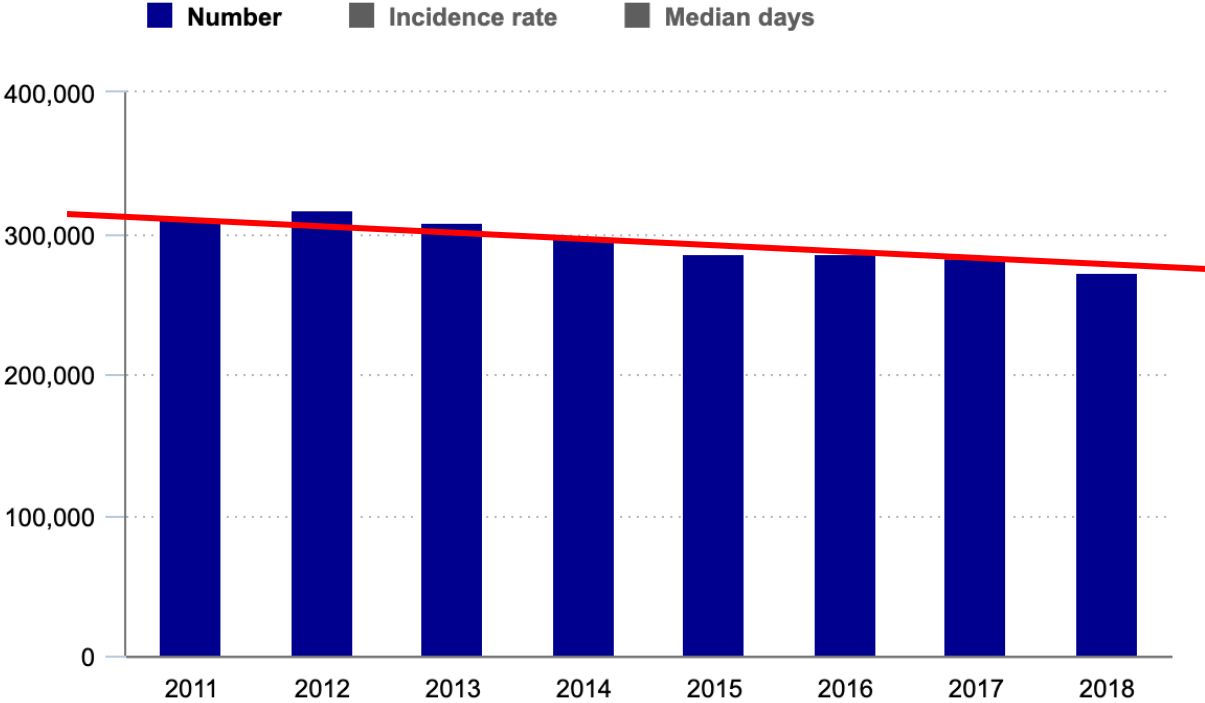
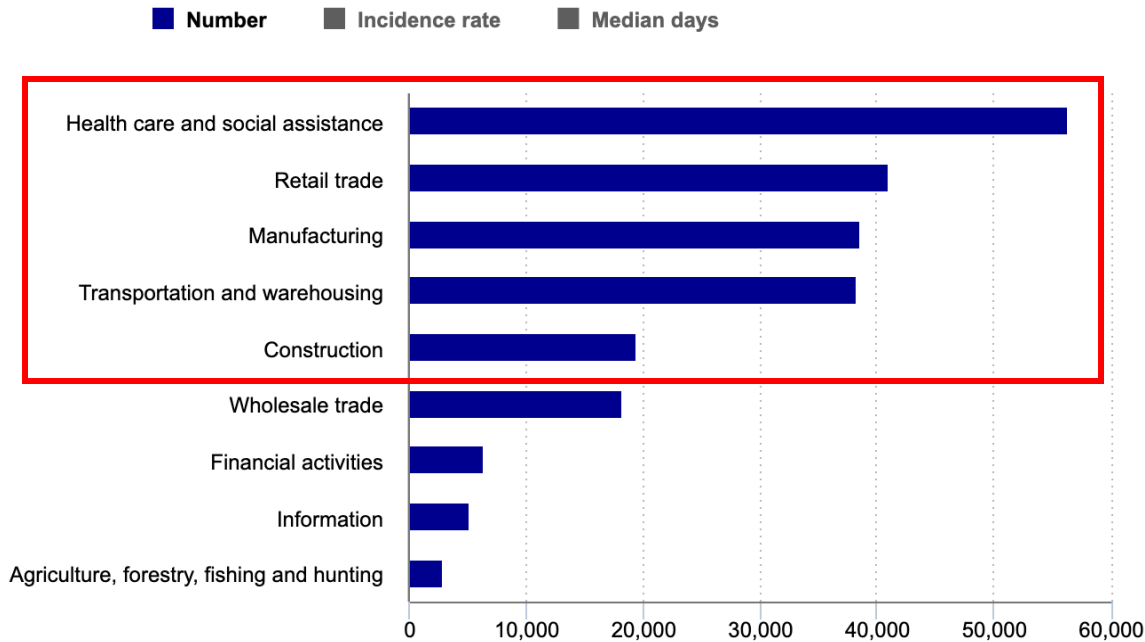


Chart 2. Number, incidence rate, and median days away from work of injuries and illnesses involving musculoskeletal disorders by selected industries, U.S., private sector, 2018



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

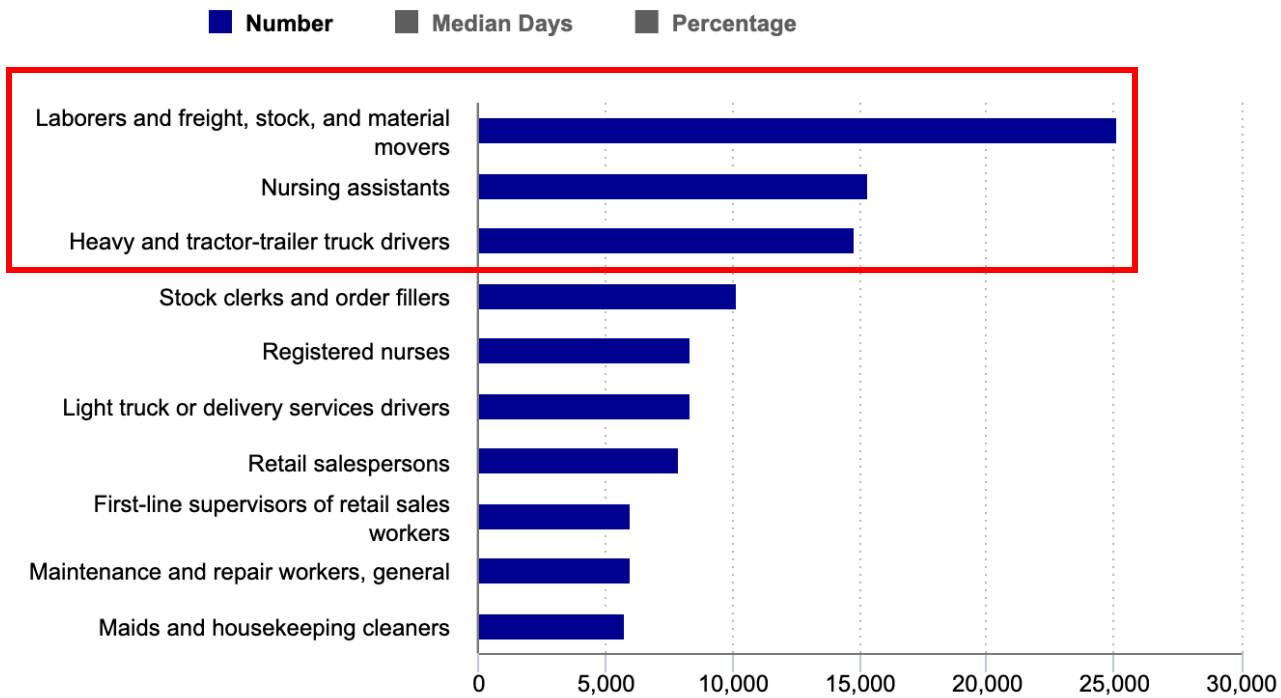
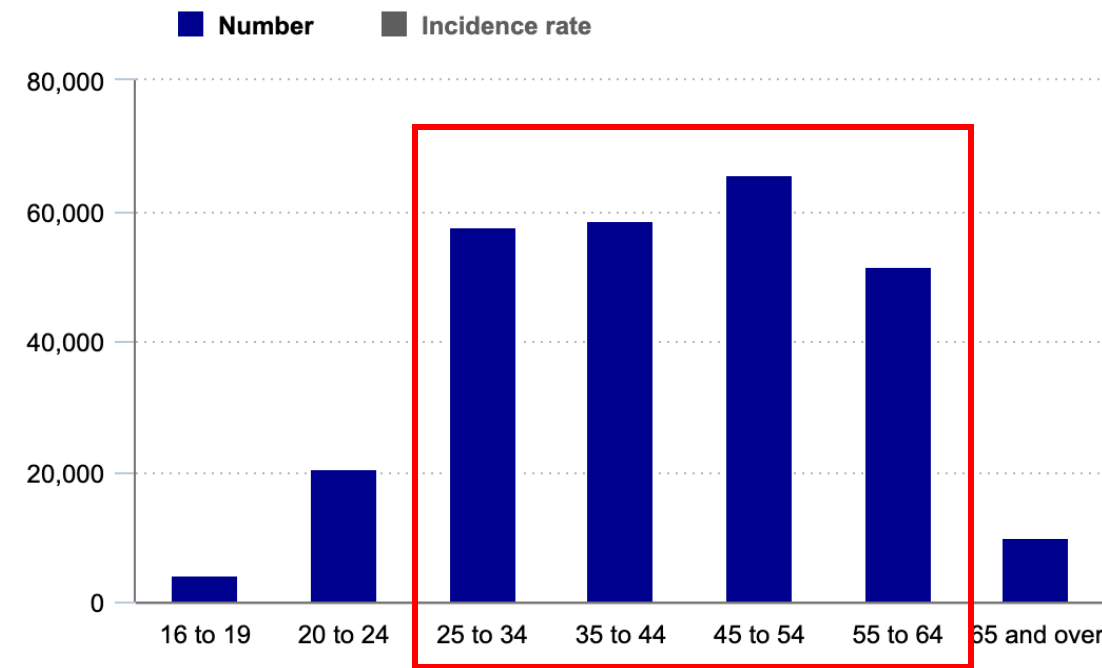


Chart 4. Number and incidence rate of injuries and illnesses involving musculoskeletal disorders, by selected age groups, U.S., private sector, 2018



Source: BLS, 2020



***What is your go-to ergonomic
hazard assessment tool?***

2. RULA and REBA



International Journal of Industrial Ergonomics

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

Dohyung Kee ✉

Rapid Upper Limb Assessment (RULA)

Advantages:

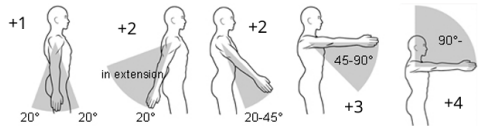
- Better for postural loading assessment
- High work-relatedness
- Applicable Industry: **All**

Disadvantages:

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

A. Arm and Wrist Analysis

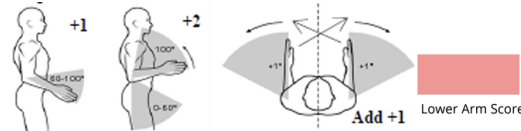
Step 1: Locate Upper Arm Position:



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

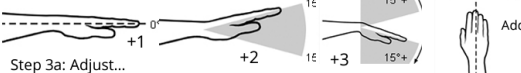
Upper Arm Score

Step 2: Locate Lower Arm Position:



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

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

Table C		Neck, Trunk, Leg Score						
Wrist / Arm Score	Neck Posture Score	1	2	3	4	5	6	7+
		1	2	3	4	5	6	7+
1	1	1	2	3	3	4	5	5
	2	2	2	3	4	4	5	5
	3	3	3	3	4	4	5	6
2	1	4	3	3	3	4	5	6
	2	5	4	4	4	5	6	7
	3	6	4	4	5	6	6	7
3	1	7	5	5	6	6	7	7
	2	8	5	5	6	6	7	7
	3	9	5	5	6	7	7	7

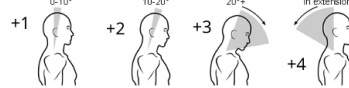
Scoring: (final score from Table C)

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:



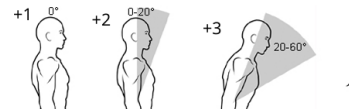
Step 9a: Adjust...

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

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

Step 2: Locate Trunk Position

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

Step 3: Legs

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

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

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

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

Step 8: Locate Lower Arm Position:

Step 9: Locate Wrist Position:

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

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

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.

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

SCORES

Table A: Neck

	Neck												
	1				2				3				
Legs	1	2	3	4	1	2	3	4	1	2	3	4	
Trunk Posture Score	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: Lower Arm

	1						2					
Wrist	1	2	3	4	5	6	1	2	3	4	5	6
Upper Arm Score	1	1	2	2	1	2	3	3	4	5	4	5
	2	1	2	3	2	3	4	4	5	5	6	7
	3	3	4	5	4	5	5	6	7	8	7	8
	4	4	5	5	5	6	6	7	8	8	9	9
	5	6	7	8	7	8	8	8	9	8	9	9
	6	7	8	8	8	9	9	9	9	9	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	7	7	8	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	11	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

Final REBA Score

Table C Score + Activity Score = Final REBA Score

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)

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

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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3. Assessment Tools for Posture, Biomechanics & Workload Risks

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

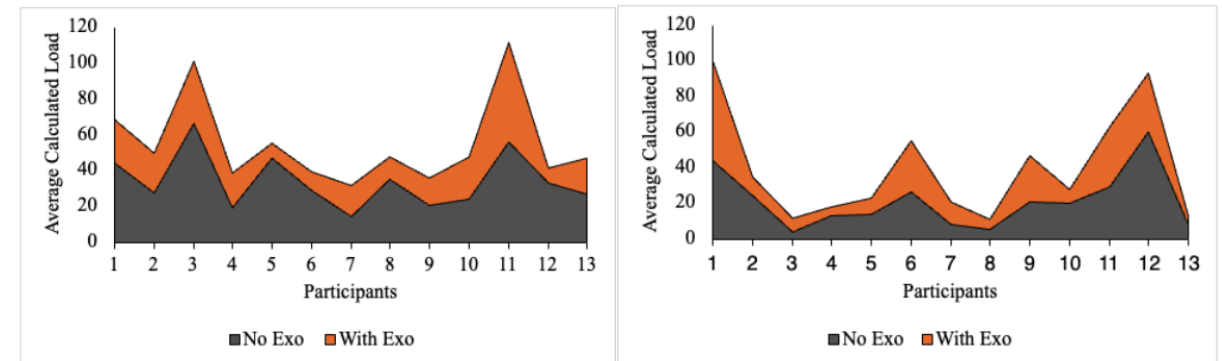
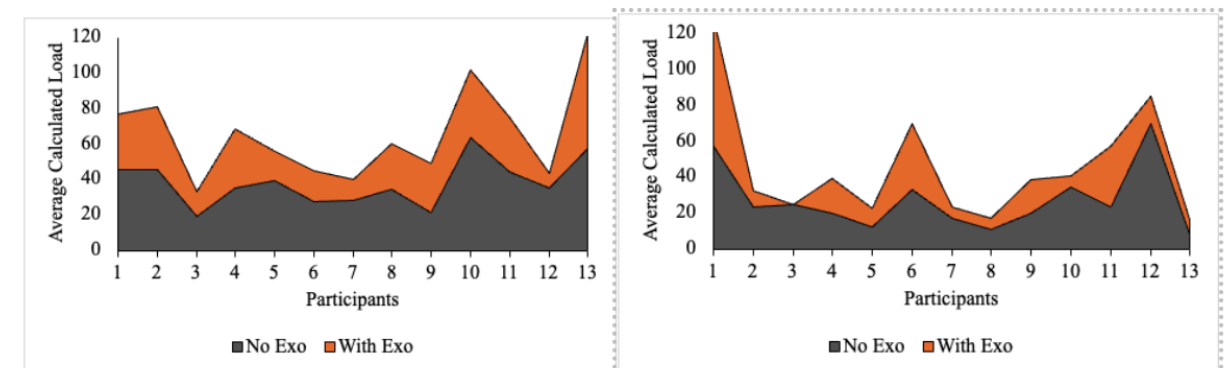


Figure 3. Cognitive demand of female (left) and male (right) participants during Task 3, N=26



2. Ovako Working posture Assessment System (OWAS)

- Classification system based on the risk of MSDs and physical load on the musculoskeletal system
- 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	3	1	2
1	1	1	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	1	1	1	2	2	2	2	2	2	1	1
	3	1	1	1	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	3	3	2	2	2
	2	2	2	3	2	2	3	2	3	3	3	3	3	4	4	3	4	4	3	3	3
	3	3	3	4	2	2	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4
3	1	1	1	1	1	1	1	1	1	1	2	3	3	3	4	4	4	4	1	1	1
	2	2	2	3	1	1	1	1	1	1	2	4	4	4	4	4	4	4	3	3	3
	3	2	2	3	1	1	1	2	3	3	4	4	4	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	4	4	4
	2	3	3	4	2	3	4	3	3	4	4	4	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																			

back posture

1 – upright
2 – leaning forward
3 – flexuous
4 – leaning forward and flexuous

forearms posture

1 – both below elbow joint
2 – one above elbow joint
3 – both above elbow joint

legs work

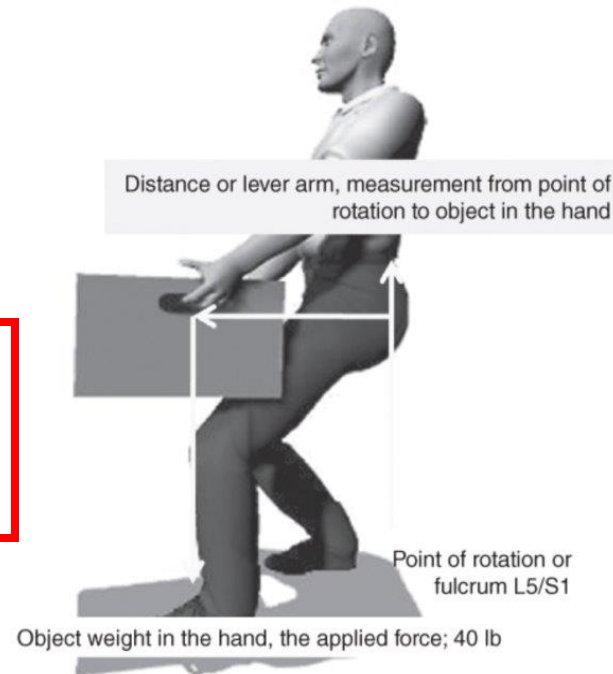
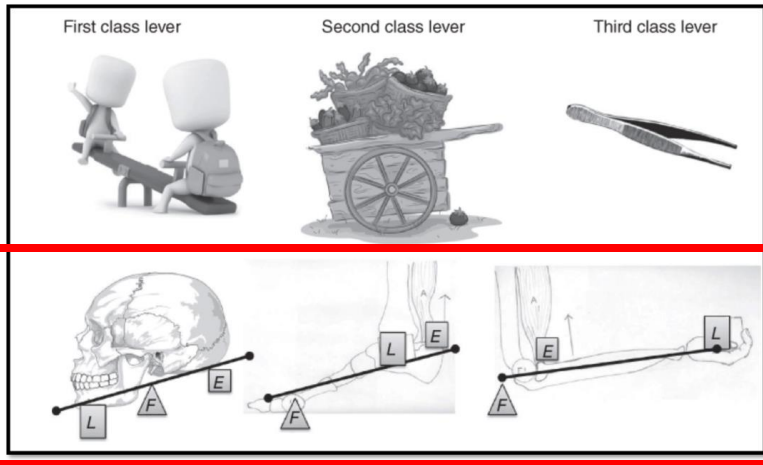
1 – sitting position
2 – standing with legs upright
3 – standing with one leg upright
4 – standing with legs bent
5 – standing with one leg bent
6 – kneeling on one or both knees
7 – walking

external load volume for men [kg]

1 – below 10
2 – within the range 10-20
3 – above 20

position	legs work code	external load volume code
1	1	1
2	2	2
3	3	3
4	4	4
5	5	5
6	6	6
7	7	7

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**

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?*

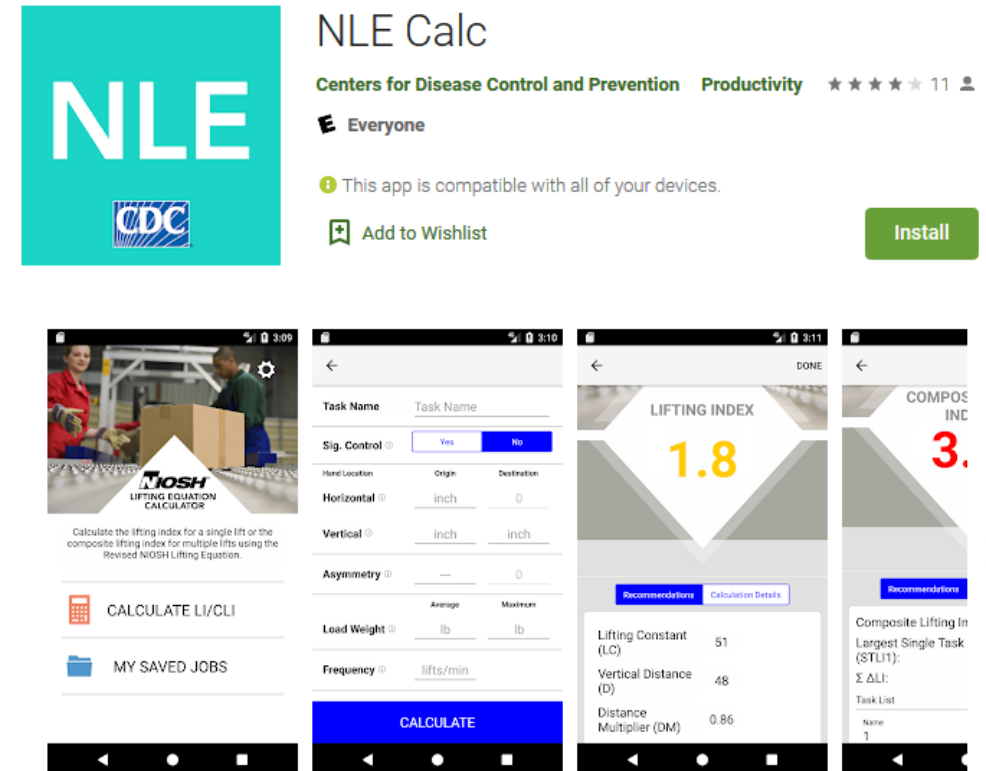
Answer: It depends on the Distance!

- 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 (Kuorinka 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)	Have you had trouble at any time during the last 7 days?	
	☐ No ☐ Yes	☐ No ☐ Yes	☐ Yes
	☐ No ☐ Yes	☐ No ☐ Yes	☐ Yes
	☐ No ☐ Yes	☐ No ☐ Yes	☐ Yes
	☐ No ☐ Yes	☐ No ☐ Yes	☐ Yes
	☐ No ☐ Yes	☐ No ☐ Yes	☐ Yes
 Back View	☐ No ☐ Yes	☐ No ☐ Yes	☐ Yes
	☐ No ☐ Yes	☐ No ☐ Yes	☐ Yes
	☐ No ☐ Yes	☐ No ☐ Yes	☐ Yes
	☐ No ☐ Yes	☐ No ☐ Yes	☐ Yes
	☐ No ☐ Yes	☐ No ☐ Yes	☐ Yes

- 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**

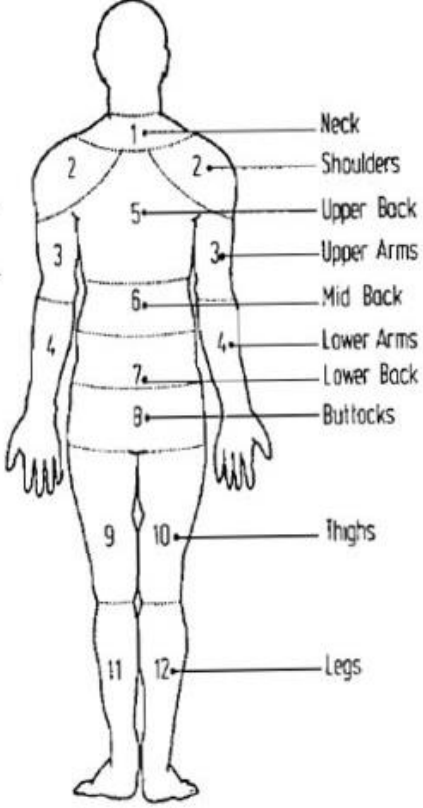


3. Body Part Discomfort (BPD) Questionnaire

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).



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						

Figure 3. Body regions.

- 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

Volume 2, Issue 1 - March 2023



SHIFT
GLOBAL EHS RESEARCH TO PRACTICE

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

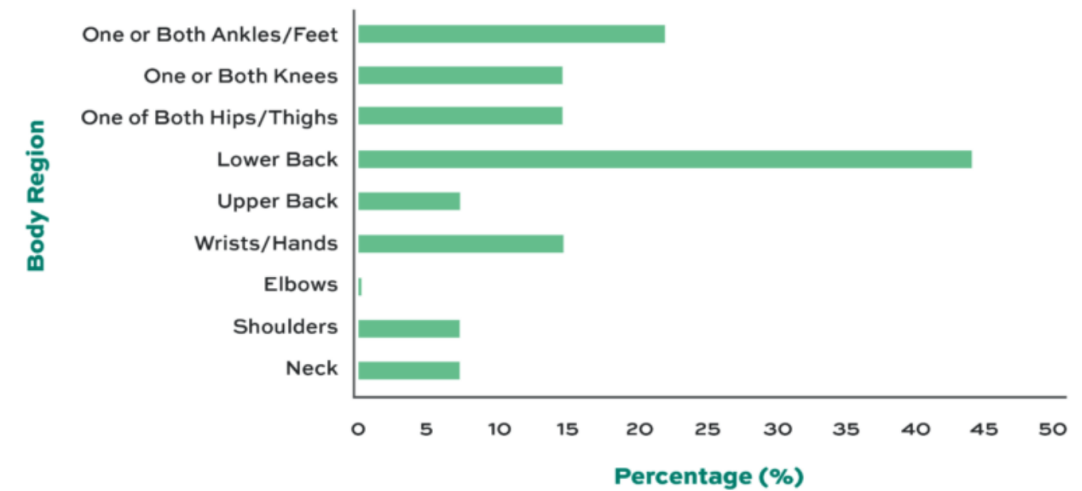
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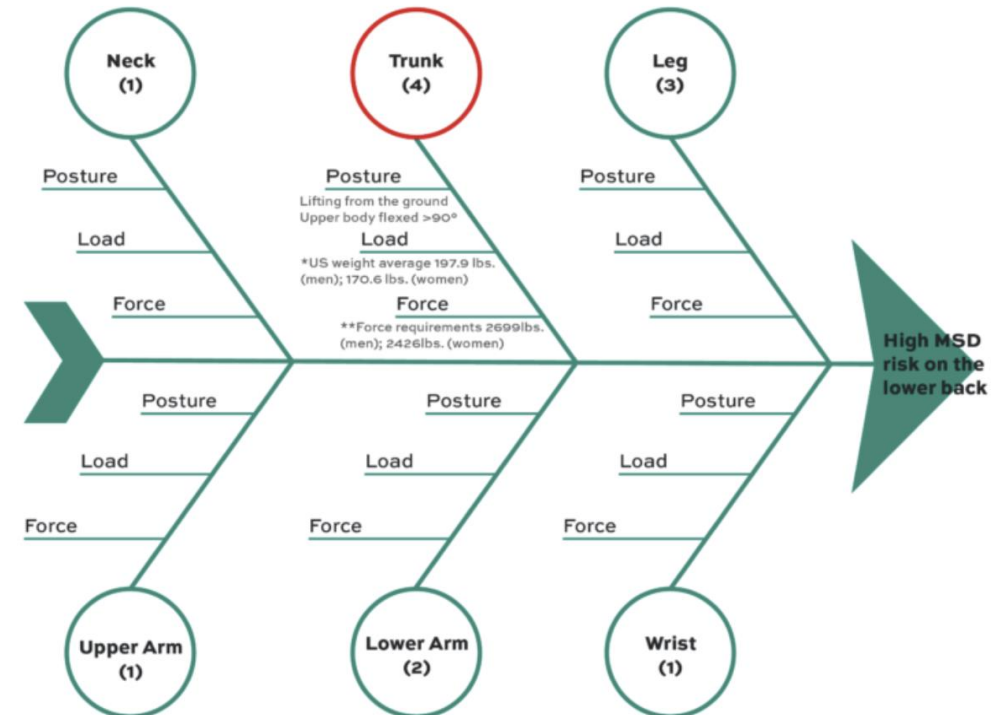
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- Allows cross-validation of findings of one or multiple assessment tools
- Minimizes bias on data



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!

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