Ergonomics: Assessments and Evaluations for Job Improvements

Travis Ellis, CSP, CHMM
Course Objectives:

1. Identify jobs or tasks with risk factors for ergonomic injuries in your workplace.
2. Snook Tables, RULA, REBA, NIOSH Lifting Equation, etc.---which one is the “best” and how do they work.
3. Practical case study for a common meat industry job.
4. Once you evaluate, what’s next? Don't do evaluations if you don’t plan to follow-up....
Identify Jobs or Tasks with Ergo Risk Factors:

1. Managers, supervisors and workers have been trained on how to recognize ergonomic hazards.
2. Incident/injury reports and data are reviewed to identify tasks or jobs that are causing injuries.
3. Surveys (e.g. feedback, discomfort, perceived exertion) are used to collect ergo related information from workers.
4. Other data (e.g. absenteeism, overtime, production, quality, suggestions for changes) is regularly reviewed to see if there are indicators that ergo hazards may be contributing to other problems.
5. Ergo hazards are included in all workplace inspections.
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Time To Complete: Low: < 2 hours  Medium: 2-4 hours  High: > 4 hours
Training Required: Low: < 4 hours  Medium: 4-8 hours  High: > 8 hours
NIOSH Lifting Equation

The NIOSH Lifting Equation is used in order to calculate a recommended weight for two-handed, symmetrical lifting tasks in order to control the hazards of lower back injuries from manual lifting.
Disqualifiers for Using the NIOSH Lifting Equation

- One handed lifts
- More than 8 hours
- Seated or kneeling
- Restricted work space
- Unstable Objects
- Carrying, pushing or pulling while lifting
- Wheelbarrows or shovels
- High speed motion
- Unreasonable foot/floor coupling
- Unfavorable environment

Note: This equation is only used for lifting, not for the whole body.
Terms:

- \( L \): Weight of the object to be lifted.
- \( H \): Distance of the hands away from the mid-point between the ankles.
- \( V \): Distance of the hands above the floor.
- \( D \): Absolute value of the difference between the vertical heights at the destination and origin of the lift.
- \( A \): Angular measure of how far the object is displaced from the front of the workers body at the beginning or ending of the lift.
- \( F \): Average number of lifts per minute over a 15 minute period.
Terms Cont:

- HM, the "Horizontal Multiplier" factor,
- VM, the "Vertical Multiplier" factor,
- DM, the "Distance Multiplier" factor,
- FM, the "Frequency Multiplier" factor,
- AM, the "Asymmetric Multiplier" factor,
- CM, the "Coupling Multiplier" factor, and
- RWL, the "Recommended Weight Limit"
Correct Hand Representation for Lifting

Figure 1  Graphic Representation of Hand Location
Angle of Asymmetry

Figure 2  Graphic Representation of Angle of Asymmetry (A)
## Multiplier Tables

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<th>Horizontal Multiplier</th>
<th>Table 2</th>
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### Table 5: Frequency Multiplier Table (FM)

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**Value of V are in inches. For lifting less frequently than once per 5 minutes, set F = 2.**

| Coupling Multiplier | CM From Table 7 | From Table 7 |
Table 6
Hand-to-Container Coupling Classification

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<tr>
<th>GOOD</th>
<th>FAIR</th>
<th>POOR</th>
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<td>1. For containers of optimal design, such as some boxes, crates, etc., a &quot;Good&quot; hand-to-object coupling would be defined as handles or handhold cut-outs of optimal design [see notes 1 to 3 below].</td>
<td>1. For containers of optimal design, a &quot;Fair&quot; hand-to-object coupling would be defined as handles or handhold cut-outs of less than optimal design [see notes 1 to 4 below].</td>
<td>1. Containers of less than optimal design or loose parts or irregular objects that are bulky, hard to handle, or have sharp edges [see note 5 below].</td>
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<tr>
<td>2. For loose parts or irregular objects, which are not usually containerized, such as castings, stock, and supply materials, a &quot;Good&quot; hand-to-object coupling would be defined as a comfortable grip in which the hand can be easily wrapped around the object [see note 6 below].</td>
<td>2. For containers of optimal design with no handles or handhold cut-outs or for loose parts or irregular objects, a &quot;Fair&quot; hand-to-object coupling is defined as a grip in which the hand can be flexed about 90 degrees [see note 4 below].</td>
<td>2. Lifting non-rigid bags (i.e., bags that sag in the middle).</td>
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</table>

1. An optimal handle design has .75 - 1.5 inches (1.9 to 3.8 cm) diameter, ≥ 4.5 inches (11.5 cm) length, 2 inches (5 cm) clearance, cylindrical shape, and a smooth, non-slip surface.

2. An optimal hand-hold cut-out has the following approximate characteristics: ≥ 1.5 inch (3.8 cm) height, 4.5 inch (11.5 cm) length, semi-oval shape, ≥ 2 inch (5 cm) clearance, smooth non-slip surface, and ≥ 0.25 inches (0.60 cm) container thickness (e.g., double thickness cardboard).

3. An optimal container design has ≤ 16 inches (40 cm) frontal length, ≤ 12 inches (30 cm) height, and a smooth non-slip surface.

4. A worker should be capable of clamping the fingers at nearly 90° under the container, such as required when lifting a cardboard box from the floor.

5. A container is considered less than optimal if it has a frontal length > 16 inches (40 cm), height > 12 inches (30 cm), rough or slippery surfaces, sharp edges, asymmetric center of mass, unstable contents, or requires the use of gloves. A loose object is considered bulky if the load cannot easily be balanced between the hand-grasps.

6. A worker should be able to comfortably wrap the hand around the object without causing excessive wrist deviations or awkward postures, and the grip should not require excessive force.

Table 7
Coupling Multiplier

<table>
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<tr>
<th>Coupling Type</th>
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<th>V &lt; 30 inches (75 cm)</th>
<th>V ≥ 30 inches (75 cm)</th>
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<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Fair</td>
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<tr>
<td>Poor</td>
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LC = 51 Pounds
HM = 10/H
VM = 1-0.0075 x / V-30/
DM = .82 + (1.8/D)
AM = 1 - (.0032 x A)
FM go to Table
CM go to Table
Recommended Weight Limit Calculation

- **Recommended Weight Limit (RWL)** is defined for a specific set of task conditions as the weight of the load that nearly all healthy workers could perform over a period of time without an increased risk of developing lifting-related lower back pain.

**How it is calculated:**

\[ \text{RWL} = \text{LC} \times \text{HM} \times \text{VM} \times \text{DM} \times \text{AM} \times \text{FM} \times \text{CM} \]
Lifting Index Calculation

- **Lifting Index (LI)** - Provides a relative estimate of the level of physical stress associated with a particular manual lifting task.

  **How it is calculated:**

  \[ LI = \frac{\text{Load weight}}{\text{Recommended Weight Limit}} \]
Calculator

- This is to plug in the amounts for it to calculate the acceptable weight to lift for that period of time.

http://www.emcins.com/lc/niosh.htm
Lifting Index Guidelines

- If the LI is 1.0 or less, the lift can be considered for most individuals.
- If the LI is 1.1 to 1.5, the lift should be evaluated and changes considered but the urgency is less.
- If the LI is between 1.5 and 2.9, modification should be made to reduce the hazard.
- Any LI 3 or above indicates the lift places most individuals at immediate risk of injury and must be changed or eliminated immediately.
Lifting Index Guidelines

- If $HM < 1.0$ : Bring the load closer to the worker by removing any horizontal barriers or reducing the size of the object. Lifts near floor should be avoided, if unavoidable, the object should fit easily between the legs.
- If $VM < 1.0$ : Raise or lower the origin or destination of the lift. Avoid lifting near the floor or above the shoulders. Optimal lifting is at 30 inches.
- If $DM < 1.0$ : Reduce the vertical distance between the origin and the destination of the lift.
- If $AM < 1.0$ : Move the origin and destination of the lift closer together to reduce the angle of twist, or move the origin and destination further apart to force the worker to turn the feet and step, rather than twist the body.
- If $FM < 1.0$ : Reduce the lifting frequency rate, reduce the lifting duration, or provide longer recovery periods (ie: light work period)
Liberty Mutual Tables (Snook Tables)

- Based on Research by Drs. Stover Snook and Vincent Ciriello at the Liberty Mutual Research Institute for Safety.
  - Used psychophysical methodology and evaluation to find the percent of an industrial population capable of sustaining the efforts tabulated in lifting, lowering, pushing, pulling, and carrying.
  - Tables are less precise than the NIOSH lifting equation because NIOSH measures biomechanics.
Psychophysical methodology includes measuring
- Oxygen consumption
- Heart rate
- Anthropometric characteristics
- What the employee feels about the job
Liberty Mutual Tables
(Snook Tables)

- Table provides guidance as to the
  - Proportion of the population that should be able to do the task as a regular part of daily work
    - NIOSH establishes recommended limits
  - Help recognize risk factors
  - Helping make good business decisions on implementing cost effective ergonomic solutions
Disqualifiers for Using Tables

- One handed lifts
- Catching or throwing items
Using the Tables

- Choose the correct table
  - 20 different tables
    - Female Population Percentages for Lifting Tasks Ending Below Knuckle Height (<28”)
    - Male Population Percentages for Lifting Tasks Ending Below Knuckle Height (<28”)
    - Female Population Percentages for Lifting Tasks Ending Above Shoulder Height (>53”)
    - Male Population Percentages for Lifting Tasks Ending Above Shoulder Height (>53”)
    - Population Percentages for Pulling Tasks Initial Forces
Using the Tables

- Depending on the task, other measurements may need to be taken
  - Initial force
    - Pushing & pulling
  - Initial hand height
    - Lifting & lowering
  - Final hand height
    - Lifting & lowering
  - Lifting distance
    - Lift & lowering
    - lifting distance = final hand height – Initial hand height
Using the Tables (Example)

- Male is carrying a box on meat
- Determine
  - Weight of the object-45 lbs.
  - Hand height-33 in.
  - Carrying distance-10 ft.
  - Frequency of one carry-1/min.
- Find the correct table
  - Since this is a task involving a male carrying a load we would use table 11M-Male population Percentages for Carrying Tasks
- Read results
- 85% of the male population should be able to perform this task without injury
### TABLE 11M - MALE POPULATION PERCENTAGES FOR CARRYING TASKS

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<th>FREQUENCY</th>
<th>7 FEET</th>
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#### OBJECT WEIGHT (POUNDS)

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#### HAND HEIGHT (INCHES)

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* = GREATER THAN 90%  -  = LESS THAN 10%
Application Considerations

- When lifting, lowering or carrying boxes without handles, reduce weights by 15%.
- When lifting or lowering with extended reach in knee to shoulder zone, reduce weight by 50%.
- Tables apply to single tasks; when used with multiple tasks (combination of lifting, lowering, push/pull and/or carrying) the authors recommend use of the weight or force corresponding to the smallest population percent for the task combined.
Application Considerations

- **Injuries**
  - Any job that is producing injuries is a good candidate for redesign.

- **Bending**
  - The deeper the bending motion, the greater is the physical stress on the low back.

- **Twisting**
  - The greater the twist, the more physically stressful the task.

- **Hand-holds**
  - Inability to get a good grip on the load presents a greater physical hazard.
Table Information

- Electronic Calculations

- Read Tables
  - [http://libertymmhtables.libertymutual.com/CM_LMTablesWeb/pdf/LibertyMutualTables.pdf](http://libertymmhtables.libertymutual.com/CM_LMTablesWeb/pdf/LibertyMutualTables.pdf)
Washington Ergonomics Assessments

- Developed by Bill Brough with Washington Ergonomics
- Washington Ergonomics-Lifting Assessment
  - Targets lower back
- Washington Ergonomics-Hand Arm Assessment
  - Targets upper extremities
Tools are designed to collect worker perceptions about the difficulty surrounding a particular task and the physical demands of the job.

Perceptions are ranked on a 0-8 scoring system.
- Higher the number the higher the risk factor.
Factors that affect a human ability to lift.

- Weight of the object
- Position of the body (Static & Dynamic)-
  - What posture is required while lifting the object?
- Frequency of lifts
  - How many times must the object be lifted?
- Twisting the back
  - Must you twist while lifting or holding the object?
- Proper grasp and solid footing
  - How is the object held while lifting or carrying?
- Opinion
  - How do employees rate the difficulty of the task?
Washington Ergonomics
Hands & Arms Assessment

- Factors used to evaluate tasks involving hands and arms.
  - Movement
    - How often must the hands and arms be used to complete the task?
  - Position
    - What is the position of the hands and arms during the task?
  - Force/Grip
    - What amount of force/grip is required during the task?
  - Contact Stress
    - Is any portion of the body pressed against an object or forced to be used as a hammer?
Washington Ergonomics
Hands & Arms Assessment (Cont.)

- Vibration
  - Does the job subject the body to vibration?

- Environment
  - Does the environment fit the needs of the human body?

- Opinion
  - How do employees rate the difficulty of the task?
Using the Washington Assessment Tools

- Determine what assessment tool you need to use.
  - Can use both assessments for the same job?
- Take assessment booklet(s) to the floor
  - Booklets help rate job.
  - As you work your way through each factor, the employee will select a number from the rating scale.
  - Color the circle on the rating sheet that corresponds to the number selected.
  - Once the rating sheet is complete, you will have an idea of the risk factors for a particular job.
Washington Assessment Info

http://www.waergo.com/
REBA Assessment Tool

- The Rapid Entire Body Assessment (REBA) method was developed by Dr. Sue Hignett and Dr. Lynn McAtamney.
- A REBA assessment gives a quick and systematic assessment of the complete body postural risks to a worker.
- Scores mechanical and postural loads.
  - Score is adjusted for activity such as static, repetition and rapid posture changes.
  - REBA generates a grand score from 1 (low) to 15 (high).
REBA Limitations

- Method does not consider the duration of the task, available recovery time or vibration.
- This method only allows for looking at either one point in time or worst case postures. Must use representative postures.
- Only allows for separate assessment of right and left sides of the body.
# REBA Employee Assessment Worksheet

**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**
- Adjust
- Leg Score

**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
- Adjust: If shock or rapid build up of force: +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.

**Scores:**
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 8a: Adjust

**Step 9: Locate Wrist Position:**
- Step 9a: Adjust
- If wrist is bent from milis 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 range power grip, good: +8
- Acceptable but not ideal hand hold or coupling acceptable with minor body part: +2
- Hand hold not acceptable but possible: -2
- No handles, awkward, unsafe with any body part: -8

**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.

**Activity Score**
- +1 1 or more body parts are laid for longer than 1 minutes (static)
- +1 Repeated small range actions (more than 9x per minutes)
- +1 Action causes rapid large range changes in postures or unstable base

---

Task name: ______________________  Reviewer: ______________________  Date: ______/_____/______  Final REBA Score: ______________________

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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provided by Practical Ergonomics
Conclusion

- Focus on making the job better for the employee, it doesn’t have to be perfect.
- Conduct a post-improvement assessment to ensure the job is better and acceptable.
- Cycle jobs through the assessment process periodically even if they’ve been assessed or evaluated previously.
- Questions???