To reduce the occurrence of work-related musculoskeletal disorders (WMSDs), practitioners need to be able to effectively assess the risk in jobs and tasks.

Ergonomic Assessment Toolkit

By Susan E. Kotowski, PhD, CPE and Sheree L. Gibson, PE, CPE and the AIHA Ergonomics Committee

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Introduction to the AIHA Ergonomic Toolkit

To reduce the occurrence of work-related musculoskeletal disorders (WMSDs), practitioners need to be able to effectively assess the risk in jobs and tasks. When many safety and health professionals begin working in the field of ergonomics, they assume there is one method, model, or tool that will permit them to assess all jobs. However, such a tool does not exist. Instead, there are many tools that can and should be used to assess the risk of WMSDs.

Practitioners—whether they are industrial hygienists, safety professionals, or ergonomists—frequently need guidance to assess the risk. Members of the AIHA Ergonomics Committee set out to help by developing the first “toolkit” in 2007. This resource was a compilation of several risk assessment tools commonly used by practitioners. It included information such as the tool developers, risk factors and regions of the body considered, and type of tasks that could be analyzed with the tool. In that version, tools had to be free to the public and require minimal equipment. There was no judgment of whether a tool was “good” or not, but validation studies were cited.

Since then, the Toolkit has been expanded to include more international tools and more recently developed tools. As we taught workshops about the different risk assessment tools, it became obvious that a practitioner often needed tool selection guidance. Therefore, we developed a flow chart to illustrate how and why WE chose specific tools to analyze a given job. Note that we do not mean to imply that this is the only way to choose a tool, but it is the one we use. We apply a two-tier approach: identifying where a problem is likely to exist with a quick “survey” tool or tools followed by a more precise analysis method that focuses on a problematic task or tasks.

We recommend that the person(s) performing the risk assessment familiarize themselves with the job and its component tasks prior to choosing a tool or tools. Some tools will only apply in particular situations, such as heavy computer use or lifting. Some tools are good for “quick and dirty” survey evaluations when a large number of jobs must be assessed to determine if and where problems exist. The downside is usually a lack of precision. Other tools may be more precise and give more guidance but require a substantial time investment (in training and/or use). Often, multiple tools may be required to assess a complex job.

This new 2023 version of the AIHA Ergonomic Assessment Toolkit includes information on 26 tools as well as the Tool Selection Flow Chart and electronic versions of almost all the tools. It also includes a new section discussing some assessment tools that may require more equipment and/or expertise. The Toolkit is a living document and will evolve with the science and research methods. We are looking forward to translation of the Toolkit into several different languages, including Arabic and Mandarin (thank you to the Foundation for Professional Ergonomics for supporting this endeavor) and an update to the Spanish version (thank you faculty and students at the University of Puerto Rico). We must also thank all the developers of these tools—without their hard work, this Toolkit wouldn’t exist!

We urge those interested in physical ergonomics to look through ALL the tools. There may be tools with which you are not familiar. They may be new or may have been developed in another part of the world. Surveys by Patrick Dempsey, Raymond McGorry, Wayne Maynard, Brian Lowe, and Evan Jones.[1,2] have shown that even experienced ergonomists choose the tools with which they are most familiar instead of looking for new tools that may be more suitable for their application.

We hope this latest version of the Toolkit will be valuable for everyone in our field.

Susan E. Kotowski, PhD, CPE and Sheree L. Gibson, PE, CPE

References

1. **Dempsey PG, McGorry RW, Maynard WS. (2005).** A survey of tools and methods used by certified professional ergonomists. *Appl Ergon, 36(4)*:489–503. https://doi.org/10.1016/j.apergo.2005.01.007

2. **Lowe BD, Dempsey PG, Jones EM. (2019).** Ergonomics assessment methods used by ergonomics professionals. *Appl Ergon, 81*:102882. https://doi.org/10.1016/j.apergo.2019.102882

Glossary of Terms

Asymmetry: The amount of angular displacement from the sagittally symmetric position, typically measured in degrees

Cycle Time: The amount of time it takes to complete a specific task from start to finish.

Duration: The amount of time it takes to do something. Can be used to describe the length of a physical exertion, time spent in a particular posture, time to complete a specific task, and so forth.

Force: Amount of effort exerted during a movement or action. May be expressed as a quantitative measurement or in relation to strength [e.g., %MVC (Maximum Voluntary Contraction)].

Frequency: The rate at which something occurs in a given period of time.

Height of Origin of Load: Vertical distance from the ground to the middle of the load or hand location at the start of an exertion.

Height of Destination of Load: Vertical distance from the ground to the middle of the load or hand location at the end of the exertion.

Height of Lift or Lower: The difference between the height of origin of load and the height of destination of load, also known as “vertical distance.”

Horizontal Distance: Horizontal length between the spine (typically the L5/S1 vertebral level) and the middle of the hands, measured parallel to the ground. Also known as “distance from the body” or “moment arm.”

Qualitative Assessment Tool: A tool that assesses the quality of a factor based on perception (e.g., difficulty of task, level of exertion).

Quantitative Assessment Tool: A tool that assesses the quantity of a factor based on measurement (e.g., a count, distance, weight, etc.).

Recovery Time: Amount of rest time between exertions or movements.

Repetition: The recurrence of a movement or exertion.

Rest: The time between muscle exertions.

Weight of Load: The mass of an object—its heaviness—measured using a scale.

Glossary of Acronyms

ACGIH: American Conference of Governmental Industrial Hygienists

AIHA: American Industrial Hygiene Association

BWC: Bureau of Workers' Compensation

NIOSH: National Institute for Occupational Safety and Health

NORA: National Occupational Research Agenda

OSHA: Occupational Safety and Health Administration

OSU: The Ohio State University

TLV: Threshold Limit Value

WMSDs: Work-Related Musculoskeletal Disorders

Ergonomic Assessment Tools in the Toolkit

Whole Body Screening Tools (Qualitative Tools)
OSHA Screening Tool
Washington State's Caution Zone
Washington State's Hazard Zone

Whole Body Assessment Tools (Semi-Quantitative)
PLIBEL
Quick Ergonomic Checklist (QEC)
Rapid Entire Body Assessment (REBA)
Rodgers Muscle Fatigue Assessment

Office Work Assessment Tools
OSHA Computer Workstation Checklist
Rapid Office Strain Assessment (ROSA)

Upper Limb Assessment Tool (Semi-Quantitative)
Distal Upper Extremity Tool (DUET)
Occupational Repetitive Action Index (OCRA)
Rapid Upper Limb Assessment (RULA)

Upper Limb Assessment Tools (Quantitative)
ACGIH® TLV® for Hand Activity Level
ACGIH® TLV® for Hand-Arm Vibration
Revised Strain Index
The Shoulder Tool

Lifting Assessments (Qualitative)
ACGIH® TLV® for Lifting

Lifting Assessments (Semi-Quantitative)
Liberty Mutual Manual Material Handling Equations/
Washington State (WISHA) Lifting Calculator

Lifting Assessments (Quantitative)
BWC/OSU Lifting Guidelines
BWC/OSU One-Handed Lifting and Lowering Guidelines
LiFFT (Lifting Fatigue Failure Tool)
Revised NIOSH Lifting Equation (1991)
The Shoulder Tool
Utah Back Compressive Force Model

Push/Pull Assessments
BWC/OSU Push/Pull Guidelines
Liberty Mutual Manual Material Handling Equations
The Shoulder Tool

** Please note, all website links were working at the time of publication of this version of the Toolkit. Given that the linked documents are hosted externally, it is possible they will change over time.*

Choosing a Risk Assessment Tool or Tools

MSD risk assessments are typically done for a few reasons:

- To identify tasks or jobs that are causing problems such as injuries or employee complaints,
- To determine the causes of the problem, then
- To develop feasible solutions; or
- To determine a baseline risk assessment for future comparison

When choosing a risk assessment tool, the goal is to fit the tool to the application. There are many assessment tools. Some require a major investment of time, equipment, and expertise. Others can be performed more quickly but may not provide enough precision and documented validity for the application. Still others may not be the best choice because they omit a risk factor that is a significant issue on the job being analyzed. Balancing time and precision can sometimes be challenging. The goal is to provide a valid assessment but avoid "paralysis by analysis". Industrial settings are not research laboratories. In most cases, interfering with production must be minimized and industrial workers are generally less tolerant as test subjects. Often, a less precise assessment tool is sufficient to solve the problem. In industry, the analysis is NOT the point of the exercise—the solution is.

We recommend using a multi-step approach to assessments:

1) Observation of the job
    a. Watch the employee(s) perform the job
    b. Develop a list of tasks performed
    c. Look for nuances such as pacing, timing, one-off tasks, and problems with particular tasks
    d. Identify extremes of postures, motions, or forces
    e. Ask the employees questions about the job such as problem tasks or other issues
2) Measurement of critical factors
    a) Video the job, if possible, to make it easier to slow down or freeze actions for more accurate analysis
    b) Use a scale and/or force gauge to measure weights and forces
    c) Use a tape measure to determine relevant distances and heights
    d) Use a stopwatch or timer on video to measure repetition rate, time spent in awkward postures, recovery time, etc.
    e) Use a protractor or goniometer to measure angles of deviation from neutral postures
3) Make a preliminary assessment of activities and risk factors of significance based on observation of work (whether in person or on video)
    a) Note what kind of activities are being performed (i.e., manual material handling, upper extremity repetitive tasks)

b) Note which risk factors are likely to need assessment (e.g., vibration, posture, force)

c) Referring to the flow chart, perform a preliminary assessment such as the OSHA Ergonomic Assessment Checklist, the Quick Ergonomic Checklist, or the Washington State Caution or Hazard Zone Checks

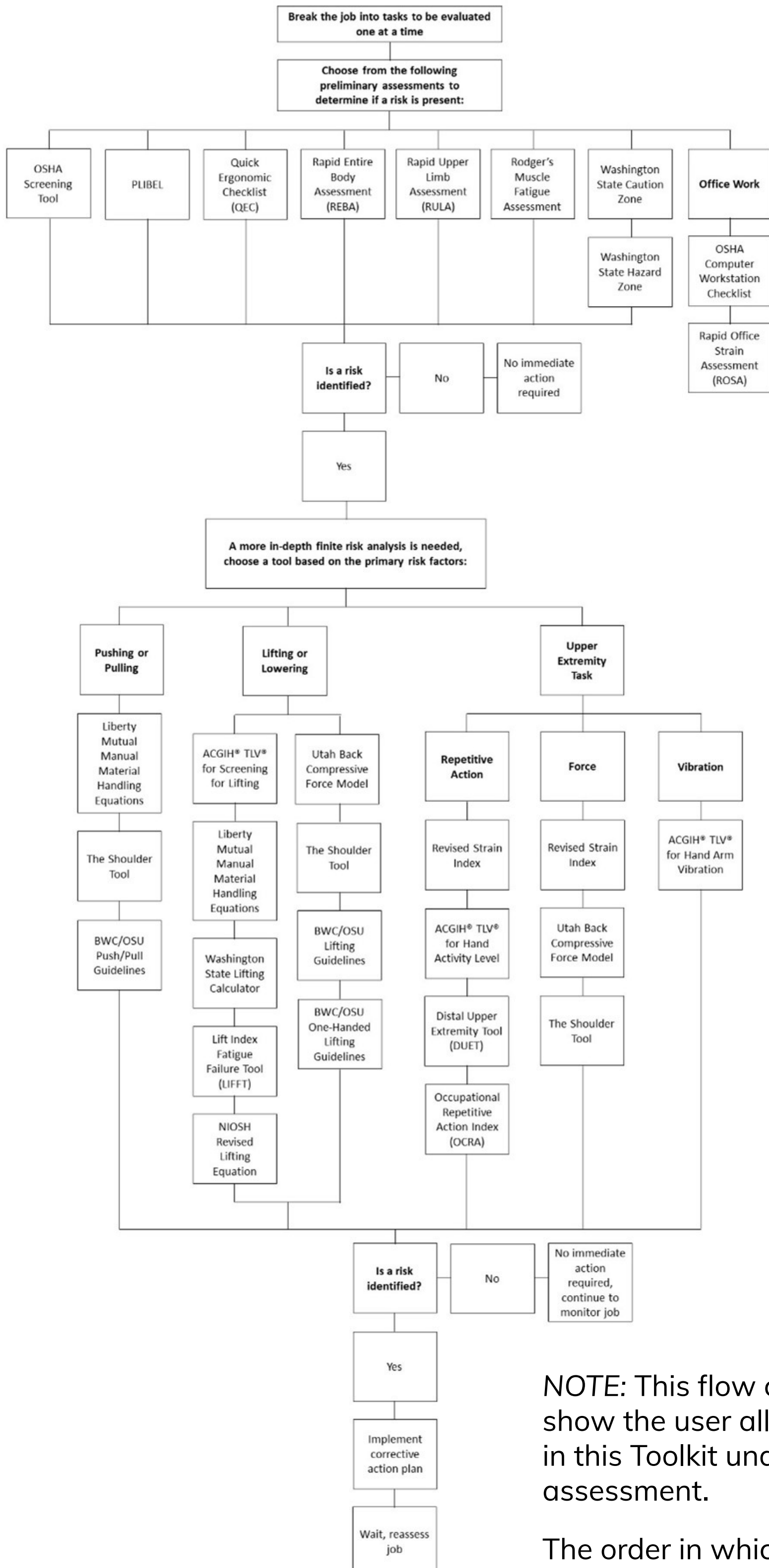
4) If the preliminary assessment does not indicate a potential problem, repeat the assessment with another tool. If the second tool does not indicate a problem, there is probably low risk for the general population. That does not mean an individual or even a select group may not have a problem. If that is the case, try to determine why they are having a problem. It may be that they have a pre-existing condition, a weakness in a muscle group, or insufficient training or they may be anthropometrically mismatched (e.g., shorter, taller, less flexible) compared to the population for which a job is designed. In these cases, it may be possible to accommodate the person by adjusting the fit or providing more training.

5) If one or more of the tools indicate there is a problem, it is often advisable to try to assess the level of risk with a more precise, more quantitative tool.* The job may need to be broken into its task elements (i.e., pushing/pulling, lifting, repetitive upper extremity exertions, forceful upper extremity exertions, hand/arm vibration exposure) for the purposes of the assessment. For example, a job may have manual material handling tasks AND repetitive upper extremity tasks. These tasks will require separate analyses.

6) Complete the analysis or analyses. Brainstorm solutions with the affected employees. Repeat the assessment for the proposed controls to compare their effectiveness in reducing the risk. Choose a control or controls. Implement them and then repeat the assessment after a short period of time to ensure the theoretical risk reduction is real. Survey the employees to determine if further improvements need to be made.

* In some cases, a preliminary analysis such as Rapid Office Strain Assessment or the OSHA Computer Workstation Checklist may be sufficient to define the controls needed.

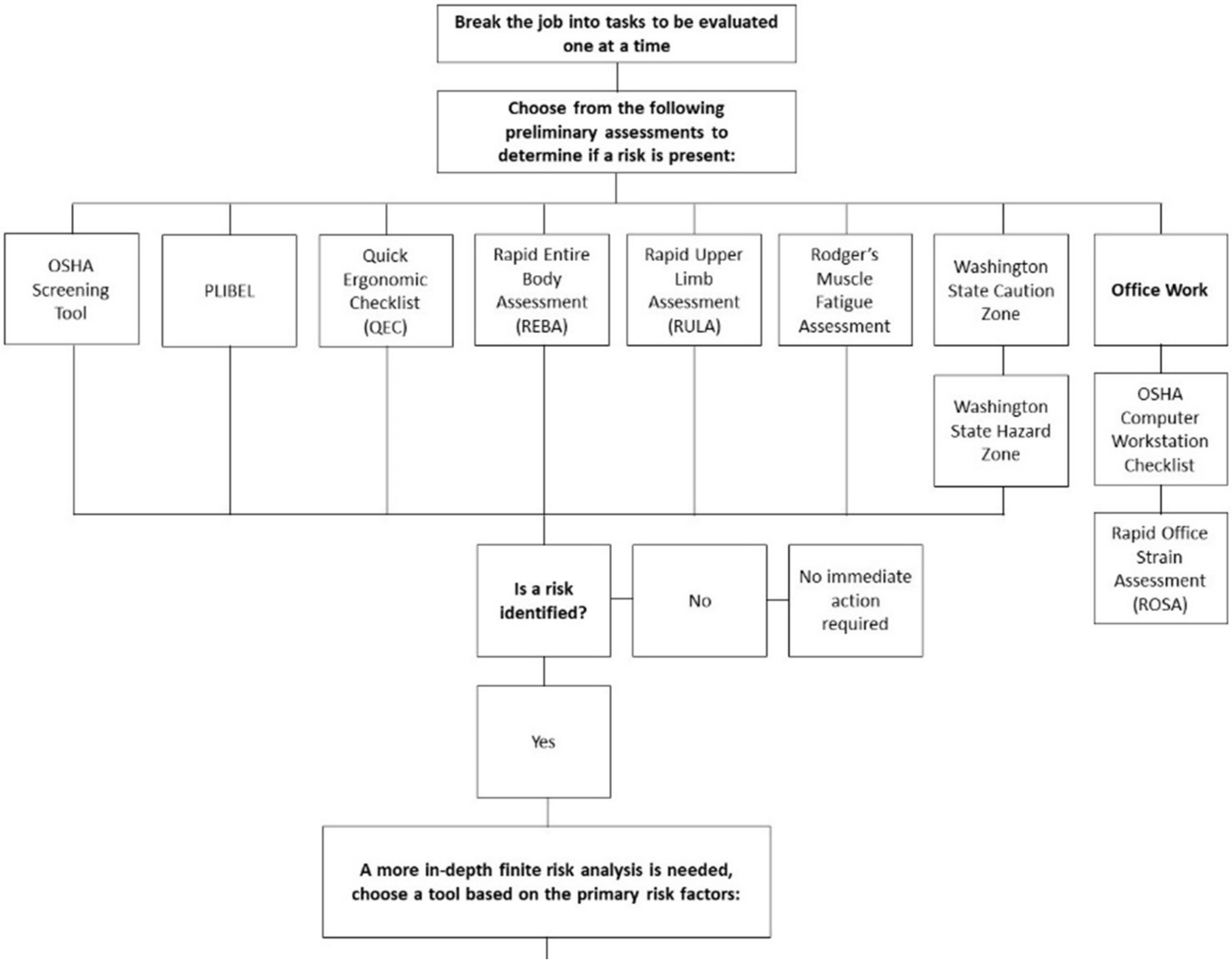
Flow Chart for Ergonomic Tool Selection (Full Version)



NOTE: This flow chart is designed to show the user all assessments included in this Toolkit under each category of assessment.

The order in which they are listed is NOT meant to imply order of priority or preference.

Flow Chart (Enlarged Sections)



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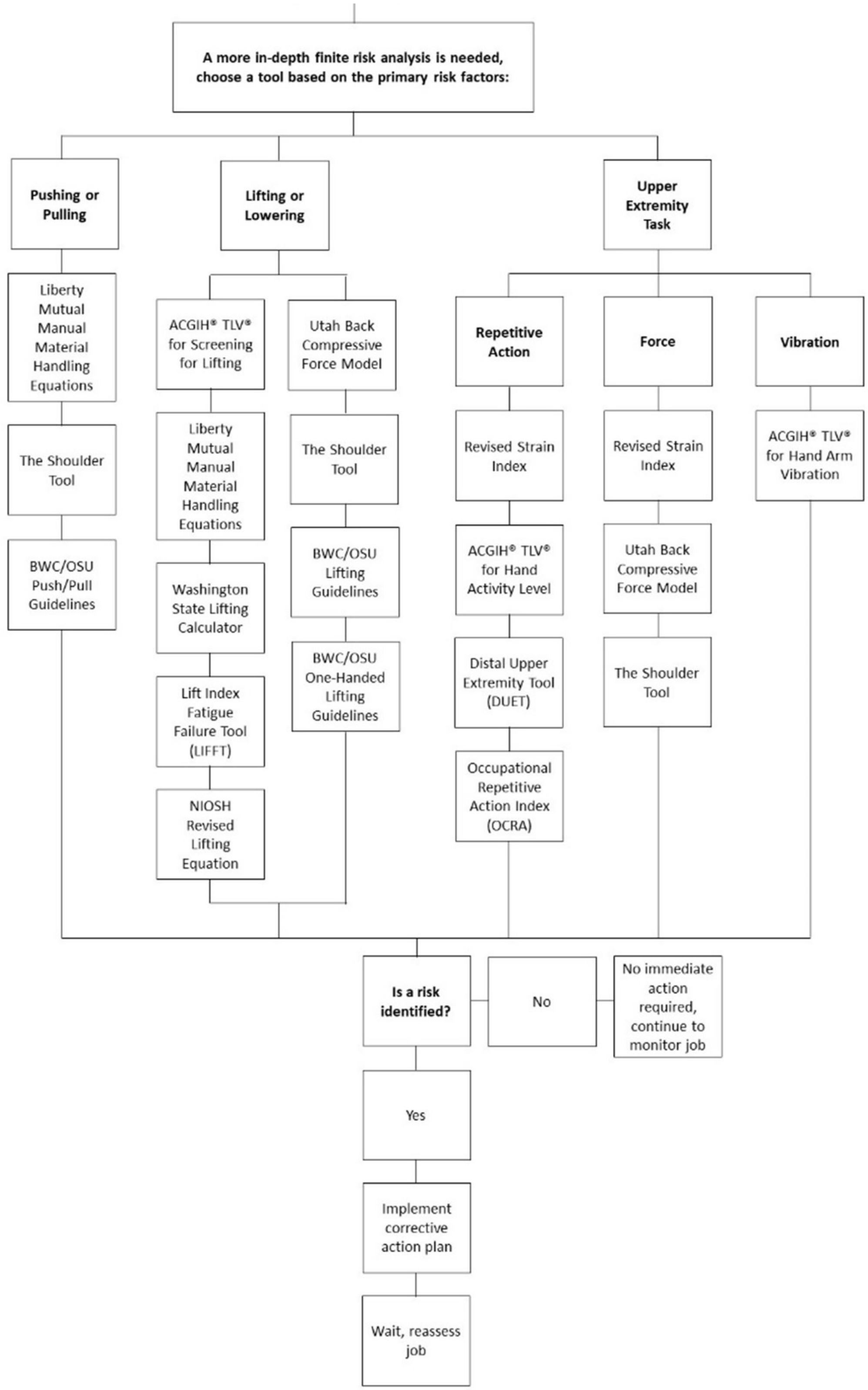
Flow Chart (Enlarged Sections)



ACGIH® TLV® for Hand Activity Level

Purpose:
To provide a basic general tool that may be used by the health and safety professional to determine job safety as it pertains to the repetitive motion, force exertion, rest/recovery period, and work demands placed on the hand region during hand-intensive work

Developed By:
TLV adopted by American Conference of Governmental Industrial Hygienists (ACGIH)

Developed When:
Updated: 2018

Original: 2002

Musculoskeletal Disorder Risk Factors Considered:
Repetition, duration, force, hand/wrist posture, rest and recovery

Body Regions Considered:
Hands, wrists, forearms, and elbows

Type of Jobs Appropriate For:
Single-task jobs performed for longer than 4 hours per day. For jobs with multiple tasks, time-weighted averaging may be applied. Seated or standing dynamic hand activities

Type of Jobs Not Appropriate For:
Static hand activities and activities requiring body regions other than hands

Limitations:
Limited to stress on the hand; does not consider vibration or contact stress

Inputs:
Repetitiveness of hand exertions, force exerted by hands

Outputs:
Comparison of hand activity to the threshold limit value (TLV) and action limit (AL) for hand activity. Work should not be above the TLV. If work is above the AL, consider general controls, surveillance, training, postures, contact stress, cold, and vibration.

Who Is the Tool Designed For:
Professionals trained in ergonomics and general users

Minimum Amount of Training:
2 hours

Studies That Provide Evidence of Validation of the Tool:
Spielholz P, Bao S, Howard N, Silverstein B, Fan J, Smith C, Salazar C. (2008). Reliability and validity assessment of the hand activity level threshold limit value and strain index using expert ratings of mono-task jobs. *J Occup Environ Hyg*, 5(4):250–257. doi: 10.1080/15459620801922211

Bonfiglioli R, Mattioli S, Armstrong TJ, Graziosi F, Marinelli F, Farioli A, Violante FS. (2013). Validation of the ACGIH TLV for hand activity in the OCTOPUS cohort: a two-year longitudinal study of carpal tunnel syndrome. *Scand J Work Environ Health, 39(2)*:155–163. doi: 10.5271/sjweh.3312

Kapellusch JM, Gerr FE, Malloy EJ, Garg A, Harris-Adamson C, Bao SS, Burt SE, Dale AM, Eisen EA, Evanoff BA, Hegmann KT, Silverstein BA, Theise MS, Rempel DM. (2014). Exposure–response relationships for the ACGIH threshold limit value for hand activity level: results from a pooled data study of carpal tunnel syndrome. *Scand J Work Environ Health, 40(6)*:610–620. doi: 10.5271/sjweh.3456.

Electronic Version:

https://health.usf.edu/publichealth/tbernard/~/media/86E38C07C414414E852414DED0EF1C89.ashx

Reference of Peer-Reviewed Publication:

Franzblau A, Armstrong TJ, Werner RA, Ulin SS. (2005). A cross-sectional assessment of the ACGIH TLV for hand activity level. *J Occup Rehabil, 15(1)*:57–67, 2005. doi: 10.1007/s10926-005-0874-z

Radwin RG, Azari DP, Lindstrom MJ, Ulin SS, Armstrong TJ, Rempel D. (2015). A frequency–duty cycle equation for the ACGIH hand activity level. *Ergonomics, 58(2)*:173–183. doi: 10.1080/00140139.2014.966154

Industries and Jobs Where Tool Has Been Applied:

Any task that requires hand and finger manipulation

Is Tool Copyrighted:

Yes

Instructional or Supplemental Information:

American Conference of Governmental Industrial Hygienists. (2020). *TLVs® and BEIs®: Based on the Documentation of the Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices*. Cincinnati, OH: ACGIH, 199–203. [Cost: $55]

Equipment Needed to Use Tool:

None

Time Required to Analyze a Typical Job:

<30 minutes (although 8 hours of data are needed to get the TLV)

ACGIH® TLV® for Hand-Arm Vibration

Purpose:

To provide recommendations for hand-arm vibration exposure limits through a combination of frequency-weighted, RMS, component accelerations, and vibration exposure duration

Developed By:

TLV adopted by American Conference of Governmental Industrial Hygienists (ACGIH) with reference to ISO 5349 and ANSI S2.70-2006

Developed When:

Updated: 2017

Original: 1984

Musculoskeletal Disorder Risk Factors Considered:

Vibration

Body Regions Considered:

Hands, arms, shoulders

Type of Jobs Appropriate For:

Jobs requiring hand-held vibrating tools

Type of Jobs Not Appropriate For:

Whole body vibration jobs and jobs without vibration

Limitations:

Limited to hand vibration; ignores other MSD risk factors

Inputs:

Cycle time, orthogonal components of vibration provided transducer

Outputs:

Comparison of hand activity to the threshold limit value (TLV) and action limit (AL) for hand vibration

Who Is the Tool Designed For:

Professionals trained in ergonomics, above a novice

Minimum Amount of Training:

2–4 hours

A high level of training and expertise are required to identify vector directions, install lightweight measurement transducer, properly use low-pass mechanical filter, and interpret results, including frequency weightings of vibration and advanced mathematic calculations.

Studies That Provide Evidence of Validation of the Tool:

None currently found in the literature

Electronic Version:

https://health.usf.edu/publichealth/tbernard/~/media/238A893ED97B448C96D9DC83B02DDA38.ashx

Reference of Peer-Reviewed Publication:

U.S. National Institute for Occupational Safety and Health (U.S. NIOSH). (1989). *Criteria for a Recommended Standard: Occupational Exposure to Hand-Arm Vibration*. DHHS (NIOSH) Publication No. 89-106. NIOSH: Cincinnati, OH.

Bovenzi M, Pinto I, Picciolo F, Mauro M, Ronchese F. (2011). Frequency weightings of hand-transmitted vibration for predicting vibration-induced white finger. *Scand J Work Environ Health, 37(3)*:244–252. doi: 10.5271/sjweh.3129

Industries and Jobs Where Tool Has Been Applied:

Grinding, sanding, chipping, drilling, sawing, production using vibrating or power hand tools, and regular use of vibrating hand tools

Is Tool Copyrighted:

Yes

Instructional or Supplemental Information:

ISO 5349 and ANSI S2.70-2006 both describe how to measure and evaluate human exposure to hand-transmitted vibration.

American Conference of Governmental Industrial Hygienists. (2020). *TLVs® and BEIs®: Based on the Documentation of the Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices.* Cincinnati, OH: ACGIH, 208–214. [Cost: $55].

Equipment Needed to Use Tool:

Small and lightweight transducer mounted to accurately record one or more orthogonal components of source vibration in the 5–1,500 Hz range

Frequency-weighted filter network needed for human response measuring

Time Required to Analyze a Typical Job:

30 minutes to 1 hour (although 8 hours of data are needed to get the TLV)

ACGIH® TLV® for Lifting

Purpose:
To identify the appropriate and safe weight to lift for different conditions based on lift frequencies, durations, and object placement

Developed By:
TLV adopted by American Conference of Governmental Industrial Hygienists (ACGIH)

Developed When:
Updated: 2020
Original: 1995

Musculoskeletal Disorder Risk Factors Considered:
Lift frequencies, lift duration, height of lift, and horizontal distance; awkward postures, overhead postures, one-hand lifting, unstable loads, and environmental conditions (high heat and humidity)

Body Regions Considered:
Low back

Type of Jobs Appropriate For:
Lifting of objects in any type of industries

Type of Jobs Not Appropriate For:
Non-lifting manual material handling tasks, sitting work

Limitations:
Weight-based; focused on pure lifting conditions only (e.g., mono-lifting); under TLV, no health risk is assumed

Inputs:
Weight of load, height of origin and destination of load, distance of load from body, frequency of lifting, duration of lifting

Outputs:
Comparison of the threshold limit value (TLV) for lifting

Who Is the Tool Designed For:
Health professionals with a basic understanding of ergonomics and general users

Minimum Amount of Training:
1–2 hours

Studies That Provide Evidence of Validation of the Tool:
Unknown

Reference of Peer-Reviewed Publication:
Marras WS, Lavender SA, Leurgans SE, Fathallah FA, Ferguson SA, Allread WG, Rajulu SL. (1995). Biomechanical risk factors for occupationally related low back disorders. *Ergonomics, 38(2)*:377–410. doi: 10.1080/00140139508925111

Electronic Version:
https://health.usf.edu/publichealth/tbernard/~/media/22413F58A2344344AAC40D6C7F1B45BB.ashx

Industries and Jobs Where Tool Has Been Applied:
Virtually all industries where jobs are isolated to lifting

Is Tool Copyrighted:
Yes

Instructional or Supplemental Information:
American Conference of Governmental Industrial Hygienists. (2020). *TLVs® and BEIs®: Based on the Documentation of the Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices*. Cincinnati, OH: ACGIH, 204–207. [Cost: $55].

Equipment Needed to Use Tool:
Scale, tape measure, and stopwatch

Time Required to Analyze a Typical Job:
<1 hour (although 8 hours of data are needed to get the TLV)

ACGIH® TLV® for Upper Limb Localized Fatigue

Purpose:
To identify the appropriate hand forces and duty cycles that can be applied repeatedly that will not lead to upper limb musculoskeletal fatigue in most healthy workers

Developed By:
TLV adopted by American Conference of Governmental Industrial Hygienists (ACGIH)

Developed When:
2018

Musculoskeletal Disorder Risk Factors Considered:
Hand forces applied during repetitive work and duration of work that those forces are applied. Can be inverted to estimate required recovery time for hand exertions.

Body Regions Considered:
Hands, wrists, forearms, elbows, and shoulders

Type of Jobs Appropriate For:
Jobs involving hand-intensive work performed for 2 or more hours per day

Type of Jobs Not Appropriate For:
Tasks that do not involve repetitive or forceful hand exertions or tasks that involve static postures

Limitations:
Hand forces normalized to strength in relevant posture; should not be applied for static exertions applied for more than 20 minutes; applies to duty cycles between 0.5% and 90%

Inputs:
Forces applied by the hand, duty cycle (percentage of total work cycle that force is applied by the hand)

Outputs:
Comparison to the threshold limit value (TLV) for upper limb localized fatigue

Who Is the Tool Designed For:
Health professionals with an understanding of ergonomics

Minimum Amount of Training:
Reviewing the TLV guide (<1 hour)

Studies That Provide Evidence of Validation of the Tool:
Potvin JR. (2012). Predicting maximum acceptable efforts for repetitive tasks: An equation based on duty cycle. *Hum Factors, 54(2)*:175–188. doi: 10.1177/0018720811424269

Reference of Peer-Reviewed Publication:
Unknown

Electronic Version:
Unknown

Industries and Jobs Where Tool Has Been Applied:

All industries where jobs involve hand-intensive, repetitive work. Not relevant for jobs with static upper extremity postures.

Is Tool Copyrighted:

Yes

Instructional or Supplemental Information:

American Conference of Governmental Industrial Hygienists. (2020). *TLVs® and BEIs®: Based on the Documentation of the Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices*. Cincinnati, OH: ACGIH, 215–216. [Cost: $55].

Equipment Needed to Use Tool:

Force gauges, stopwatch, video camera

Time Required to Analyze a Typical Job:

<1 hour (although 8 hours of data are needed to get the TLV)

BWC/OSU Lifting Guidelines

Purpose:

Classify risk for low back injury associated with lifting based on health status, vertical lift origin, reach distance, asymmetry, and object weight

Developed By:

The Ohio State University (OSU) Spine Research Institute in collaboration with Ohio Bureau of Workers' Compensation (BWC)

Developed When:

2020

Musculoskeletal Disorder Risk Factors Considered:

Lifting

Body Regions Considered:

Low back

Type of Jobs Appropriate For:

Lifting with stable loads

Type of Jobs Not Appropriate For:

Lowering, one-handed lifting, seated or kneeling tasks, lifting unstable objects

Limitations:

Risk limits not validated outside allowable range of inputs for vertical lift origin, reach distance, or object weight; cannot predict injuries to individual operators; does not account for individual risk factors, including gender or age

Inputs:

Health status (healthy or low back disorder), vertical lift origin (floor, knee, waist, shoulder level), horizontal reach (≤ 12 inches, between 12 and 24 inches), trunk-twisting angle (≤ 30°, between 30° and 60°, between 60° and 90°)

Outputs:

Green (low)/yellow (medium)/red (high) risk of injury ranking

Who Is the Tool Designed For:

Novice to expert

Minimum Amount of Training:

<1 hour

Studies That Provide Evidence of Validation of the Tool:

None currently found in the literature

Electronic Version:

https://info.bwc.ohio.gov/for-employers/safety-and-training/safety-education/one-handed-lifting-guidelines

Reference of Peer-Reviewed Publication:

Weston EB, Aurand AM, Dufour JS, Knapik GG, Marras WS. (2020). One versus two-handed lifting and lowering: lumbar spine loads and recommended one-handed limits protecting the lower back. *Ergonomics*, 63*(4)*:505–521. doi: 10.1080/00140139.2020.1727023

Industries and Jobs Where Tool Has Been Applied:

All industries for which one-handed lifting is performed

Is Tool Copyrighted:

No

Instructional or Supplemental Information:

https://www.bwc.ohio.gov/downloads/blankpdf/OneHandLift-PublicGuide.pdf

Equipment Needed to Use Tool:

Scale and tape measure

Time Required To Analyze a Typical Job:

<30 minutes

BWC/OSU One-Handed Lifting Guidelines

Purpose:
Classify risk for low back injury associated with one-handed lifting and lowering tasks based on inputs of vertical height, reach distance, asymmetry, object weight, and lift/lower frequency

Developed By:
The Ohio State University (OSU) Spine Research Institute in collaboration with Ohio Bureau of Workers' Compensation (BWC)

Developed When:
2020

Musculoskeletal Disorder Risk Factors Considered:
Lifting/lowering, repetition, spinal loading

Body Regions Considered:
Low back

Type of Jobs Appropriate For:
One-handed lifting and lowering with stable loads

Type of Jobs Not Appropriate For:
Two-handed lifting/lowering, one-handed lifting/lowering across the body, seated or kneeling tasks, lifting/lowering unstable objects

Limitations:
Risk limits not validated outside allowable range of inputs for vertical height, reach distance, or object weight; cannot predict injuries to individual operators; does not account for individual risk factors, including gender, age, or medical history

Inputs:
Vertical height of lift origin/lift destination (cm), reach distance (40–70 cm), asymmetry (0–90 degrees), object weight (0–11.5 kg), lift/lower frequency (0.2–15 per minute)

Outputs:
Green/yellow/red ranking, corresponding to safe for 80% or more of working population, safe for 50–80% of working population, and safe for <50% of working population, respectively

Who Is the Tool Designed For:
Novice to expert

Minimum Amount of Training:
<1 hour

Studies That Provide Evidence of Validation of the Tool:
None currently found in the literature

Electronic Version:

https://info.bwc.ohio.gov/for-employers/safety-and-training/safety-education/one-handed-lifting-guidelines

Reference of Peer-Reviewed Publication:

Weston EB, Aurand AM, Dufour JS, Knapik GG, Marras WS. (2020). One versus two-handed lifting and lowering: lumbar spine loads and recommended one-handed limits protecting the lower back. *Ergonomics*, 63*(4)*:505–521. doi: 10.1080/00140139.2020.1727023

Industries and Jobs Where Tool Has Been Applied:

All industries for which one-handed lifting is performed

Is Tool Copyrighted:

No

Instructional or Supplemental Information:

https://www.bwc.ohio.gov/downloads/blankpdf/OneHandLift-PublicGuide.pdf

Equipment Needed to Use Tool:

Scale and tape measure

Time Required To Analyze a Typical Job:

<30 minutes

BWC/OSU Push/Pull Guidelines

Purpose:
Classify the biomechanically determined risk for low back injury associated with occupational pushing and pulling tasks based on inputs of push/pull force, hand height, and exertion type

Developed By:
The Ohio State University (OSU) Spine Research Institute in collaboration with Ohio Bureau of Workers' Compensation (BWC)

Developed When:
2018

Musculoskeletal Disorder Risk Factors Considered:
Push/pull forces, spinal loading

Body Regions Considered:
Low back

Type of Jobs Appropriate For:
Manual handling (straight and turning push/pull exertions), other static/dynamic push/pull tasks

Type of Jobs Not Appropriate For:
Turning push/pull exertions where hands are not centered on the object being turned, turning push/pull exertions with very narrow or wide hand widths (<12 inches or >36 inches)

Limitations:
Guidelines were developed to be protective of the low back only (i.e., no shoulders); for turning, assumes hands are centered on the object being turned and are spaced at approximately shoulder-width; guidelines do not include a frequency component or task duration

Inputs:
Action (pull with 1 hand, pull with 2 hands, push with 2 hands), type of exertion (straight/turning), hand height (32–48 inches), hand width (12–36 inches, turning only), measured push/pull force (lbf.)

Outputs:
Green/yellow/red ranking, corresponding to safe for 80% or more of working population, safe for 50–80% of working population, and safe for <50% of working population, respectively

Who Is the Tool Designed For:
Novice to expert

Minimum Amount of Training:
<1 hour

Studies That Provide Evidence of Validation of the Tool:
None currently found in the literature

Electronic Version:
https://www.bwc.ohio.gov/employer/programs/safety/PushPullGuide/PushPullGuide.aspx

Reference of Peer-Reviewed Publication:

Weston EB, Aurand A, Dufour JS, Knapik GG, Marras WS. (2018). Biomechanically determined hand force limits protecting the low back during occupational pushing and pulling tasks. *Ergonomics, 61(6)*:853–865. doi: 10.1080/00140139.2017.1417643

Weston EB, Marras WS. (2020). Comparison of push/pull force estimates using a single-axis gauge versus a three-dimensional hand transducer. *Appl Ergonomics*, 88:103184. doi: 10.1016/j.apergo.2020.103184

Industries and Jobs Where Tool Has Been Applied:

All industries

Is Tool Copyrighted:

No

Instructional or Supplemental Information:

https://www.bwc.ohio.gov/downloads/blankpdf/PushPullGuidelines.pdf

Equipment Needed to Use Tool:

Hand dynamometer/force gauge, and measuring tape

Time Required to Analyze a Typical Job:

<30 minutes

Distal Upper Extremity Tool (DUET)

Purpose:
To assess the risk of distal upper extremity disorders associated with hand-intensive jobs. Designed to assess "daily dose" of distal upper extremity exposure—tool designed to assess multiple tasks and will identify tasks that are responsible for highest proportion of risk.

Developed By:
Sean Gallagher, Mark C. Schall, Jr., Richard Sesek, and Rong Huangfu (Auburn University)

Developed When:
2016

Musculoskeletal Disorder Risk Factors Considered:
Force, repetition

Body Regions Considered:
Distal upper extremity

Type of Jobs Appropriate For:
Hand-intensive tasks

Type of Jobs Not Appropriate For:
Lifting, shoulder-intensive tasks

Limitations:
Does not currently account for risk due to personal characteristics

Inputs:
Rating of perceived exertion (OMNI-RES scale), repetitions (per day)

Outputs:
Provides cumulative damage and related probability of upper extremity outcome

Who Is the Tool Designed For:
Practitioners, researchers

Minimum Amount of Training:
Tool is fairly intuitive and requires as little as 15–20 minutes of training

Studies That Provide Evidence of Validation:
Gallagher et al. (2018) provide concurrent validation with a cross-sectional study (Sesek, 1999). Dose-response relationships were demonstrated between the tool's Cumulative Damage measure and five separate distal upper extremity outcomes.

Electronic Version:
http://duet.pythonanywhere.com

Reference of Peer-Reviewed Publication:

Gallagher S, Schall Jr. MC, Sesek RF, Huangfu R. (2018). An upper extremity risk assessment tool based on material fatigue failure theory: The Distal Upper Extremity Tool (DUET). *Hum Factors,* 60(8):1146–1162. doi: 10.1177/0018720818789319

Sesek RF. (1999). *Evaluation and Refinement of Ergonomic Survey Tools to Evaluate Worker Risk of Cumulative Trauma Disorders* (Dissertation).

Industries and Jobs Where Tool Has Been Applied:

Multiple

Is Tool Copyrighted:

Yes, but freely available at website provided above

Instructional or Supplemental Information:

Instructions available at website provided above

Equipment Needed to Use Tool:

None, other than perhaps a stopwatch

Time Required to Analyze a Typical Job:

~15 minutes

Liberty Mutual Manual Material Handling (LM-MMH) Equations

(formally known as the Liberty Mutual Psychophysical Tables)

Purpose:
To provide guidance for manual material handling tasks

Developed By:
Jim R. Potvin, Vincent M. Ciriello, Stover H. Snook, Wayne S. Maynard, George E. Brogmus (2021)
Stover Snook (1978) with Vincent Ciriello (1991)

Developed When:
Updated: 2021

Original tables:
1978–1991

Musculoskeletal Disorder Risk Factors Considered:
Force, posture, frequency, gender

Body Regions Considered:
Whole body

Type of Jobs Appropriate For:
Manual material handling (lifting, lowering, pushing, pulling)

Type of Jobs Not Appropriate For:
Repetitive task jobs except manual material handling

Limitations:
Based on psychophysical ratings of industrial work groups, not strength or probability of injury

Inputs:
Varies by task type (lift/lower/push/pull/carry): coupling, lift frequency, object weight, start/end hand height, start/end hand distance, initial/sustained force, horizontal distance

Outputs:
Percentage of population capable (male and female)

Who Is the Tool Designed For:
Novice to expert

Minimum Amount of Training:
1–2 hours

Studies That Provide Evidence of Validation of the Tool:

Waters TR, Putz-Anderson V, Garg A. (1994). *Applications Manual for the Revised NIOSH Lifting Equation*. Cincinnati, OH: National Institute for Occupational Safety and Health, (NIOSH) Publication No. 94-110 (Revised 9/2021).

Weston EB, Marras WS. (2020). Comparison of push/pull force estimates using a single-axis gauge versus a three-dimensional hand transducer. *Appl Ergon, 88*:103184. doi: 10.1016/j.apergo.2020.103184

Electronic Version:

Liberty Mutual Manual Materials Handling Population Percentiles:
https://libertymmhtables.libertymutual.com/

ErgoValuator™ (iPhone app, available 7/1/2021)

Reference of Peer-Reviewed Publication:

Potvin JR, Ciriello VM, Snook SH, Maynard WS, Brogmus GE. (2021). The Liberty Mutual manual materials handling (LM-MMH) equations. *Ergonomics, 64(8)*:955–970. doi: 10.1080/00140139.2021.1891297

Ciriello VM, Maikala RV, Dempsey PG, O'Brien NV. (2011). Gender differences in psychophysically determined maximum acceptable weights and forces for industrial workers observed after twenty years. *Int Arch Occup Environ Health, 84(5)*:569–575. doi: 10.1007/s00420-010-0589-0

Ciriello VM, Maikala RV, Dempsey PG, O'Brien NV. (2010). Psychophysically determined forces of dynamic pushing for female industrial workers: Comparison of two apparatuses. *Appl Ergon, 41(1)*:141–145. doi: 10.1016/j.apergo.2009.06.001

Ciriello VM, Dempsey PG, Maikala RV, O'Brien NV. (2008). Secular changes in psychophysically determined maximum acceptable weights and forces over 20 years for male industrial workers. *Ergonomics, 51(5)*:593–601. doi: 10.1080/00140130701733590

Ciriello VM. (2007). The effects of container size, frequency and extended horizontal reach on maximum acceptable weights of lifting for female industrial workers. *Appl Ergon, 38(1)*:1–5. doi: 10.1016/j.apergo.2006.02.001

Ciriello VM, Dempsey PG, Maikala RV, O'Brien NV. (2007). Revisited: Comparison of two techniques to establish maximum acceptable forces of dynamic pushing for male industrial workers. *Int J Ind Ergo, 37(11–12)*:877–882. doi: 10.1016/j.ergon.2007.07.003

Ciriello VM. (2004a). The effects of distance on psychophysically determined pushing and pulling tasks for female industrial workers. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 48(12)*:1402–1406. doi: 10.1177/154193120404801228

Ciriello VM. (2004b). Comparison of two techniques to establish maximum acceptable forces of dynamic pushing for female industrial workers. *Int J Ind Ergo, 34(2)*:93–99. doi: 10.1016/j.ergon.2004.02.001

Ciriello VM. (2003). The effects of box size, frequency and extended horizontal reach on maximum acceptable weights of lifting. *Int J Ind Ergo, 32(2)*:115–120. doi: 10.1016/S0169-8141(03)00045-3

Ciriello VM. (2002). The effects of distance on psychophysically determined pushing and pulling tasks. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 46(13)*: 1142–1146. doi: 10.1177/154193120204601329

Ciriello VM. (2001). The effects of box size, vertical distance, and height on lowering tasks. *Int J Ind Ergo, 28(2)*:61–67. doi: 10.1016/S0169-8141(01)00012-9

Ciriello VM, McGorry RW, Martin SE, Bezverkhny IB. (1999). Maximum acceptable forces of dynamic pushing: comparison of two techniques. *Ergonomics, 42(1)*:32–39. doi: 10.1080/001401399185784

Ciriello VM. (1999). The effects of box size, frequency and extended horizontal reach on maximum acceptable weights of lifting. *Ergonomics, 42*:32–39.

Ciriello VM, Snook SH, Hughes GJ. (1993). Further studies of psychophysically determined maximum acceptable weights and forces. *Hum Factors, 35(1)*:175–186. doi: 10.1177/001872089303500110

Snook SH, Ciriello VM. (1991). The design of manual handling tasks: revised tables of maximum acceptable weights and forces. *Ergonomics, 34(9)*:1197–1213. doi: 10.1080/00140139108964855

Ciriello VM, Snook SH, Buck AC, Wilkinson PL. (1990). The effects of task duration on psychophysically-determined maximum acceptable weights and forces. *Ergonomics, 33(2)*:187–200. doi: 10.1080/00140139008927109

Ciriello VM, Snook SH. (1983). A study of size, distance, height, and frequency effects on manual handling tasks. *Hum Factors, 25(5)*:473–483. doi: 10.1177/001872088302500502

Snook SH. (1978). The design of manual handling tasks. *Ergonomics, 21(12)*:963–985. doi: 10.1080/00140137808931804

Industries and Jobs Where Tool Has Been Applied:

All industries

Is Tool Copyrighted:

Yes

Instructional or Supplemental Information:

https://libertymmhtables.libertymutual.com/instructions
https://libertymmhtables.libertymutual.com/interpreting-results
https://libertymmhtables.libertymutual.com/cautions

Equipment Needed to Use Tool:

Measuring tape, stopwatch, scale

Time Required to Analyze a Typical Job:

<1 hour

Lifting Fatigue Failure Tool (LiFFT)

Purpose:
To assess low back disorder risk associated with manual lifting and lowering tasks. Designed to assess "daily dose" of low back exposure—tool designed to assess multiple tasks and will identify tasks that are responsible for highest proportion of risk.

Developed By:
Sean Gallagher, Richard Sesek, Mark C. Schall, Jr., and Rong Huangfu (Auburn University)

Developed When:
2016

Musculoskeletal Disorder Risk Factors Considered:
Force (load moment), repetition

Body regions considered:
Low back

Type of Jobs Appropriate For:
Manual lifting and lowering tasks

Type of Jobs Not Appropriate For:
Carrying

Limitations:
Does not currently account for risk due to personal characteristics; does not assess carrying tasks

Inputs:
Load weight, peak horizontal distance from low back to center of load, repetition

Outputs:
Provides probability that that the job is high risk. A "High Risk Job" is defined as a job experiencing 12+ injuries per 200,000 hours worked, as defined by Marras et al. (1993).

Who Is the Tool Designed For:
Practitioners, researchers

Minimum Amount of Training:
<1 hour

Studies That Provide Evidence of Validation:
Gallagher et al. (2017) provide concurrent validation with two separate cross-sectional epidemiology studies (Zurada et al., 1997; Sesek, 1999). Dose-response relationships were demonstrated between the tool's Cumulative Damage measure and low back outcomes in both epidemiology studies.

Electronic Version:
http://lifft.pythonanywhere.com

Reference of Peer-Reviewed Publication:

Gallagher S, Sesek RF, Schall MC, Huangfu R. (2017). Development and validation of an easy-to-use risk assessment tool for cumulative low back loading: The Lifting Fatigue Failure Tool (LiFFT). *Appl Ergon*, 63:142–150. doi: 10.1016/j.apergo.2017.04.016

Industries and Jobs Where Tool Has Been Applied:

Warehousing, manufacturing, any sector with MMH

Is Tool Copyrighted:

Yes, but freely available at website provided above

Instructional or Supplemental Information:

Instructions available at website provided above

Equipment Needed to Use Tool:

Tape measure

Time Required to Analyze a Typical Job:

Depends on number of lifting tasks performed in the job. However, the analysis of individual tasks can often be done in a couple of minutes.

References:

Marras WS, Lavender SA, Leurgans SE, Rajulu SL, Allread WG, Fathallah FA, Ferguson SA. (1993). The role of dynamic three-dimensional trunk motion in occupationally-related low back disorders: The effects of workplace factors, trunk position, and trunk motion characteristics on risk of injury. *Spine* (Phila Pa 1976), 18(5): 617–628. doi: 10.1097/00007632-199304000-00015

Sesek RF. (1999). *Evaluation and Refinement of Ergonomic Survey Tools to Evaluate Worker Risk of Cumulative Trauma Disorders* (Dissertation).

Zurada J, Karwowski W, Marras WS. (1997). A neural network-based system for classification of industrial jobs with respect to risk of low back disorders due to workplace design. *Appl Ergon, 28(1)*:49–58. doi: 10.1016/s0003-6870(96)00034-8

Revised NIOSH Lifting Equation (1991) (RNLE)

Purpose:
To provide an easy-to-use and simple job analysis tool to control overexertion injuries associated with manual material handling and lifting

Developed By:
Tom Waters, Vern Putz-Anderson, Arun Garg
National Institute for Occupational Safety and Health

Developed When:
1991–1993

Musculoskeletal Disorder Risk Factors Considered:
Lifting force, posture, repetition, duration

Body Regions Considered:
Low back

Type of Jobs Appropriate For:
Two-hand lifting and lowering with stable loads

Type of Jobs Not Appropriate For:
Repetitive non-lifting tasks, static lifting tasks, lifting tasks with high acceleration or extremely fast movements, seated tasks

Lifting and lowering:

- with one hand
- for tasks lasting over 8 hours
- while seated or kneeling
- in a restricted workspace
- unstable objects
- while carrying/pushing or pulling
- with wheelbarrows or shovels
- with high-speed motion (faster than about 30 inches/second)
- with unreasonable foot/floor coupling (<0.4 coefficient of friction between the sole and the floor)
- in an unfavorable environment [i.e., temperature significantly outside 66–79°F (19–26°C) range; relative humidity outside 35–50% range]

Limitations:
Does not factor in whole body vibration, direct trauma to the back, or non-lifting MSD hazards; cannot predict injuries to individual operators; does not account for individual risk factors, including gender, age, or medical history

Inputs:
Horizontal reach distance, vertical distances, frequency of lifts, coupling, asymmetry, task duration, weight of object

Outputs:
Recommended weight limit and Lift Index

Who Is the Tool Designed For:
Professionals trained in ergonomics and general users

Minimum Amount of Training:
2–4 hours

Studies That Provide Evidence of Validation of the Tool:
Fox RR, Lu M, Occhipinti E, Jaeger M. (2019). Understanding outcome metrics of the revised NIOSH lifting equation. *Appl Ergon, 81*:102897. doi: 10.1016/j.apergo.2019.102897

Electronic Version:
Complete NIOSH Lifting Equation Guide: http://www.cdc.gov/niosh/docs/94-110/

Free online calculators based on 1991 Lifting Equation: https://www.ergocenter.ncsu.edu/wp-content/uploads/sites/18/2020/07/ECNC-NIOSH-LE-Calculator_2020.xlsx

https://health.usf.edu/publichealth/tbernard/ergotools (click on “Back” and then scroll down)

https://www.ready.navy.mil/content/dam/navfac/Safety/PDFs/ergo_page/tools/NIOSHLiftingEquation.xlsx

Free NIOSH Lifting Equations Apps are available for both Apple and Android Devices. Search “NLE Calc” for the version developed by NIOSH or “NIOSH Lifting Equation” for other versions from other parties.

*For jobs made up of multiple lifting tasks, please utilize the NIOSH Variable Lifting Index (VLI): https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4937352/

Reference of Peer-Reviewed Publication:
Waters TR, Putz-Anderson V, Garg A, Fine LJ. (1993). Revised NIOSH equation for the design and evaluation of manual lifting tasks. *Ergonomics, 36(7)*:749–776. doi: 10.1080/00140139308967940

Industries and Jobs Where Tool Has Been Applied:
Package sorting and handling, package delivery, beverage delivery, assembly work, production jobs with forceful exertions, stationary lifting, etc.

Is Tool Copyrighted:
No

Instructional or Supplemental Information:
Waters TR, Putz-Anderson V, Garg A (1994). Applications Manual for the Revised NIOSH Lifting Equation. Cincinnati, OH: National Institute for Occupational Safety and Health (NIOSH) Publication No. 94–110. https://www.cdc.gov/niosh/docs/94-110/default.html

Garg A, Kapellusch JM. (2016). The Cumulative Lifting Index (CULI) for the revised NIOSH lifting equation: quantifying risk for workers with job rotation. *Hum Factors, 58(5)*: 683–694. doi: 10.1177/0018720815627405

Lu M, Waters TR, Krieg E, Werren D. (2014). Efficacy of the revised NIOSH lifting equation to predict risk of low-back pain associated with manual lifting: a one-year prospective study. *Hum Factors, 56(1)*:73–85. doi: 10.1177/0018720813513608

Waters TR, Lu M, Piacitelli LA, Werren D, Deddens JA. (2011). Efficacy of the revised NIOSH lifting equation to predict risk of low back pain due to manual lifting: expanded cross-sectional analysis. *J Occup Environ Med, 53(9)*:1061–1067. doi: 10.1097/JOM.0b013e31822cfe5e

Garg A, Boda S, Hegmann KT, Moore JS, Kapellusch JM, Bhoyar P, Thiese MS, Merryweather A, Deckow-Schaefer G, Bloswick D, Malloy EJ. (2014). The NIOSH lifting equation and low-back pain, Part 1: Association with low-back pain in the backworks prospective cohort study. *Hum Factors, 56(1)*:6–28. doi: 10.1177/0018720813486669

Marras WS, Fine LJ, Ferguson SA, Waters TR. (1999). The effectiveness of commonly used lifting assessment methods to identify industrial jobs associated with elevated risk of low-back disorders. *Ergonomics, 42(1)*:229–245. doi: 10.1080/001401399185919

Waters TR, Baron SL, Piacitelli LA, Anderson VP, Skov T, Haring-Sweeney M, Wall DK, Fine LJ. (1999). Evaluation of the revised NIOSH lifting equation. A cross-sectional epidemiologic study. *Spine* (Phila Pa 1976), 24(4):386–394; discussion 395. Doi: 10.1097/00007632-199902150-00019

Hidalgo J, Genaidy A, Karwowski W, Christensen D, Huston R, Stambough J. (1995). A cross-validation of the NIOSH limits for manual lifting. *Ergonomics, 38(12)*:2455–2464. doi: 10.1080/00140139508925279

Equipment Needed to Use Tool:

Scale, tape measure, and protractor

Time Required to Analyze a Typical Job:

<1 hour

Occupational Repetitive Action Index (OCRA)

Purpose:
To provide a measurement tool that quantifies the relationship between the daily number of actions actually performed by the upper limbs in repetitive tasks and the corresponding number of recommended actions

Developed by:
Enrico Occhipinti and Daniela Colombini

Developed When:
1996

Musculoskeletal Disorder Risk Factors Considered:
Repetitiveness, force, awkward posture and movements, and lack of recovery time

Body Regions Considered:
Upper limbs

Type of Jobs Appropriate For:
Repetitive tasks where upper limbs are the majority used to handle materials

Type of Jobs Not Appropriate For:
Jobs where considerable risk is inherent due to use of the lower extremities

Limitations:
Tool cannot predict risk associated with vibration or contact stress or disorders of the shoulder, neck, or back

Inputs:
Shift duration, task duration, number and duration of rest breaks, number of dynamic and static durations, upper extremity postures and duration, force, impact, pacing

Outputs:
OCRA Score

Who Is the Tool Designed For:
Professionals trained in ergonomics

Minimum Amount of Training:
8 hours

Studies That Provide Evidence of Validation of the Tool:
None currently found in the literature

Electronic Version:
http://www.epmresearch.org/a57_free-software-in-english.html

- Scroll down the page to find multiple checklist options

https://kuliahdianmardi.files.wordpress.com/2016/04/ocra-1.pdf

Reference of Peer-Reviewed Publication:

Rhén I-M, Forsman M. (2020). Inter-and intra-rater reliability of the OCRA checklist method in video-recorded manual work tasks. *Appl Ergon, 84*:103025. doi: 10.1016/j.apergo.2019.103025.

Enrico O, Daniela C. (2019). Multitask analysis of UL repetitive movements by OCRA method: Criteria and tools. In: *Proceedings of the 20th Congress of the International Ergonomics Association (IEA 2018), Volume III: Musculoskeletal Disorders*, edited by Bagnara S, Tartaglia R, Albolino S, Alexander T, Fujita Y. Cham, Denmark: Springer, 60–71. doi: 10.1007/978-3-319-96083-8_9

Colombini D, Occhipinti E. (2016). *Risk Analysis and Management of Repetitive Actions: A Guide for Applying the OCRA System (Occupational Repetitive Actions)* (3rd ed.). Boca Raton: Taylor & Francis Group, CRC Press. doi: 10.1201/9781315382678

Paulsen R, Gallu T, Gilkey D, Reiser R 2nd, Murgia L, Rosecrance J. (2015). The inter-rater reliability of Strain Index and OCRA Checklist task assessments in cheese processing. *Appl Ergon, 51*:199–204. doi: 10.1016/j.apergo.2015.04.019

Occhipinti E, Colombini D. (2007). Updating reference values and predictive models of the OCRA method in the risk assessment of work-related musculoskeletal disorders of the upper limbs. *Ergonomics, 50(11)*, 1727–1739. doi: 10.1080/00140130701674331

Colombini D and Occipinti E. (2006). Preventing upper limb musculoskeletal disorders (UL-WMSDS): New approaches in job (re)design and current trends in standardization. *Appl Ergon, 37(4)*: 441–450. doi: 10.1016/j.apergo.2006.04.008

Colombini D, Occhipinti E, Grieco A. (2002). *Risk Assessment and Management of Repetitive Movements and Exertions of Upper Limbs: Job Analysis, Ocra Risk Indices, Prevention Strategies, and Design Principles*, vol. 2. The Netherlands: Elsevier Science.

Occhipinti E. (1998). OCRA: A concise index for the assessment of exposure to repetitive movements of the upper limbs. *Ergonomics, 41(9)*:1290–1311. doi: 10.1080/001401398186315

Colombini D. (1998). An observational method for classifying exposure to repetitive movements of the upper limbs. *Ergonomics, 41(9)*:1261–1289. doi: 10.1080/001401398186306

Grieco A. (1998). Application of the concise exposure index (OCRA) to tasks involving repetitive movements of the upper limbs in a variety of manufacturing industries: preliminary validations. *Ergonomics, 41(9)*:1347–1356. doi: 10.1080/001401398186351

Industries and Jobs Where Tool Has Been Applied:

Package sorting and handling, package delivery, beverage delivery, assembly work, manual handling of less than 10 pounds, production jobs with forceful exertions, stationary lifting

Is Tool Copyrighted:

Yes

Instructional or Supplemental Information:

None currently found in the literature

Equipment Needed to Use Tool:

Computer, stopwatch, counter, and software

Time Required to Analyze a Typical Job:

<30 minutes

OSHA Screening Tool

Purpose:

To provide a basic screening tool that can be used to identify areas of concern for potential MSD risk factors or be used when an MSD is reported to an employer

Developed By:

Occupational Safety and Health Administration (OSHA)

Developed When:

2002

Musculoskeletal Disorder Risk Factors Considered:

Repetition, force, contact stress, awkward posture, impact and vibration

Body Regions Considered:

All joints and total body

Type of Jobs Appropriate For:

Most jobs that may cause an MSD or have particular risk factors

Type of Jobs Not Appropriate For:

None

Limitations:

Screening tool provides limited guidance on how hazardous the job is; does not consider individual factors such as age or gender

Inputs:

Disease history, repetition rate, lifting magnitude, posture, duration, reach, workstation height, impact tool use, vibration exposure

Outputs:

Low, medium, or high risk classification

Who Is the Tool Designed For:

Professionals trained in ergonomics and general users

Minimum Amount of Training:

2 hours

Studies That Provide Evidence of Validation of the Tool:

None currently found in the literature

Electronic Version:

https://www.osha.gov/sites/default/files/2018-12/fy14_sh-26336-sh4_Ergonomic-Assessment-Checklist.pdf

Reference of Peer-Reviewed Publication:

None currently found in the literature

Industries and Jobs Where Tool Has Been Applied:
Manual material handling, bulk manufacturing, assembly line, general manufacturing, and construction

Is Tool Copyrighted:
No

Instructional or Supplemental Information:
None currently found in the literature

Equipment Needed to Use Tool:
Protractor

Time Required to Analyze a Typical Job:
<30 minutes

OSHA Computer Workstation Checklist

Purpose:
To assess possible deficiencies in computer workstation design, fit, or layout, especially for those who use computers more than 2 hours per day

Developed By:
AIHA Ergonomics Committee subcommittee of Cathy White, Mary O'Reilly, Marjorie Werrell, and Sheree Gibson (updated and expanded an earlier version from the 2000 OSHA Ergonomics Standard). Accompanied by Equipment Purchasing Guide.

Developed When:
2019

Musculoskeletal Disorder Risk Factors Considered:
Posture, repetition, force, work/rest

Body Regions Considered:
All

Type of Jobs Appropriate For:
Jobs involving routing computer use, particularly for more than 2 hours per day

Type of Jobs Not Appropriate For:
Any jobs where computer use is not prolonged

Limitations:
Does not provide a quantitative assessment of risk

Inputs:
Posture, characteristics of workstation components (chair, keyboard/input device, work surface, lighting, telephone, headset, footrest, etc.), input device, use of mobile devices

Outputs:
Identifies where workstation equipment may not fit individual user and when work organization may need to be adjusted

Who Is the Tool Designed For:
Practitioners, computer users

Minimum Amount of Training:
Self-training, <1 hour

Studies That Provide Evidence of Validation of the Tool:
None currently found in the literature

Electronic Version:
https://www.osha.gov/etools/computer-workstations/checklists/evaluation

Reference of Peer-Reviewed Publication:

Gibson SL, O'Reilly M, Werrell MK, White C. (2019). *An Ergonomics Guide to Computer Workstations*, 3rd edition. Falls Church, VA: AIHA.

Industries and Jobs Where Tool Has Been Applied:

All where computer use is prevalent

Is Tool Copyrighted:

No

Instructional or Supplemental Information:

https://www.osha.gov/etools/computer-workstations

Equipment Needed to Use Tool:

Tape measure, camera (optional)

Time Required to Analyze a Typical Job:

Depends on observation of tasks performed, so it will be affected by task composition; likely <1 hour

PLIBEL

Purpose:
To provide a valid and rapid checklist to identify potential risk factors in the workplace

Developed By:
Kristina Kemmlert

Developed When:
1995

Musculoskeletal Disorder Risk Factors Considered:
Repetition, duration, coupling force, lift force, push/pull force, awkward posture, and contact stress/impact

Body Regions Considered:
Neck, shoulders, upper back, elbows, forearms, hands, feet, knees, hips, and low back

Type of Jobs Appropriate For:
Manual handling, repetitive tasks, static tasks, dynamic tasks, seated and standing tasks

Type of Jobs Not Appropriate For:
Vibration-intensive jobs

Limitations:
Interobserver reliability not high (Kemmlert 1995); it is difficult to justify the magnitude of "risks" when the combination of several factors is presented within a job; answers limited to "yes" or "no"

Inputs:
Locations of body injury/pain; job characteristics including work surface, space constraints, tools, work height, posture, duration, repetition, time demands, etc.

Outputs:
Identifies body region(s) with highest risk

Who Is the Tool Designed For:
Non-specialist users

Minimum Amount of Training:
<4 hours

Studies That Provide Evidence of Validation of the Tool:
Kemmlert K. (1995). A method assigned for the identification of ergonomic hazards – PLIBEL. *Appl Ergon, 26(3)*:199–211. doi: 10.1016/0003-6870(95)00022-5

Electronic Version:
None available

Reference of Peer-Reviewed Publication:

Kemmlert K. (1995). A method assigned for the identification of ergonomic hazards – PLIBEL. *Appl Ergon*, 26*(3)*:199–211. doi: 10.1016/0003-6870(95)00022-5

Industries and Jobs Where Tool Has Been Applied:

Suitable for all industries

Is Tool Copyrighted:

No

Instructional or Supplemental Information:

https://www.taylorfrancis.com/chapters/edit/10.1201/9780203489925-12/plibel%E2%80%94the-method-assigned-identification-ergonomic-hazards-kristina-kemmlert

Equipment Needed to Use Tool:

None

Time Required to Analyze a Typical Job:

<1 hour

Quick Ergonomic Checklist (QEC)

Purpose:
To provide an easy-to-use and practical tool to assess physical exposures and predict risk for work-related musculoskeletal disorders

Developed By:
Peter Buckle and Guangyan Li

Developed When:
1998

Musculoskeletal Disorder Risk Factors Considered:
Repetitive movements, lifting force, push/pull force, awkward postures, task duration, and vibration

Body Regions Considered:
Neck, shoulders, hands, wrists, arms, back, and legs

Type of Jobs Appropriate For:
Manual handling, repetitive tasks, static tasks, dynamic tasks, seated and standing

Type of Jobs Not Appropriate For:
None

Limitations:

- Only allows for looking at the “worst” task and, for each body area, when the body area is most heavily loaded
- Requires judgment when selecting tasks to assess and deciding when the body part is most heavily loaded
- Hand force and weight of objects handled are determined by the worker, who may not understand how to estimate them
- Only examines individual tasks, not cumulative effects of all activities performed
- Cannot predict injuries to individual operators
- Does not account for individual risk factors, including gender, age, or medical history

Inputs:
Posture (back, shoulder/arm/hand/wrist, neck), frequency of movement, input of worker (weight handled, task duration, force exertion, visual demands, drive a vehicle, vibration exposure, perception of pace and stress)

Outputs:
Exposure score for back, shoulder/arm, wrist/hand, and neck into one of four categories: low, moderate, high, very high

Who Is the Tool Designed For:
Professionals trained in ergonomics and general users

Minimum Amount of Training:
2 hours

Studies That Provide Evidence of Validation of the Tool:
http://www.hse.gov.uk/research/rrpdf/rr211.pdf

Electronic Version:
https://www.msdprevention.com/resource-library/view/quick-exposure-checklist-qec-.htm

Reference of Peer-Reviewed Publication: R
Li G, Buckle P. (1999). *Evaluating Change in Exposure to Risk for Musculoskeletal Disorders - A Practical Tool* [HSE Contract Report 251/1999]. Norwich, England: HSE Books, p. 82.

Li G, Buckle P. (1998). A practical method for the assessment of work-related musculoskeletal risks - Quick Exposure Check (QEC). *Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 42(19)*:1351–1355. doi: 10.1177/154193129804201905

Brown R, Li G. (2003). The development of action levels for the 'Quick Exposure Check' (QEC) system. In: *Contemporary Ergonomics 2003*, edited by McCabe PT. London: Taylor & Francis, 41–46. doi: 10.1201/b12800

Industries and Jobs Where Tool Has Been Applied:
Suitable for all industries

Is Tool Copyrighted:
No

Instructional or Supplemental Information:
"User Guide" for QEC (Part 2, p16): http://www.hse.gov.uk/research/rrpdf/rr211.pdf\

Stanton N, Hedge A, Bookhuis K, Salas E, Hendrick HW. (2005; 2004). *Handbook of Human Factors and Ergonomics Methods*. Boca Raton, FL: CRC Press.

Equipment Needed to Use Tool:
Questionnaire for employee, weight scale, force gauges

Time Required to Analyze a Typical Job:
~1 hour

Rapid Entire Body Assessment (REBA)

Purpose:
To develop a postural analysis system sensitive to musculoskeletal risk in a variety of jobs that is based on body segment-specific ratings within specific movement planes—using a scoring system for muscle activity including static, dynamic, rapidly changing or unstable postures—and provide a benchmark for urgency of action

Developed by:
Sue Hignett and Lynn McAtamney

Developed When:
2000

Musculoskeletal Disorder Risk Factors Considered:
Awkward postures, load/force, coupling, activity level

Body Regions Considered:
Trunk, neck, legs, knees, upper and lower arms, wrists

Type of Jobs Appropriate For:
Jobs with a range of frequencies, involving multiple body regions, standing or sitting or combination

Type of Jobs Not Appropriate For:
None

Limitations:
Some factors (e.g., twisting, lateral bending, abduction) are weighted equally no matter to what degree they exist (e.g., 5° of twisting or 20° of twisting)

Inputs:
Postures of the neck, trunk, legs, arms, wrists, force/load, coupling, activity level

Outputs:
Risk score category: negligible risk, low risk, medium risk, high risk, very high risk

Who Is the Tool Designed For:
General users

Minimum Amount of Training:
4 hours

Studies That Provide Evidence of Validation of the Tool:
Interobserver reliability was found to be 62–85% for 14 users (Hignett and McAtamney, 2000).

Joshi M, Deshpande V. (2020). Investigative study and sensitivity analysis of Rapid Entire Body Assessment (REBA). *Int J Ind Ergo, 79*:103004. doi: 10.1016/j.ergon.2020.103004

Schwartz AH, Albin TJ, Gerberich SG. (2019). Intra-rater and inter-rater reliability of the rapid entire body assessment (REBA) tool. *Int J Ind Ergo, 71*:111–116. doi: 10.1016/j.ergon.2019.02.010

Al Madani D, Dababneh A. (2016). Rapid entire body assessment: A literature review. *Am J Eng Appl Sci, 9(1)*:107–118. doi: 10.3844/ajeassp.2016.107.118

Electronic Version:

https://ergo.human.cornell.edu/CUErgoTools/REBA%206.xls
https://ergo-plus.com/wp-content/uploads/rapid-entire-body-assessment-reba-1.png?x81069

Reference of Peer-Reviewed Publication:

Hignett S, McAtamney L. (2000). Rapid entire body assessment (REBA). *Appl Ergon, 31(2)*:201–205. doi: 10.1016/s0003-6870(99)00039-3

Industries and Jobs Where Tool Has Been Applied:

Suitable for all industries

Is Tool Copyrighted:

No

Instructional or Supplemental Information:

None found in the literature

Equipment Needed to Use Tool:

Worksheet, protractor, and scale

Time Required to Analyze a Typical Job:

~1 hr

Rapid Office Strain Assessment (ROSA)

Purpose:
To quantify the exposure to ergonomic risk factors in an office environment using a picture-based scoring checklist that evaluates worker posture and duration of chair, monitor, mouse, keyboard, and telephone use.

Developed by:
Michael Sonne, MhK, CK.

Developed When:
2012

Musculoskeletal Disorder Risk Factors Considered:
Posture, duration

Body Regions Considered:
Back, knees, legs, feet, shoulders, elbows, arms, neck

Type of Jobs Appropriate For:
Office jobs involving routine computer use

Type of Jobs Not Appropriate For:
Any office job not involving routine computer use

Limitations:
Does not provide suggestions of how to correct work posture if identified as risky

Inputs:
Body postures and work techniques while sitting in chair, adjustability of chair, and duration of chair use. Body postures and work techniques while using monitor, telephone, mouse and keyboard, availability of peripherals and duration of use.

Outputs:
Score for each area (e.g., chair, keyboard, etc.) is combined using a table to determine an overall ROSA score. ROSA scores range from 1-10, with scores ≤ 5 deemed "further assessment not immediately required," and scores >5 deemed "high risk" and "further assessment required as soon as possible."

Who Is the Tool Designed For:
Practitioners, computer users

Minimum Amount of Training:
Self-training, <1 hour

Studies That Provide Evidence of Validation of the Tool:
Sonne, M, Villalta, DL, Andrews, DM, (2012). Development and evaluation of an ergonomic risk checklist: ROSA – Rapid Office Strain Assessment. *Applied Ergonomics*, 43, 98-108.

Matos, M, Arezes, PM, (2015). Ergonomic evaluation of office workplaces with Rapid Office Strain Assessment (ROSA). *Procedia Manufacturing*, 3, 4689-4694.

Electronic Version:
https://ergo.human.cornell.edu/CUErgoTools/ROSA/ROSA%20forms.pdf

Reference of Peer-Reviewed Publication:

de Barros, FC, Moriguchi, CS, Chaves, TC, Andrews, DM, Sonne, M, de Oliveria Sato, T. (2022). Usefulness of the Rapid Office Strain Assessment (ROSA) tool in detecting differences before and after an ergonomics intervention. *BMC Musculoskelet Disord*, 23, 526. https://doi.org/10.1186/s12891-022-05490-8

Ghanbary-Sartang, A, Habibi, H, (2015). Evaluation of musculoskeletal disorders to method Rapid Office Strain Assessment (ROSA) in computers users. *Journal of Preventive Medicine, 10*;2(1), 47-54.

Liebregts, J, Sonne, M, Potvin, JR, (2016). Photograph-based ergonomic evaluations using the Rapid Office Strain Assessment (ROSA). *Applied Ergonomics, 1*;52, 317-24.

Rezaee-Hachesu, V, Hokmabadi, R, (2022). Ergonomic Evaluation of Computer Users by Rapid Office Strain Assessment (ROSA) Method and Its Relationship with the Prevalence of Musculoskeletal Disorders. *Journal of health research in community, 10*, 8(2), 63-75.

Salehi Sahlabadi, A, Karim, A, Khatabakhsh, A, Soori, H, (2020). Ergonomic evaluation of office staff by Rapid Office Strain Assessment method and its relationship with the prevalence of musculoskeletal disorders. *Journal of Health, 11(2)*, 223-34.

Sonne M, Andrews DM, (2012). The Rapid Office Strain Assessment (ROSA): Validity of online worker self-assessments and the relationship to worker discomfort. *Occupational Ergonomics, 10(3)*, 83-101.

Industries and Jobs Where Tool Has Been Applied:
All where computer use is prevalent

Is Tool Copyrighted:
No

Instructional or Supplemental Information:
https://ergo.human.cornell.edu/CUErgoTools/ROSA/ROSA%20-%20Instructions%202011-2012.pdf

Equipment Needed to Use Tool:
Worksheet, tape measure and goniometer to verify distances/angles

Time Required to Analyze a Typical Job:
Depends on observation of tasks performed, so it will be affected by task composition; likely <1 hour

Rapid Upper Limb Assessment (RULA)

Purpose:
To investigate the exposure to risk factors for upper limb disorders and provide a method of screening the work population quickly so that the results can go into a wider, more versatile ergonomic assessment while eliminating the need for assessment equipment

Developed by:
Lynn McAtamney, E. Nigel Corlett

Developed When:
1992

Musculoskeletal Disorder Risk Factors Considered:
Repetition, awkward/static postures, force, time worked without break

Body Regions Considered:
Upper arms, lower arms, wrists, trunk, neck, and legs

Type of Jobs Appropriate For:
Jobs with a range of frequencies, involving multiple body regions, standing or sitting or combination

Type of Jobs Not Appropriate For:
None

Limitations:
Some factors (e.g., twisting, lateral bending, abduction) are weighted equally no matter to what degree they exist (e.g., 5° of twisting or 20° of twisting)

Inputs:
Arm, wrist, neck, trunk and leg positions, force/load, activity

Outputs:
Level of MSD Risk: negligible risk, low risk, medium risk, high risk

Who Is the Tool Designed For:
General users

Minimum Amount of Training:
1–2 hours

Studies That Provide Evidence of Validation of the Tool:
Joshi M, Deshpande V. (2021). Identification of indifferent posture zones in RULA by sensitivity analysis. *Int J Ind Ergo*, *83*:103123. doi: 10.1016/j.ergon.2021.103123

Electronic Version:
http://ergo.human.cornell.edu/Pub/AHquest/CURULA.pdf
http://www.rula.co.uk/

Reference of Peer-Reviewed Publication:

McAtamney L, Corlett EN. (1993). RULA: a survey method for the investigation of work-related upper limb disorders. *Appl Ergon, 24(2)*:91–99. doi: 10.1016/0003-6870(93)90080-s

Industries and Jobs Where Tool Has Been Applied:

Suitable for all industries

Is Tool Copyrighted:

No

Instructional or Supplemental Information:

None found in the literature

Equipment Needed to Use Tool:

Worksheet, protractor, scale

Time Required to Analyze a Typical Job:

<1 hour

Rodgers Muscle Fatigue Assessment

Purpose:
To provide a method of evaluating the physiological demands of a task against published criteria of acceptable levels of oxygen consumption for whole body or upper body work

Developed by:
Suzanne Rodgers

Developed When:
1978–1992

Musculoskeletal Disorder Risk Factors Considered:
Fatigue

Body Regions Considered:
Neck, shoulders, hands, wrists, arms, back, legs, elbows, and knees

Type of Jobs Appropriate For:
Jobs that require high frequency and duration and have awkward postures

Type of Jobs Not Appropriate For:
Non-fatiguing job analysis and seated jobs

Limitations:
Any task evaluated is limited to 30 seconds of continuous effort and 15 minutes of effort frequency. After this point, the job is considered very high priority. No numerical value is assigned after this point.

Inputs:
Body region (neck, shoulders, back, arms/elbows, wrists/hands/fingers, legs/knees, ankles/feet/toes) postures, effort, activity, duration, frequency

Outputs:
Overall priority by body region (low, moderate, high, very high)

Who Is the Tool Designed For:
Professional users

Minimum Amount of Training:
8 hours

Studies That Provide Evidence of Validation of the Tool:
None currently found in the literature

Electronic Version:
https://www.ergocenter.ncsu.edu/wp-content/uploads/sites/18/2018/09/ECNC-Rodgers-MFA-Calc-2018.pdf

https://www.ergocenter.ncsu.edu/wp-content/uploads/sites/18/2017/01/ECNC-Rodgers-Muscle-Fatigue-Analysis-Calc-01.03.2017.xlsx

Reference of Peer-Reviewed Publication:

Rodgers SH. (1992). A functional job evaluation technique. *Occup Med, 7(4)*:679–711.
Rodgers SH. (1988). Job evaluation in worker fitness determination. *Occup Med, 3(2)*:219–239.

Industries and Jobs Where Tool Has Been Applied:

General manufacturing, construction, and healthcare

Is Tool Copyrighted:

No

Instructional or Supplemental Information:

None

Equipment Needed to Use Tool:

None

Time Required to Analyze a Typical Job:

1–2 hours

Revised Strain Index

Purpose:
To provide a relatively simple risk assessment method designed to evaluate a job's level of risk for developing a disorder of the distal upper extremities

Developed By:
(Revised) Arun Garg, J. Steven Moore, Jay M. Kapellusch
(Original) J. Steven Moore and Arun Garg

Developed When:
(Revised) 2016
(Original) 1995

Musculoskeletal Disorder Risk Factors Considered:
Exertion intensity, frequency, duration, upper extremity posture, repetition

Body Regions Considered:
Hands, wrists

Type of Jobs Appropriate For:
Hand-intensive repetitive tasks

Type of Jobs Not Appropriate For:
Static tasks and awkward posture tasks

Limitations:
Does not account for contact stress, cold temperatures, hand-arm vibration, or recovery time between exertions. Only looks at MSD risk for the upper extremity, particularly hands/wrist. User must estimate intensity of exertions, postures, and speed of work.

Inputs:
Intensity of exertion (Borg Scale rating), efforts per minute, duration per exertion, hand/wrist posture, duration of task per day

Outputs:
Strain Index (SI) value and determination of whether job is probably safe (SI ≤ 10) or probably hazardous (SI > 10) for both left and right hands

Who Is the Tool Designed For:
Professionals trained in ergonomics and general users

Minimum Amount of Training:
2–4 hours

Studies That Provide Evidence of Validation of the Tool:
Kapellusch J, Garg A. (2017). A comparison of distal upper limb physical exposure quantification tools: the Strain Index, ACGIH TLV for HAL, and the recently developed revised strain index. *Occup Environ Med, 74*:A147.

Electronic Version:

https://www.ergocenter.ncsu.edu/wp-content/uploads/sites/18/2020/07/ECNC-Revised-Strain-Index-Calculator-07.20.2020.pdf

Reference of Peer-Reviewed Publication:

Garg A, Moore JS, Kapellusch JM. (2017). The Revised Strain Index: an improved upper extremity exposure assessment model. Ergonomics, 60(7):912–922. doi: 10.1080/00140139.2016.1237678.

Kapellusch J, Garg A. (2018). Quantifying complex tasks using the revised strain index. Occup Environ Med, 75:A258–A259.

Paulsen R, Gallu T, Gilkey D, Reiser R 2nd, Murgia L, Rosecrance J. (2015). The inter-rater reliability of Strain Index and OCRA Checklist task assessments in cheese processing. Appl Ergon, 51:199–204. doi: 10.1016/j.apergo.2015.04.019

Industries and Jobs Where Tool Has Been Applied:

Small parts assembly, inspecting, meatpacking, sewing, packaging, keyboarding, data processing, and highly repetitive hand motion jobs

Is Tool Copyrighted:

No

Instructional or Supplemental Information:

Garg A, Moore JS, Kapellusch JM. (2017). The composite strain index (COSI) and cumulative strain index (CUSI): Methodologies for quantifying biomechanical stressors for complex tasks and job rotation using the revised strain index. Ergonomics, 60(8):1033–1041. doi: 10.1080/00140139.2016.1246675

Equipment Needed to Use Tool:

Stopwatch

Time Required to Analyze a Typical Job:

~1 hour

The Shoulder Tool

Purpose:

To assess the risk of shoulder outcomes due to shoulder-intensive tasks. Tool is designed to assess "daily dose" of exposure to the shoulder for mono- and multiple-task jobs. Tool will help identify tasks that are driving the risk of injury to the shoulder.

Developed By:

Dania Bani Hani, Rong Huangfu, Rich Sesek, Mark Schall, Jr., Jerry Davis, and Sean Gallagher

Developed When:

2019

Musculoskeletal Disorder Risk Factors Considered:

Load moment about the shoulder, repetition

Body Regions Considered:

Shoulder

Type of Jobs Appropriate For:

Tasks involving handling objects or other forceful exertions that place stress on the shoulder

Type of Jobs Not Appropriate For:

Does not address prolonged static overhead exertions

Limitations:

Does not account for risks associated with personal characteristics (age, gender, anthropometry)

Inputs:

Type of exertion (handling loads, pushing/pulling, pull or push downward), force or load, maximum load lever arm, and repetition for each task assessed

Outputs:

Cumulative damage, probability of shoulder outcome, proportion of total damage resulting from each task

Who Is the Tool Designed For:

Practitioners, researchers

Minimum Amount of Training:

<1 hour

Studies That Provide Evidence of Validation:

Bani Hani D, Huangfu R, Sesek R, Schall Jr. MC, Davis GA, Gallagher S. (2020). Development and validation of a cumulative exposure shoulder risk assessment tool based on fatigue failure theory. *Ergonomics, 64(1)*:1–39. doi: 10.1080/00140139.2020.1811399

Bandekar AJ, Sesek R, Schall Jr M, Huangfu R, Bani Hani D, Gallagher S. (2021). Validation of Fatigue Failure Risk Assessment Tools Against Physician-Diagnosed Outcomes. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting 65(1)*: 710–714.

Electronic Version:
Web-based version available at http://theshouldertool.pythonanywhere.com

Excel versions (English and Spanish) that permit saving of analyses on spreadsheets available at:
http://eng.auburn.edu/occupational-safety-ergonomics-injury-prevention/research/research%202.html

Reference of Peer-Reviewed Publication:
Bani Hani et al. (2020)

Industries and Jobs Where Tool Has Been Applied:
All industries

Is Tool Copyrighted:
Yes

Instructional or Supplemental Information:
Information on tool use is provided on the web-based version's website and included in the Excel versions as well.

Equipment Needed to Use Tool:
Measuring tape, force gauge (for some tasks)

Time Required to Analyze a Typical Job:
Time depends on number of shoulder-intensive tasks performed by worker. Each task should take only a couple of minutes to perform.

Utah Back Compressive Force

Purpose:

To provide a screening tool that can be used to get an early insight to the compressive forces placed on the back when performing manual material handling (MMH) tasks. Tool should be used to identify potential areas of concern.

Developed By:

Donald S. Bloswick

Developed When:

2000

Musculoskeletal Disorder Risk Factors Considered:

Load, posture, frequency, duration and static positions

Body Regions Considered:

Upper and lower back

Type of Jobs Appropriate For:

Manual material handling tasks

Type of Jobs Not Appropriate For:

Non-lifting job, high-risk postural jobs may present false positive

Limitations:

Very primitive and general in terms of usable data for change

Inputs:

Horizontal reach distance, back posture, worker body weight, load weight

Outputs:

Estimated back compressive force

Who Is the Tool Designed For:

General users

Minimum Amount of Training:

2 hours

Studies That Provide Evidence of Validation of the Tool:

Abadi M, Ghanbary A, Habibi E, Palyzban F, Ghasemi H. (2018). Back Compressive Force (BCF) assessment using UTAH method in manual handling tasks among workers of a chemical manufacturing company. *J Occup Health Epidemiol, 7(4)*:222–226. doi: 10.29252/johe.7.4.222

Electronic Version:

None

Reference of Peer-Reviewed Publication:
https://www.researchgate.net/profile/Andrew-Merryweather/publication/40785995_A_revised_back_compressive_force_estimation_model_for_ergonomic_evaluation_of_lifting_tasks/links/0fcfd510a8c7e5b1c2000000/A-revised-back-compressive-force-estimation-model-for-ergonomic-evaluation-of-lifting-tasks.pdf

Industries and Jobs Where Tool Has Been Applied:
None currently identified

Is Tool Copyrighted:
Yes

Instructional or Supplemental Information:
https://health.usf.edu/publichealth/tbernard/~/media/D7F7CFCBC5EF43EBB9A23E592BC84411.ashx

Equipment Needed to Use Tool:
None

Time Required to Analyze a Typical Job:
1 hour

Washington State (WISHA) Caution Zone

Purpose:
To control exposure to MSD hazards in workplace by using a screening tool for typical work activities to find jobs that have a sufficient degree of risk

Developed By:
Washington State's Department of Labor and Industries

Developed When:
2000

Musculoskeletal Disorder Risk Factors Considered:
Repetitive movements, lifting force, push/pull force, grip force, awkward postures, task duration, and vibration

Body Regions Considered:
Neck, shoulders, hands, wrists, arms, back, and legs

Type of Jobs Appropriate For:
Most tasks

Type of Jobs Not Appropriate For:
Non-labor intensive jobs

Limitations:
The checklist is general in nature. Best used as a preliminary measurement to assess a hazardous job. Must be followed-up with a finite risk analysis.

Inputs:
Work posture (hands, elbows, neck, back, lower extremities), hand force, repetition, lifted object weight, vibration, frequency

Outputs:
Count of areas of concern

Who Is the Tool Designed For:
Professionals trained in ergonomics and general users

Minimum Amount of Training:
1–2 hours

Studies That Provide Evidence of Validation of the Tool:
Motamedzade M, Tavakoli M, Golmohammadi R, Moghimbeyg AI. (2014). Reliability assessment of Washington States ergonomic checklist using agreement method between the observers of two groups of ergonomic specialist and non-specialist. *J Occup Hyg Eng, 1(2)*:67–73.

Eppes SE. (2004). *Washington State Ergonomics Tool: Predictive Validity in the Waste Industry* (Doctoral dissertation). Texas A&M University.

Electronic Version:
https://lni.wa.gov/safety-health/_docs/CautionZoneJobsChecklist.pdf

Reference of Peer-Reviewed Publication:
Bao S, Silverstein B. (2012). Categorizing job physical exposures using simple methods. *Work, 41(Suppl 1)*:3945–3947. doi: 10.3233/WOR-2012-0691-3945

Industries and Jobs Where Tool Has Been Applied:
General manufacturing, construction, and healthcare

Is Tool Copyrighted:
No

Instructional or Supplemental Information:
None found

Equipment Needed to Use Tool:
Tape measure and stopwatch

Time Required to Analyze a Typical Job:
15–30 minutes

Washington State (WISHA) Hazard Zone

Purpose:
To provide a regulatory effort for performing further risk assessment on jobs that have been identified as caution zone jobs. The checklist criteria are at levels that most workers would be at a high risk of developing a work-related MSD if exposed on a regular basis.

Developed By:
Washington State's Department of Labor and Industries

Developed When:
2000

Musculoskeletal Disorder Risk Factors Considered:
Repetitive movements, lifting force, push/pull force, grip force, awkward postures, task duration, and vibration

Body Regions Considered:
Neck, shoulders, hands, wrists, arms, back, and legs

Type of Jobs Appropriate For:
Most tasks

Type of Jobs Not Appropriate For:
Non-labor intensive jobs

Limitations:
Some of the criteria on the hazard zone checklist were increased above levels suggested in the research literature due to practical limitations

Inputs:
Hands, elbows, neck, back, knees, pinch/grip force, repetition, keying, impact, duration

Outputs:
Count of areas of concern

Who Is the Tool Designed For:
Professionals trained in ergonomics and general users

Minimum Amount of Training:
1–2 hours

Studies That Provide Evidence of Validation of the Tool:

Motamedzade M, Tavakoli M, Golmohammadi R, Moghimbeyg AI. (2014). Reliability assessment of Washington States ergonomic checklist using agreement method between the observers of two groups of ergonomic specialist and non-specialist. *J Occup Hygiene Eng, 1(2)*:67–73.

Eppes, SE. (2004). *Washington State Ergonomics Tool: Predictive Validity in the Waste Industry.* (Dissertation). Texas A&M University.

Electronic Version:
https://lni.wa.gov/safety-health/_docs/HazardZoneChecklist.pdf

Reference of Peer-Reviewed Publication:
Bao S, Silverstein B. (2012). Categorizing job physical exposures using simple methods. *Work, 41(Suppl 1)*:3945–3947. doi: 10.3233/WOR-2012-0691-3945

Industries and Jobs Where Tool Has Been Applied:
General manufacturing, construction, and healthcare

Is Tool Copyrighted:
No

Instructional or Supplemental Information:
None found

Equipment Needed to Use Tool:
None

Time Required to Analyze a Typical Job:
15–30 minutes

Washington State (WISHA) Lifting Calculator

Purpose:
To perform a quick analysis of a lifting job in order to determine the need for more detailed analyses

Developed By:
Washington State's Department of Labor and Industries

Developed When:
Not known

Musculoskeletal Disorder Risk Factors Considered:
Lifting force, repetitive movements, most awkward lifting and lowering position

Body Regions Considered:
Low back

Type of Jobs Appropriate For:
Manual material handling

Type of Jobs Not Appropriate For:
Any non-lifting job

Limitations:
Not concerned with the compression forces at any region within the body; sole purpose is to predict if the weight lifted is less than the limit set

Inputs:
Weight being lifted, frequency of lift, duration of lifting task, region in which lift is being performed, amount of twisting

Outputs:
Calculated weight limit

Who Is the Tool Designed For:
Professionals trained in ergonomics and general users

Minimum Amount of Training:
1–2 hours

Studies That Provide Evidence of Validation of the Tool:
None currently found in the literature

Electronic Version:
https://lni.wa.gov/safety-health/_docs/HazardZoneChecklist.pdf (scroll to page 4)

https://osha.oregon.gov/OSHAPubs/apps/liftcalc/lift-calculator.html

https://health.usf.edu/publichealth/eoh/tbernard/~/media/5A20135771B24806B38A4558E445502E.ashx

Reference of Peer-Reviewed Publication:

Russell SJ, Winnemuller L, Camp JE, Johnson PW. (2007). Comparing the results of five lifting analysis tools. *Appl Ergon, 38(1)*:91–97. doi: 10.1016/j.apergo.2005.12.006

Industries and Jobs Where Tool Has Been Applied:

General manufacturing, construction, and healthcare

Is Tool Copyrighted:

No

Instructional or Supplemental Information:

None currently found in the literature

Equipment Needed to Use Tool:

None

Time Required to Analyze a Typical Job:

15–30 minutes

The Need for Advanced Ergonomic Assessment Tools

Screening questionnaires and quantitative assessments are useful for identifying ergonomic risk factors and problem areas, but sometimes they are not enough to identify the root cause of the issue. If the issue cannot be identified with the tools provided in this document, a more advanced assessment will need to be conducted. With these assessments comes a greater need for advanced ergonomics knowledge and sometimes advanced and expensive equipment or software. An appropriate person to contact in this scenario would be a trained ergonomist, preferably one who is a CPE (Certified Professional Ergonomist, www.bcpe.org). The following are just some examples of these advanced assessment tools and techniques. The provided details are not meant to be endorsements of a particular brand or product, only examples in that category.

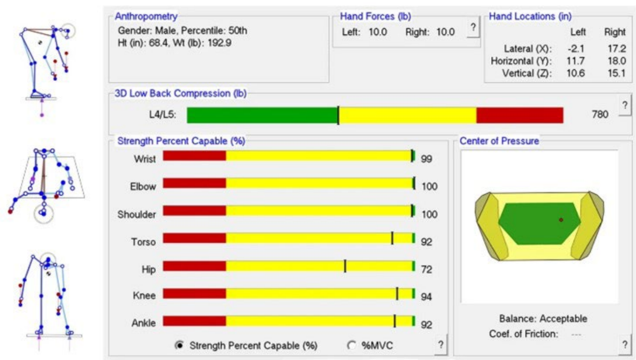
BIOMECHANICAL MODELING SOFTWARE

3D SSPP (3D Static Strength Prediction Program)

Windows-based only

Cost: Single User License—Industrial use, one-time fee = $2,500 (USD) (perpetual license)

Academic License—Unlimited use for research and teaching, one-time fee = $2,000 (USD) (perpetual license)



The 3D Static Strength Prediction Program™ (3D SSPP) software, managed by VelocityEHS® (https://www.ehs.com/solutions/ergonomics/3d-sspp/), allows users to predict static strength requirements for common manual tasks and make rapid, simple improvements to ergonomic conditions that improve the safety, productivity, and quality of life of employees. The program provides an approximate job simulation that includes posture data, force parameters and male/female anthropometry.

The 3D SSPP software is based on 50+ years of research by University of Michigan's Center for Ergonomics. It predicts the level of exertion required for common tasks in the workspace design phase, allowing users to incorporate that data into process and comply with National Institute for Occupational Safety and Health (NIOSH) guidelines. Output consists of ten reports that include predicted low-back compression forces and the percentage of the population that have the strength to perform a prescribed job. Users can analyze torso twists and bends and make complex hand force entries.

OpenSim

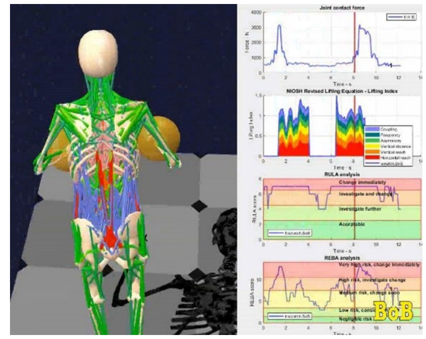
Windows, MacOS, and Linux; Cost: free

Housed by the National Center for Simulation in Rehabilitation Research (NCSRR), OpenSim is a freely available, user extensible software system that lets users develop models of musculoskeletal structures and create dynamic simulations of movement. Registration and a software download is required (https://opensim.stanford.edu/join/index.html). More than 1,500 projects are housed in the OpenSim community (www.simtk.org).

Biomechanics of Bodies (BoB) Software

Windows or MacOS; Cost: $2,400–$3,500 (USD) depending on license type/duration

BoB is a family of biomechanical modeling software packages developed in the MATLAB environment. It combines a human musculoskeletal model with an easy-to-use, intuitive interface and powerful analysis functionality, resulting in quantitative, objective information.



ADVANCED MOVEMENT ANALYSIS

Industrial Lumbar Motion Monitor™ (iLMM™)

Approximate Cost: NA

The iLMM3™ is a wireless device worn on the body of the user to quantitatively measure the position, velocity, and acceleration in the sagittal, lateral, and twist planes of motion during manual material handling tasks. These data, along with some task parameters such as load magnitude, task frequency, and duration, are fed into an LBD (low back disorder) risk model to identify which elements of a job led to an increase in LBD risk and thus which elements need to be changed. The LMM allows you to compare the task to a normative database of common variables associated with jobs that have a high incidence of low back disorders.

Courtesy of NexGen Ergonomics Inc www.nexgenergo.com & BioDynamic Solutions, Inc.

Biometrics Ltd Electrogoniometers and Torsiometers

Base Unit plus Management software approximate cost: $5,500 (USD)

Goniometers + Cable approximate cost: $1,000 (USD) each

Analysis software approximate cost: $2,750 (USD)

Electrogoniometers and torsiometers allow for continuous quantitative evaluation of a joint. Depending on the sophistication of the sensor, a single plane or multiple planes of motion can be assessed. Regions that can be assessed include the back, hip, knee, ankle, toes, neck, elbow, forearm, wrist, and finger DIP/PIP/MCP. Collected data can be processed to determine what percentage of time a joint is in a known risky posture and/or the maximum range of motion. Goniometers and torsiometers are particularly useful when movements are rapid and span a large range of motion.

Motion Capture Systems

(Motion Analysis Corp., OptiTrack, Qualisys, Vicon, Xsens, etc.)

System Cost: Variable

Movella's Xsens Analyze motion capture system.

When it is not feasible to collect data in the field, or when one desires to test potential ergonomic interventions prior to implementation, evaluation through simulation may be the best option. One way to perform this type of evaluation is to use motion capture. This is when a series of cameras are used to track markers placed on locations of interest on the individual's body (e.g., joints and segments) and on the objects with which they interact while they perform various tasks. Posture and motion characteristics can be tracked and analyzed between scenarios and compared to known risk levels. Other components such as force plates, pressure sensors, and EMG can usually be integrated with motion capture systems. The drawback to motion capture is that most systems are lab based, equipment is very costly, and the systems require highly trained individuals to operate and analyze the data.

Markerless Motion Capture Systems

Theia, Simi Shape, Captury, Kinetisense, Dartfish, etc.

Cost: Variable

Markerless motion capture systems use a variety of techniques to analyze human movement. These systems are usually significantly less expensive than their markered counterparts and offer greater flexibility in terms of performing analysis out in the field (e.g., they're not restricted to a lab). However, there can be some trade-off in accuracy and precision compared to the markered systems. Some systems allow for integration of other components such as force plates, pressure sensors, and EMG.

VIBRATION

Casella, Adash, Grainger, etc.

Cost: Variable

Hand-arm vibration is present in vibrating hand tools and can potentially lead to hand-arm vibration syndrome (HAVS). Workers who sit on vehicles or stand on vibrating floors are exposed to whole body vibration. Both should be measured by trained individuals using vibration meters in accordance with standards set forth by ISO and ANSI, as well as other agencies depending on geographic location.

MUSCLE ACTIVITY

EMG (Electromyography)

Biopac, Biometrics, Delsys, Noraxon, etc.

Cost: Variable

Surface EMG measures the amount of electrical activity, or muscle activation, produced during a movement. The data can be used standalone but are more often utilized as inputs into biomechanical models as a means of assessing the risk of a task. Units can be wired or wireless, allowing for usage in a wide range of settings.

WEARABLE SENSORS

This category of assessment tools encompasses several different types of instrumentation. One of the most commonly used tools in ergonomic assessment is inertial measurement units (IMUs), which include accelerometers, gyroscopes, magnetometers, etc. Wearables are noninvasive and worn directly on the body. IMUs can be used to determine position, orientation, velocity, and acceleration of the body or specific body parts. The sensors can be attached to the body using different methods, including elastic bands worn around extremities, attached to a garment via Velcro, or worn directly on the skin via double-sided tape. Wearables are wireless, which allows for unconstrained data collection in a variety of settings. Data are transmitted to external units for analysis via Bluetooth, Wi-Fi, or other methodologies, where the data are then post processed.

Ergonomics Resources for Specialized Scenarios

Agriculture

- https://www.cdc.gov/niosh/docs/2001-111/pdfs/2001-111.pdf
- https://www.ehs.ufl.edu/departments/occupational-safety-risk/ergonomics/agricultural/

Baggage Handling

- https://www.osha.gov/SLTC/etools/baggagehandling/index.html

Construction

- https://www.osha.gov/SLTC/etools/electricalcontractors/index.html
- https://blogs.cdc.gov/niosh-science-blog/2007/12/17/erg/

Foundries

- https://www.osha.gov/sites/default/files/publications/osha3465.pdf

Healthcare

- https://www.osha.gov/SLTC/etools/hospital/hazards/ergo/ergo.html
- https://www.oshatrain.org/courses/studyguides/623studyguide.pdf
- https://www.cdc.gov/niosh/docs/wp-solutions/2006-148/
- https://www.cdc.gov/niosh/docs/2006-117/

Laboratory

- https://www.osha.gov/sites/default/files/publications/OSHAfactsheet-laboratory-safety-ergonomics.pdf
- https://ehs.unc.edu/topics/ergonomics/laboratory-ergonomics/

Mining

- https://www.cdc.gov/niosh/mining/works/coversheet1906.html

Poultry Processing

- https://www.osha.gov/sites/default/files/publications/OSHA3213.pdf

Shipyards

- https://www.cdc.gov/niosh/topics/ergonomics/ergship/default.html
- https://www.osha.gov/sites/default/files/publications/OSHA3341shipyard.pdf

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We are most thankful for the original authors of the assessments included in this Toolkit. Their time and effort spent in developing assessments to help make the workplace safer is greatly appreciated.

CONTROLS | HAZARD RECOGNITION & EVALUATION | SAFETY

Ergonomic Assessment Toolkit

Edited by Susan E. Kotowski, PhD, CPE and Sheree L. Gibson, PE, CPE
By the AIHA Ergonomics Committee

To reduce the occurrence of work-related musculoskeletal disorders (WMSDs), practitioners need to be able to effectively assess the risk in jobs and tasks.

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HEALTHIER WORKPLACES | A HEALTHIER WORLD