



THE OVERLOOKED RISK

ERGONOMICS IN KAIZEN AND CONTINUOUS IMPROVEMENT

Protecting Employee Health While Driving Process Excellence

A Complete Professional Guide to
Ergonomic Risk Assessment • Kaizen Integration • Regulatory Compliance
Injury Prevention • Workforce Engagement • Sustainable Improvement

Continuous Improvement Professional Series

The Paradox at the Heart of Process Improvement

There is a painful irony embedded in many kaizen events, Lean transformations, and Six Sigma projects: the same teams dedicated to eliminating waste and improving performance can — and frequently do — inadvertently create the most damaging form of waste there is. Musculoskeletal disorders. Repetitive strain injuries. Chronic pain that follows workers home, into their weekends, and into their futures.

Ergonomics is consistently the discipline that falls off the agenda when improvement teams are under pressure to deliver results. Cycle time gets measured in seconds. Defect rates are tracked to decimal places. But the biomechanical load being placed on the worker who now performs a task 40% faster — doing it not 200 times per shift but 320 times — rarely appears on anyone's A3 or value stream map.

This is not a failure of character. It is a failure of process. Kaizen events are structured to achieve operational outcomes: takt time compliance, throughput, quality metrics. Unless ergonomics is explicitly woven into the methodology — with its own assessment tools, its own success criteria, and its own champions — it will be bypassed. Every time.



The Core Problem, Stated Plainly:

A process improvement that reduces cycle time by 30% while doubling the rate of shoulder injuries is not an improvement. It is a cost transfer — from the operations budget to the workers' bodies, the compensation system, and the long-term retention of experienced labor.

What Ergonomics Brings to Continuous Improvement

- Prevents the creation of new injury risks while eliminating existing operational waste
- Protects the workforce whose skill and experience is the organization's most valuable — and most fragile — asset
- Identifies improvement opportunities that pure efficiency analysis misses: awkward postures hide delays, high-force tasks mask unnecessary friction
- Sustains improvement gains by reducing turnover and absenteeism caused by injury
- Builds worker trust in the improvement process, improving engagement and idea generation
- Reduces direct costs: workers' compensation, medical treatment, OSHA recordables, litigation, and accommodation requirements

This guide is written for improvement practitioners, industrial engineers, EHS professionals, team leaders, and anyone who sits at the intersection of process improvement and workforce wellbeing. The goal is not to slow improvement down — it is to make improvement real.

Section 1: How Kaizen Creates Ergonomic Hazards

Understanding how ergonomic risk is introduced during improvement activities requires understanding the mechanisms — the specific dynamics of kaizen events and Lean implementation that make workers vulnerable. These are not theoretical concerns; they are documented, recurring patterns observed across manufacturing, healthcare, logistics, and service industries alike.

The Speed Trap

The most common ergonomic harm in kaizen comes from cycle time reduction without commensurate reduction in physical demand. When a standard 45-second task is redesigned to 30 seconds, the worker now performs that task 60 additional times per hour. If the task involves any significant force, awkward posture, or repetitive joint motion, the injury exposure has just increased by 33% — not in a single dramatic event, but through the insidious accumulation of microtrauma that defines musculoskeletal disorders.

Lean's focus on takt time and flow efficiency is precisely calibrated to surface and eliminate time-based waste. It is not calibrated to surface cumulative physical exposure. The stopwatch and the time-observation form simply do not capture whether the worker is reaching above shoulder height, rotating their lumbar spine, or pinching a small component between forefinger and thumb. A motion that takes 2 seconds and is invisible on a time study can, repeated 1,200 times per shift, become the source of career-ending carpal tunnel syndrome.



The Exposure Equation:

Injury risk from repetitive tasks is a function of $\text{FORCE} \times \text{REPETITION} \times \text{POSTURE} \times \text{DURATION}$. Kaizen directly manipulates duration and repetition while often being blind to force and posture. Every time cycle time decreases without examining the other variables, exposure risk increases.

The Layout Illusion

Workstation redesign is a staple of kaizen events — moving materials closer, rearranging tools, creating 'shadow boards' for 5S compliance. These changes are often genuine improvements. But they can also introduce new ergonomic hazards that weren't present in the original layout:

- Parts bins relocated to reduce travel distance may end up positioned at the wrong height for a significant portion of the workforce
- Consolidated work zones that improve material flow may require workers to rotate their trunk repeatedly to access adjacent stations
- New tooling mounted for efficiency may require sustained grip or awkward wrist angles
- Floor markings and 5S reorganization that improves visual management may force workers to stand on hard surfaces without anti-fatigue matting

- Automation of one portion of a task may leave a remaining manual operation that now demands higher speed to keep pace with the automated element

The kaizen team sees travel time eliminated. They see motion waste reduced. They do not see — because they are not looking — that the new layout requires the worker to laterally flex their neck 80 times per hour more than before.

The Pace-Setting Problem

When a process is timed and balanced by an engineering team that does not include ergonomics expertise, pace targets are typically set based on observed average performance — often from a small sample of operators, observed over a short period, while workers are aware they are being studied. This creates multiple ergonomic hazards:

- Observed workers may be faster, younger, or more experienced than the median workforce
- Workers are observed fresh, not at the end of an 8- or 10-hour shift when fatigue-related injury risk peaks
- Pace targets don't account for the cumulative exposure across the full shift — they capture a snapshot
- When pace targets are posted and enforced, workers under productivity pressure may skip rest micro-breaks, change their posture to go faster, or absorb increased force demands rather than flag a concern



The Worker Silence Factor:

Workers in improvement-driven environments frequently do not report ergonomic discomfort because they fear being seen as slow, obstructive, or negative about the change. Creating psychological safety for ergonomic feedback is not a soft HR concern — it is a core safety requirement.

The 'We'll Address It Later' Failure Mode

Perhaps the most insidious dynamic in kaizen-generated ergonomic risk is the deferral pattern. The improvement team identifies a potential ergonomic issue during the event — a reach that seems too far, a container that seems too heavy — but the 30-day action item to 'evaluate workstation height' never gets resourced, never gets completed, and within 90 days becomes invisible on any tracking system.

Kaizen events generate energy and momentum during their 3–5 day execution window. That energy dissipates rapidly once the team disperses. Ergonomic improvements that require capital investment, design iteration, or vendor engagement are especially vulnerable to this pattern because they cannot be solved in the event itself. Without explicit ownership, budget authority, and accountability mechanisms that survive the event, these items become permanent backlog.

Common Kaizen Scenario	Ergonomic Hazard Created	Why It Gets Missed	Consequence
Cycle time reduced 25% through motion elimination	Force and repetition per hour increase without task redesign	Time savings is visible on data; exposure increase is not measured	Shoulder and wrist cumulative trauma disorders in 6–18 months
Parts bins relocated to reduce travel distance	Bin height wrong for workforce range; reaching above shoulder level	Team optimizes for distance, not anthropometrics	Shoulder rotator cuff injuries; neck strain
Two-handed task redesigned to one-handed	Single hand now bears full pinch/grip force; asymmetric loading	Efficiency gain is obvious; unilateral load isn't tracked	Lateral epicondylitis (tennis elbow); carpal tunnel
Line balancing creates new station with multiple sequential operations	Combined task exceeds safe cumulative exposure threshold	Individual tasks looked acceptable; combined exposure not assessed	Lumbar and cervical spine disorders
Standing workstation converted from sit-stand option	Prolonged static standing on hard floor with no movement opportunity	Footprint optimization drove decision	Lower back pain; plantar fasciitis; varicose vein risk
Manual cart replaced with powered conveyor to eliminate push/pull	Remaining manual interface points require sustained pinch grip at speed	The obvious push/pull hazard was solved; the residual one wasn't	Hand-arm vibration; grip fatigue injuries

The Diversity Blindspot

Workstation and process design that is validated on one operator — typically a current employee of average experience — may be significantly hazardous for workers with different anthropometric profiles. The American workforce is not homogeneous. A workstation designed around a 50th-percentile male operator creates biomechanical stress for a 5th-percentile female worker, a taller worker with different reach geometry, an older worker with reduced grip strength, or a worker returning from a previous injury.

Lean improvement often standardizes work methods as part of sustaining gains — standard work documents, visual aids, takt time boards. When the standard method was not designed for the full range of workers who will perform it, standardization locks in the hazard and removes the individual accommodation flexibility that previously allowed workers to protect themselves.

Section 2: The Primary Ergonomic Risk Factors

Ergonomic risk assessment is built around a small set of biomechanical risk factors that, alone or in combination, drive the vast majority of work-related musculoskeletal disorders (WMSDs). Understanding these factors is the foundation of any ergonomics program — and particularly critical for anyone participating in kaizen events, because these are the variables that improvement activities most commonly affect.

⚡ Force — The Load Your Body Carries

Force is the amount of muscular effort required to perform a task. It is the most direct driver of musculoskeletal injury risk and is especially dangerous in combination with repetition. Force demands come from many sources that improvement teams may not recognize as force issues:

- **Grip and pinch force** required to hold, manipulate, or fasten components
- **Push and pull force** to move carts, open/close containers, or operate tooling
- **Lifting and carrying** — both the weight itself and the distance from the body at which it is held (moment arm)
- **Vibrating tool use** — power tools transmit vibration force into the hand-arm system even at low physical resistance
- **Foot force** — pedals, floor-mounted controls, or kick-releasing mechanisms

Force limits are body-part-specific and task-specific. NIOSH recommends maximum acceptable lift weights of 51 lbs under ideal conditions — but ideal conditions (lift directly in front of the body, from knuckle to waist height, infrequently) almost never exist in real production environments. The actual recommended weight limit (RWL) in a typical industrial task is often 20–30 lbs or less once task geometry, frequency, and asymmetry are accounted for.



Force + Repetition = Exponential Risk:

A task requiring 10 lbs of grip force performed 10 times per hour carries significantly less risk than the same 10 lb grip force performed 600 times per hour. Kaizen's primary output — cycle time reduction — directly multiplies repetition without changing force. The product of these two variables is what drives injury.

Repetition — The Slow Accumulation of Damage

Repetition is the number of times a muscle, tendon, or joint is loaded within a given time period. Tissue damage occurs when the rate of microtrauma exceeds the rate of tissue repair. At low frequency, the body's natural repair mechanisms are adequate. As frequency increases — as cycle times decrease — cumulative damage outpaces recovery.

Occupational medicine guidelines define high repetition risk thresholds, though these vary by body region and the force involved. As a general reference: tasks with cycle times under 30

seconds, or tasks in which the same muscle group is active for more than 50% of a cycle, are considered high repetition. Wrist-intensive tasks become high risk at roughly 30 or more similar exertions per minute.

Body Region	High Repetition Threshold	Common Kaizen Trigger	Resulting Disorder Risk
Wrist / Hand	30+ exertions/minute; cycle time < 30 seconds	Assembly standardization, parts bin relocation, fastening tasks	Carpal tunnel syndrome, De Quervain's tenosynovitis, trigger finger
Shoulder	Reaches above mid-torso more than 2x/minute	Overhead storage placement, conveyor height changes, kitting redesign	Rotator cuff tendinopathy, shoulder impingement, bursitis
Elbow / Forearm	Forearm rotation > 60x/minute	Torquing, twisting, tool use standardization	Lateral/medial epicondylitis, pronator teres syndrome
Lumbar Spine	Bending > 20° more than 2x/minute	Floor-level material placement, low-height workstations	Disc herniation, facet joint degeneration, muscle strain
Cervical Spine	Head flexion > 20° sustained or repeated	Low-position inspection, display placement, documentation station	Cervical radiculopathy, trapezius myalgia, headache

Posture — Where Your Body Is During the Work

Posture refers to the position of body segments relative to neutral — the anatomically optimal position in which joints experience the least compressive and shear stress and muscles operate most efficiently. Work performed in non-neutral posture requires greater muscular effort, compresses joint structures, and reduces vascular supply to tendons and nerves.

Awkward postures are particularly dangerous because they are often invisible to improvement teams reviewing a task for efficiency. The worker who reaches past 90 degrees of shoulder flexion 300 times per shift, or whose wrist deviates 30 degrees during every fastening cycle, appears productive on a time observation. The posture is simply not what the observation was designed to capture.

- ****Neutral posture zones**** — elbows at roughly 90° to 120°, wrists straight (neutral), back upright with natural lumbar curve, shoulders relaxed and below 45° elevation
- ****Above-shoulder work**** is one of the highest-risk posture categories in industrial ergonomics — reducing blood supply to rotator cuff tendons and dramatically increasing compressive shoulder load
- ****Forward trunk flexion**** beyond 20° increases lumbar disc compression by 150–400% depending on angle and load
- ****Wrist deviation**** beyond 15° in any direction significantly reduces grip strength and increases carpal tunnel pressure

- ****Head-forward posture**** (chin forward, neck flexed) for every inch of forward head position adds approximately 10 lbs of effective cervical spine load



The Neutral Posture Standard:

A workstation properly designed for ergonomic safety keeps all primary work activity within the 'power zone' — from mid-thigh to mid-chest height, within 16 inches of the body's centerline. Kaizen events must evaluate whether new layouts maintain or violate this zone for the full range of workers who will use them.

★ Contact Stress — The Hidden Hazard

Contact stress occurs when a hard edge, surface, or object presses against soft tissue — tendons, nerves, blood vessels — compressing them against underlying bone. It is one of the least discussed ergonomic risk factors, yet it is common in kaizen-redesigned workstations where new equipment, fixtures, or work surfaces introduce hard edges that workers rest against while working.

- Resting forearms on a hard table edge while performing fine assembly — compressing the median nerve against the carpal bones
- Knee contact with the underside of a standing workstation surface during work requiring forward lean
- Finger contact with sharp tool edges, trigger guards, or component edges during gripping tasks
- Thigh contact with the leading edge of a seat during seated work with forward reach requirements

📺 Vibration — The Invisible Cumulative Injury

Occupational vibration comes in two primary forms, both of which may be introduced or intensified by process changes in a kaizen event:

- ****Hand-Arm Vibration (HAV):**** Transmitted through power tools, grinding wheels, impact wrenches, chipping hammers. Causes Hand-Arm Vibration Syndrome (HAVS), white finger (Raynaud's phenomenon), and carpal tunnel syndrome. HAV risk increases when kaizen introduces power tooling to replace manual operations that were previously less hazardous.
- ****Whole-Body Vibration (WBV):**** Transmitted through seated or standing work on vibrating platforms — forklifts, powered industrial vehicles, certain floor-mounted machinery. Changes in material handling equipment during kaizen may transfer workers from standing tasks to operated vehicle tasks, significantly increasing WBV exposure.

The EU Physical Agents Directive and ACGIH TLVs (Threshold Limit Values) provide specific daily exposure action values and limit values for both HAV and WBV. These are often unknown to improvement teams selecting new tooling.

The Risk Factor Interaction — Why Combined Exposure Is Exponentially Dangerous

These five primary risk factors do not behave independently. Research consistently shows that the injury risk associated with combined exposure to multiple risk factors exceeds the sum of the individual risks. A task that is moderately repetitive, moderately forceful, and performed in a slightly awkward posture carries substantially higher injury risk than any one of those factors considered alone.

This interaction effect is one reason why cumulative trauma disorders often emerge suddenly after a process change, even when no individual aspect of the change seems dramatic. Kaizen may have moved the tipping point — not by introducing a new extreme hazard, but by shifting one variable enough to push the combined exposure across a threshold.

Risk Factor Combination	Relative Risk Multiplier (Approximate)	Example Scenario
Repetition alone (high)	2-3x baseline	Fast assembly with light loads, good posture
Force alone (high)	2-3x baseline	Heavy lifting performed infrequently with good posture
Posture alone (awkward)	1.5-2x baseline	Overhead reach but light load, performed infrequently
Repetition + Force	5-6x baseline	Fast assembly with forceful grip — extremely common post-kaizen
Repetition + Posture	4-5x baseline	Rapid cycles involving reach, twist, or deviation
Force + Posture + Repetition	8-15x baseline	High-speed, forceful, posturally compromised task — crisis level

Section 3: Ergonomic Assessment Tools for Improvement Teams

Ergonomic risk assessment is a discipline with well-validated tools designed for exactly the kind of task analysis that kaizen events require. The key is selecting the right tool for the body region and type of exposure being evaluated, and having team members trained to use these tools reliably. An untrained evaluator using an ergonomic assessment tool produces worse outcomes than no assessment at all — false assurance is more dangerous than acknowledged ignorance.

Observational Assessment Tools

These tools are designed to be used in the field, during or immediately after task observation. They translate visual observation of work into quantified risk scores. They are the primary tools of choice for kaizen ergonomics assessment.

RULA — Rapid Upper Limb Assessment

RULA is one of the most widely used postural assessment tools in occupational ergonomics. It evaluates upper extremity posture (upper arm, forearm, wrist, neck, trunk, leg position) and produces an action level score from 1 to 7, with higher scores indicating greater urgency of intervention. RULA is particularly well-suited to manufacturing, assembly, and office tasks where upper extremity posture is the primary concern.

- **Score 1–2:** Acceptable posture. No action required unless sustained for long periods.
- **Score 3–4:** Further investigation warranted; changes may be needed.
- **Score 5–6:** Investigation and change required soon.
- **Score 7:** Investigation and change required immediately.

REBA — Rapid Entire Body Assessment

REBA extends RULA's approach to cover the entire body, making it more appropriate for tasks involving significant trunk, lower extremity, or whole-body loading — materials handling, patient care, warehouse operations, and tasks requiring frequent body position changes. Like RULA, REBA produces an action level score from 1 to 15 with corresponding urgency levels.



Tool Selection Quick Guide:

Use RULA for assembly, inspection, computer work, and bench tasks where the upper extremity is the primary concern. Use REBA for lifting, carrying, patient handling, and tasks requiring full-body assessment. Both tools can be learned in a half-day training session — they should be part of every improvement team's standard toolkit.

NIOSH Lifting Equation

The National Institute for Occupational Safety and Health (NIOSH) lifting equation is the gold standard for assessing manual lifting tasks. It calculates the Recommended Weight Limit (RWL) — the maximum weight that 90% of healthy workers can lift under the defined task conditions — and a Lifting Index (LI) comparing actual load to RWL. An LI greater than 1.0 indicates increased risk; an LI greater than 3.0 indicates high risk requiring immediate intervention.

The NIOSH equation accounts for: horizontal distance from the body to the load, vertical height of the lift, vertical travel distance, frequency of lifting, trunk asymmetry (rotation), and quality of the hand-to-load coupling. Each of these variables is directly affected by workstation layout changes that are the everyday output of kaizen events.

Strain Index (SI) and Revised Strain Index (RSI)

The Strain Index is specifically designed to assess distal upper extremity (hand, wrist, forearm) risks — carpal tunnel syndrome, tenosynovitis, and related disorders. It evaluates intensity of exertion, duration of exertion, efforts per minute, hand/wrist posture, speed of work, and duration of the task. An SI score above 5.0 has been associated with significantly elevated WMSD risk; scores above 10.0 are considered high risk.

Direct Measurement Tools

When observational tools suggest significant risk, or when the stakes are high (new production line, major process change), direct measurement provides more precise characterization of exposure:

Measurement Tool	What It Measures	When to Use in CI Context	Approximate Cost/Complexity
Force gauge / dynamometer	Push, pull, pinch, and grip force in Newtons or lbs	When a task change involves new tooling, new containers, or altered material presentation	Low — handheld device, \$100–\$500
Electromyography (EMG)	Muscle activation level and duration — quantifies actual muscular effort	For high-stakes evaluations of new production standards; when RULA/REBA indicate high risk	High — lab-grade equipment; requires expertise to interpret
Video motion analysis	Joint angles, velocity, acceleration over time — more precise than observation	For new station design validation before full rollout; persistent high-risk areas	Moderate — software systems available from \$2,000+
Accelerometers / vibration meters	Hand-arm and whole-body vibration exposure levels	Any time new power tooling or vibrating equipment is introduced	Moderate — \$500–\$3,000; compare to ACGIH TLVs

Measurement Tool	What It Measures	When to Use in CI Context	Approximate Cost/Complexity
Heart rate monitoring	Cardiovascular load — useful for whole-body physical demand assessment	High-pace manual tasks; assessing recovery adequacy in balanced flow	Low — consumer-grade monitors are sufficient for screening
Lumbar motion monitors	Lumbar velocity, acceleration, and posture in three dimensions	When back injury risk is the primary concern and direct measurement is warranted	High — specialized equipment requiring trained operators

Worker-Centered Assessment Methods

Observational and measurement tools capture what analysts can see and quantify. Worker-centered methods capture what workers actually experience — the discomfort that precedes injury, the adaptations they've learned to make, the concerns they would share if anyone asked. These methods are not secondary — they often surface the most critical information.

Body Discomfort Surveys

Structured questionnaires asking workers to identify which body regions they experience discomfort in, when, and at what severity. Body discomfort mapping — having workers mark locations and intensity on a body diagram — is a rapid, high-yield screening tool. Prevalence of discomfort in a specific body region among 30% or more of workers on a task is a strong indicator of an ergonomic problem.

Body discomfort surveys should be conducted before and after process changes. A post-kaizen increase in reported discomfort in a specific region is a direct signal that the change introduced or intensified a hazard.

Participatory Ergonomics

Participatory ergonomics formalize the inclusion of workers in the identification, analysis, and solution of ergonomic problems. This is not simply 'ask the workers' — it is a structured methodology in which workers are trained in basic ergonomic risk factor recognition and are given tools, authority, and time to propose and evaluate solutions.

Participatory ergonomics has the strongest evidence base of any ergonomics intervention approach for producing sustainable improvements. Workers performing a task have thousands of hours of firsthand exposure that no improvement team can replicate through observation. Their knowledge of where the task hurts, where it strains, and what has been tried before is irreplaceable.



The Participatory Principle:

Workers are not subjects of ergonomic assessment — they are its primary data source and its most effective solution generators. Any kaizen process that assesses tasks without deeply engaging the workers performing those tasks is operating with a fraction of the available information.

The Ergonomic Assessment Decision Matrix

Not every kaizen event requires the same depth of ergonomic assessment. This matrix helps teams determine the appropriate level of assessment based on the nature and scale of the proposed changes:

Change Type	Minimum Assessment Required	Additional Assessment if Risk Indicators Present
Minor 5S reorganization (cleaning, labeling, shadow boards)	Walk-through checklist; worker discussion	Body discomfort survey if existing high-risk area
Workstation layout modification (bin placement, shelf height, work surface)	RULA or REBA + worker interview	Direct measurement of reach distances and heights vs. anthropometric tables
Cycle time reduction > 15% on existing task	RULA/REBA + repetition count pre- and post-change + worker survey	Strain Index for upper extremity tasks; NIOSH LI for lifting tasks
Introduction of new tooling or equipment	Full RULA/REBA + vibration assessment if power tools + force measurement	Video analysis; vendor ergonomic data review
New process or work method design (green-field)	Full ergonomic design review before implementation	Prototyping with adjustable mockup; worker evaluation panel across anthropometric range
Line balancing or job rotation redesign	Cumulative exposure assessment across all affected tasks + worker survey	Physical demand analysis with time-in-task weighting

Section 4: Integrating Ergonomics into the Kaizen Process

Ergonomics cannot be effectively addressed as an afterthought to the improvement process. It must be embedded as a systematic component of the kaizen methodology itself — with defined activities at each phase of the event, designated responsibility, success criteria that appear alongside operational metrics, and follow-up mechanisms that survive the event's conclusion.

The following framework describes how ergonomics integrates across the full kaizen lifecycle: from pre-event preparation through post-event sustainment. Organizations that implement this integration report not only fewer post-kaizen injuries, but better improvement results overall — because ergonomic analysis surfaces hidden wastes and constraints that pure efficiency analysis misses.

Phase 1: Pre-Event Preparation (2–4 Weeks Before the Event)

The most effective ergonomic integration happens before the kaizen team ever walks onto the floor. Pre-event activities establish the ergonomic baseline, surface existing concerns, and ensure the event team arrives with the context they need to make informed decisions.

- ****Assign ergonomics responsibility**** — identify who on the team has ergonomics training and accountability. This does not need to be a full-time ergonomist; a team member trained in observational assessment tools is sufficient for most events.
- ****Review injury and illness records**** — OSHA 300 logs, workers' compensation claims, near-miss reports, and first aid logs for the target area. Patterns of body-region-specific complaints are directional indicators of existing hazards that kaizen changes may intensify.
- ****Conduct a baseline ergonomic assessment**** — walk the target area, perform RULA/REBA on primary tasks, and conduct brief worker interviews. Document the current ergonomic state before any changes are made.
- ****Administer a body discomfort survey**** to workers in the target area. Establish the pre-event baseline against which post-event discomfort will be compared.
- ****Include ergonomic success criteria in the event charter**** — specify that no process change will be implemented that increases RULA/REBA scores, increases force requirements, or conflicts with anthropometric design standards.



The Pre-Event Ergonomic Baseline:

Without a documented pre-event baseline, it is impossible to determine whether a kaizen event improved or worsened the ergonomic condition of a work area. The baseline takes 2–4 hours to establish and is the most cost-effective ergonomic investment in the entire improvement process.

Phase 2: During the Kaizen Event

Within the kaizen event itself, ergonomic analysis is integrated into the observe-analyze-improve-test cycle that defines kaizen methodology. It is not a separate track — it is a lens applied to the same activities the team is already performing.

Day 1: Observation Phase

- During time observation and process walks, designate one team member to specifically observe posture and physical effort (while others observe time and motion)
- Conduct RULA/REBA on each primary work task in the target area
- Record reach distances, heights, and force demands on a task-by-task basis
- Conduct structured worker interviews — specifically ask about discomfort, fatigue, and physical difficulty
- Document all existing ergonomic concerns on the event tracking board alongside wastes and defects

Day 2–3: Analysis and Solution Generation

- During waste analysis, explicitly include ergonomic hazards in the waste/problem inventory
- When evaluating proposed solutions, run a rapid RULA/REBA simulation for significant changes to work method or layout
- Apply the ergonomic design hierarchy (see Section 5) to solution evaluation — prefer engineering controls over administrative controls
- Check proposed workstation dimensions against anthropometric design standards (OSHA ergonomics guidelines, published anthropometric tables)
- Require workers who perform the task to evaluate proposed changes before they are implemented

Day 4: Implementation and Testing

- After implementing changes, conduct a post-change ergonomic assessment before the event closes — do not wait for post-event monitoring
- Have workers perform the modified task and specifically solicit ergonomic feedback during trial runs
- Compare post-change RULA/REBA scores to pre-event baseline — improvement or maintained scores are the target
- Document any ergonomic issues identified during testing as explicit action items with owner and due date

Phase 3: Post-Event Follow-Up and Sustainment

The 30–90 day period following a kaizen event is when ergonomic hazards most frequently materialize as injuries. Workers are adapting to new methods. Pace pressure resumes. Observation intensity drops. Ergonomic follow-up during this period is not a luxury — it is an essential component of the improvement process.

Timeframe	Activity	Responsible Party	Success Indicator
Week 2 post-event	Follow-up body discomfort survey with workers in target area	Area supervisor + ergo lead	No significant increase vs. pre-event baseline
Week 4 post-event	Review first aid logs and near-miss reports for target area	EHS / Area manager	No new upper extremity or back-related entries
Week 4 post-event	Walk-through observation of target area at pace under production conditions	Kaizen team lead + ergo resource	RULA/REBA scores maintained at or below post-event levels
30-day action item review	Status check on all ergonomic action items from event	Kaizen facilitator + management	All items on track; escalate any blocked items with budget authority
90-day post-event	Formal ergonomic audit of area with comparison to pre-event baseline	EHS or designated ergonomist	No adverse ergonomic trend; all open items closed or actively resourced
6 months post-event	Review injury and workers' comp data for target area	EHS + management	No increase in recordable injuries attributable to changed tasks

Ergonomic Criteria for Kaizen Event Sign-Off

Just as a kaizen event should not be closed unless operational targets have been achieved, it should not be closed without documented verification of ergonomic acceptability. The following criteria provide a practical sign-off standard:

- RULA/REBA scores for all primary tasks are equal to or better than pre-event baseline
- No new above-shoulder work has been introduced without an engineering control to eliminate or reduce it
- No new manual lifting task has been introduced with a NIOSH Lifting Index > 1.0 without a documented plan to reduce it
- All new tooling has been evaluated for vibration, force, and handle ergonomics
- Workstation dimensions have been verified against anthropometric standards for the target workforce
- Worker representatives from the target area have provided feedback on the changes and that feedback has been documented and addressed
- All ergonomic action items generated during the event have been assigned an owner and a due date



The Ergonomic Sign-Off Standard:

An improvement that has not been verified ergonomically has not been fully verified. The sign-off process for kaizen events must include documented ergonomic acceptability — not as a parallel track, but as an equal and required element of implementation approval.

Section 5: The Hierarchy of Ergonomic Controls

The hierarchy of controls — the foundational framework of industrial hygiene and occupational safety — applies directly and powerfully to ergonomic risk reduction. Too many ergonomics programs rely on administrative controls and PPE when engineering controls are available and superior. Understanding and applying the hierarchy is one of the highest-leverage actions an improvement team can take.

Critically, the hierarchy aligns naturally with Lean and kaizen thinking: engineering controls address the root cause of the problem, while administrative controls and PPE manage the symptom. A Lean thinker who accepts ergonomic risk as something to be managed through behavior rather than eliminated through design is applying the same logic that Lean explicitly rejects in quality and efficiency contexts.

Level 1: Elimination — Remove the Hazard Entirely

The most effective ergonomic control eliminates the hazardous task altogether. This is the natural outcome of true Lean thinking applied ergonomically: if a motion is hazardous, don't improve how it is done — eliminate the need to do it.

- Automate a high-force, high-repetition task that cannot be made safe through redesign
- Eliminate a manual lifting task by redesigning the process to keep materials at gravity-neutral height throughout the flow
- Remove a twisting motion from a task by redesigning the orientation of the work surface or the component presentation
- Eliminate floor-level work by raising the process to an accessible height

Elimination requires the most investment and the most creative problem-solving. It also produces the most durable results and should always be the first question: Can we eliminate the need for this motion entirely?

Level 2: Engineering Controls — Redesign the Work

Engineering controls modify the physical work environment, equipment, or process to reduce exposure — without relying on worker behavior or compliance. They are the workhorse of effective ergonomics programs and the appropriate target for most kaizen ergonomic improvements.

Hazard Type	Engineering Control Examples	Lean Alignment
Lifting heavy loads from floor level	Adjustable-height lift tables, pallet positioners, vacuum lift assists, spring-loaded platforms that rise as product is removed	Eliminates non-value-added reaching and stooping motion; improves throughput

Hazard Type	Engineering Control Examples	Lean Alignment
Above-shoulder reach to retrieve materials	Lower shelf heights to power zone; pneumatic or counterweighted storage systems; gravity-feed bin design	Reduces motion waste; improves point-of-use material presentation
High pinch/grip force on components	Improved handle design; powered assembly tools replacing manual torquing; fixture design that holds components without manual grip	Improves cycle time consistency; reduces hand fatigue errors
Awkward posture due to fixed workstation height	Adjustable-height workstations (sit-stand) with appropriate range for workforce; tilted work surfaces for improved access angle	Supports standard work across diverse operators; reduces setup variation
Repetitive manual materials handling between stations	Gravity roller conveyors; pneumatic or electric slides; tote exchange tables at ergonomic height	Directly eliminates transport waste; natural kaizen improvement target
Vibrating power tool exposure	Dampened handles; anti-vibration gloves (secondary); powered tools rated below ACGIH action value; torque reaction arms	Maintains precision; often improves fastening quality and consistency
Prolonged standing on hard surfaces	Anti-fatigue matting; cushioned shoe programs; sit-stand options; floor surface analysis and remediation	Reduces shift-end fatigue errors; improves sustained performance

Level 3: Administrative Controls — Manage the Exposure

Administrative controls reduce exposure through changes in how and when work is performed — job rotation, scheduled rest breaks, pace limits, and training. They do not change the hazard; they reduce how much exposure any individual worker receives. They are appropriate as supplemental controls when engineering controls cannot fully resolve the risk, but should never be primary controls for known high-risk tasks.

- ****Job rotation**** — rotating workers between tasks with different physical demands. Effective only when rotation tasks involve different muscle groups; rotating between two tasks that both stress the wrist is not effective rotation.
- ****Micro-break protocols**** — structured brief recovery periods (30–90 seconds) built into high-repetition, high-pace tasks. Not the same as meal and rest breaks — these are within-task recovery opportunities.
- ****Pace limits**** — setting maximum acceptable cycle rates based on ergonomic exposure limits rather than solely on demand requirements. Requires management commitment to enforce.
- ****Two-person lift requirements**** — administrative designation of loads above a defined weight as requiring team lift. Effective only with consistent enforcement and a culture where asking for help is supported.

- ****Ergonomics training**** — teaching workers to recognize risk factors and self-report early discomfort before injury develops. Essential foundational element but not a substitute for engineering controls.



The Administrative Control Trap:

Job rotation and training are widely used as primary ergonomic interventions — but both are administrative controls with documented limitations. Training tells workers what hurts them without changing what hurts them. Rotation distributes exposure rather than eliminating it. These controls should supplement, never replace, engineering solutions.

Level 4: Personal Protective Equipment — Last Resort

PPE for ergonomic hazards — wrist splints, anti-vibration gloves, back belts, padded knee pads — occupies the same position in the ergonomic hierarchy as it does in chemical or noise hazard control: last resort, not primary protection. These devices have significant limitations:

- Wrist splints restrict motion and may reduce grip strength, altering the ergonomics of the task itself
- Back belts have not been shown in research to reduce injury rates when used as a primary control; they provide false assurance without addressing the source of the risk
- Anti-vibration gloves are effective for specific frequency ranges and must be matched to the specific tool — mismatched gloves may amplify rather than attenuate vibration
- All PPE degrades, must be maintained, and requires compliance — behavioral dependencies that engineering controls eliminate

Section 6: Regulatory Framework and Organizational Liability

Ergonomic risk in the workplace exists within a specific regulatory and legal context that improvement teams, managers, and EHS professionals must understand. The consequences of ergonomic failures — injuries, OSHA recordables, workers' compensation costs, and litigation — are not abstract. They are among the most costly and legally complex outcomes in occupational health and safety.

OSHA's Ergonomics Framework

OSHA does not currently have a comprehensive ergonomics standard (the 2000 ergonomics standard was rescinded by Congress in 2001). However, ergonomic hazards are regulated through several existing OSHA mechanisms that improvement teams must understand:

- ****The General Duty Clause (Section 5(a)(1))**** requires employers to provide a workplace 'free from recognized hazards that are causing or are likely to cause death or serious physical harm.' OSHA has issued ergonomic citations under the General Duty Clause, and ergonomic hazards that are recognized by the employer — including those created or documented during kaizen events — fall within this requirement.
- ****OSHA Recordkeeping (29 CFR 1904)**** requires recording of work-related musculoskeletal disorders on the OSHA 300 log. WMSDs are one of the most commonly recorded injury categories in manufacturing and healthcare. A kaizen event that results in increased WMSD recordables is directly measurable on the employer's OSHA recordkeeping data.
- ****Industry-Specific Standards**** — OSHA has ergonomics requirements in specific standards including 29 CFR 1910.269 (electrical utilities), 1926.502 (construction), and OSHA guidelines (non-mandatory) for meatpacking, nursing homes, retail grocery, and poultry processing industries.



The Legal Exposure of Documented Knowledge:

If a kaizen event generates documentation that identifies an ergonomic hazard — a risk assessment, a worker complaint, an action item log — that documentation establishes that the employer had knowledge of the hazard. Failure to address a documented hazard substantially increases both OSHA enforcement and civil litigation exposure. Documentation of assessment without documentation of remediation is worse than no assessment at all.

Workers' Compensation and Cost Impact

The direct and indirect costs of work-related musculoskeletal disorders represent one of the largest components of occupational injury costs in the United States. Understanding the full cost picture is essential for making the business case for ergonomic investment in kaizen events.

Cost Category	Typical Range / Notes
Medical treatment — acute	\$5,000–\$30,000 per musculoskeletal claim for surgery, physical therapy, imaging
Lost work time / temporary disability	Median lost time for WMSDs: 12–28 days; extended periods common for surgical cases
Permanent partial disability settlements	\$25,000–\$200,000+ depending on severity, body region, and jurisdiction
Replacement labor and overtime	1.5–3x direct cost of the claim to cover productivity loss and replacement staffing
Retraining and knowledge transfer	\$10,000–\$50,000 when an experienced worker is permanently removed from their role
Litigation (where applicable)	Legal fees and settlements that can dwarf medical costs in contested cases
Productivity loss (non-injured workers)	Research indicates a 10–20% productivity reduction among coworkers following a serious injury event
OSHA inspection and citation costs	\$15,625 per serious violation (2024 maximum); willful violations: \$156,259 per violation

The OSHA Safety Pays program ([osha.gov/safetypays](https://www.osha.gov/safetypays)) provides an interactive tool for calculating the revenue impact of workplace injuries, accounting for profit margin. A company with a 5% profit margin must generate \$600,000 in additional revenue to offset the indirect costs of a single serious injury with a \$15,000 direct cost estimate. This context gives ergonomic investment in kaizen events a financial dimension that should appear in any business case.

International Frameworks

For organizations operating globally, ergonomic regulatory requirements vary significantly by jurisdiction. Major frameworks include:

- ****EU Manual Handling Directive (90/269/EEC)**** and ****Display Screen Equipment Directive (90/270/EEC)****: EU member states implement these directives with varying specificity; Germany, UK (pre-Brexit), and Nordic countries have particularly detailed implementation
- ****ISO 9241 (Ergonomics of Human-System Interaction)****: International standard covering workstation design, cognitive ergonomics, and user interface design
- ****EN 1005 series (Safety of Machinery — Human Physical Performance)****: European standards covering recommended force limits, manual handling, and assembly posture
- ****ISO 11228 series****: International standards covering manual handling of loads (lifting, carrying, pushing, pulling, and handling of low loads at high frequency)
- ****Japan's Industrial Safety and Health Act****: Includes specific regulations on repetitive tasks and display screen work; JISHA (Japan Industrial Safety and Health Association) publishes detailed ergonomic guidelines

Section 7: Building an Ergonomics-Integrated CI Culture

Integrating ergonomics into individual kaizen events is a necessary but insufficient response to the problem. Sustainable protection of worker health while driving continuous improvement requires a cultural shift — one in which ergonomic thinking is as embedded in the improvement mindset as cycle time analysis, defect reduction, or 5S discipline. This is not a soft aspiration; it is a structural requirement that demands specific organizational mechanisms to achieve and maintain.

Leadership Commitment — The Non-Negotiable Foundation

No ergonomics program succeeds without authentic leadership commitment. In the CI context, this commitment must be specific and visible:

- ****Establish ergonomic success criteria alongside operational KPIs**** — kaizen events should report ergonomic outcomes (RULA score changes, worker survey results, action item completion) in the same briefings as efficiency and quality outcomes
- ****Fund ergonomic improvements**** — the most common failure mode of ergonomic action items is lack of budget authority. Leadership must ensure a mechanism exists to fund engineering controls identified during improvement events without requiring a separate, months-long capital approval cycle
- ****Make ergonomic degradation a kaizen failure criterion**** — explicitly state that a kaizen event cannot be declared a success if ergonomic conditions in the target area have declined
- ****Walk the floor with ergonomic eyes**** — senior leaders who conduct gemba walks that include ergonomic observation send an unmistakable cultural signal about organizational priorities



The Leadership Test:

Ask a frontline supervisor whether they would feel comfortable stopping a kaizen event implementation because it created an ergonomic hazard. If the answer is 'probably not' — because productivity pressure would override ergonomic concern — the cultural foundation does not yet exist to make integrated ergonomics work.

Ergonomics Capability Development

Organizations cannot rely on the availability of a dedicated ergonomist for every improvement event. The solution is a tiered capability model that distributes ergonomic competency across the workforce:

Tier	Who	Capabilities Required	Training Investment
Awareness (All Personnel)	Every worker, team leader, and supervisor	Recognize the five primary risk factors; know how to report ergonomic concerns; understand basic body mechanics for common tasks	2–4 hour initial training; annual refresher
Practitioner (Key CI Resources)	Kaizen team members, industrial engineers, area supervisors involved in improvement events	Conduct RULA and REBA assessments; apply NIOSH lifting equation; administer body discomfort surveys; interpret results and prioritize action	2–3 day formal training in ergonomic assessment methods; hands-on practice with certification
Technical Expert (EHS / Senior CI)	EHS professionals, senior industrial engineers, CI facilitators	Full assessment battery including Strain Index; design review against anthropometric standards; facilitate participatory ergonomics processes; specify engineering controls; interface with regulatory requirements	Ergonomics certificate program (BCPE or equivalent); 40+ hours of formal training plus mentored application
Certified Ergonomist (CPE/CIE)	External consultant or dedicated organizational resource (larger organizations)	All of the above plus advanced biomechanical analysis, expert testimony capability, complex program design, and peer review of organizational programs	Board Certification in Professional Ergonomics (BCPE) — professional certification requiring education, experience, and examination

Metrics That Drive Ergonomic Culture

What gets measured gets managed. Ergonomic culture requires ergonomic metrics that are tracked with the same rigor as operational performance:

- ****WMSD Recordable Rate**** — track separately from total recordable injury rate; trend by area, shift, and task
- ****Ergonomic Risk Score Trends**** — track average RULA/REBA scores before and after improvement events by area; positive trend (decreasing risk scores) should be a KPI
- ****Body Discomfort Survey Prevalence**** — percentage of workers reporting moderate-to-severe discomfort in specific body regions; track quarterly and after each improvement event

- ****Ergonomic Action Item Closure Rate**** — percentage of ergonomic action items from kaizen events closed within 30/60/90 days; a leading indicator of program effectiveness
- ****Near-Miss and First-Aid Trend**** — ergonomic near-misses and first-aid visits that don't reach recordable status; the leading edge of the injury iceberg
- ****Worker Ergonomic Concern Reporting Rate**** — the number of worker-initiated ergonomic concerns; a low rate does not mean a safe environment — it may mean workers don't trust the reporting process

Job Rotation Design — Doing It Right

Job rotation is one of the most widely used administrative ergonomic controls, and one of the most frequently implemented incorrectly. Effective rotation is not simply moving workers between tasks on a schedule — it is carefully designed exposure management based on which muscle groups are loaded by each task.

Rotation Design Principle	Correct Application	Common Error to Avoid
Rotate between dissimilar physical demands	If Task A loads the wrist extensors primarily, Task B should require minimal wrist activity — e.g., a visual inspection or locomotion task	Rotating between two assembly tasks that both require repetitive wrist flexion provides no ergonomic benefit
Consider cumulative exposure across the full shift	Design rotation schedules that ensure no worker exceeds daily exposure action values for any risk factor when all task exposures are summed	Focusing only on single-task exposure without calculating cumulative daily exposure
Account for skill and training requirements	Rotation must respect qualification requirements — workers can only rotate to tasks they are trained and certified to perform	Creating rotation schedules that cannot be implemented due to training gaps
Include recovery opportunity in the rotation	At least one station in a rotation cycle should provide meaningful physical recovery — low force, low repetition, flexible pace	Designing rotations across tasks that are all high-pace or high-force — the rotation distributes but does not reduce exposure
Validate rotation with workers	Have workers who perform the rotated tasks evaluate whether the rotation actually provides physical relief before deploying it	Implementing rotation based on analyst judgment without worker input

The Ergo-Kaizen Integration Checklist

Use this checklist to verify ergonomic integration at each phase of a kaizen event:

Before the Event

- Pre-event ergonomic walkthrough of target area completed
- Baseline RULA/REBA scores documented for all primary tasks
- Pre-event body discomfort survey administered to target area workers
- OSHA 300 log and first-aid records reviewed for target area
- Ergonomic success criteria included in event charter
- Ergonomically trained team member identified for the event

During the Event

- Ergonomic risk factors explicitly included in waste and problem identification
- Worker interviews conducted with specific ergonomic questions
- RULA/REBA applied to proposed new task methods before implementation
- Anthropometric standards checked for new workstation layout proposals
- New tooling evaluated for force, vibration, and handle design
- Workers in target area consulted on proposed changes before implementation
- Post-implementation RULA/REBA conducted and compared to baseline

After the Event

- All ergonomic action items assigned with owner and due date
- Post-event body discomfort survey scheduled (2 weeks out)
- 30-day and 90-day ergonomic follow-up visits scheduled
- Ergonomic outcomes included in event results briefing
- First-aid and near-miss monitoring activated for target area
- Engineering control items have identified budget source

Quick Reference: Ergonomics in Kaizen at a Glance

Primary Risk Factors and Kaizen Triggers

Risk Factor	Definition	Kaizen Activities That Increase It	Threshold of Concern
Force	Muscular effort required to perform the task	Faster pace with same loads; new tooling; changed material presentation	> 10 lbs grip; > 51 lbs lift (ideal conditions); any above-shoulder force
Repetition	Frequency of similar joint motion per unit time	Cycle time reduction; line balancing; task consolidation	Wrist: > 30 motions/min; any body part: cycle time < 30 seconds
Posture	Position of body segments relative to neutral	Workstation relocation; height changes; new equipment placement	Shoulder > 45°; trunk > 20°; wrist > 15° deviation; neck > 20°
Contact Stress	Hard surface pressure on soft tissue	New work surfaces; fixture design; equipment placement	Any sustained contact on tendon, nerve, or vessel paths
Vibration	Hand-arm or whole-body vibration exposure	New power tooling; change to powered vehicles or platforms	Compare to ACGIH TLV: HAV action value 2.5 m/s ² ; WBV 0.5 m/s ²

Assessment Tool Quick Selection

Tool	Best For	Output	Training Required
RULA	Upper extremity posture — assembly, bench work, office	Action level 1–7 (7 = immediate action)	Half-day; available free online with scoring sheets
REBA	Full-body posture — materials handling, healthcare, warehouse	Action level 1–15	Half-day
NIOSH Lifting Equation	Manual lifting task assessment	Recommended Weight Limit (RWL) and Lifting Index (LI > 1.0 = risk)	Half-day; NIOSH calculator available free online
Strain Index	Distal upper extremity — wrist, hand, forearm	SI score (> 5.0 = elevated risk; > 10.0 = high risk)	Full day; requires practice application

Tool	Best For	Output	Training Required
Body Discomfort Survey	Workforce screening; pre/post kaizen comparison	Body-region prevalence of discomfort; trend comparison	Minimal — standard validated questionnaires available
Participatory Ergonomics	Solution generation; worker-led improvement	Worker-identified hazards and solutions; engagement data	Facilitation skills; worker training in risk factor recognition

Control Hierarchy at a Glance

Level	Type	Examples	Effectiveness	Cost Typically
1 (Best)	Elimination	Automate the task; redesign process to remove the motion	Highest — hazard no longer exists	Highest upfront; best long-term ROI
2	Engineering Controls	Lift assists; adjustable workstations; improved tooling; gravity feeds	High — does not rely on behavior	Moderate to high; strongest sustainable impact
3	Administrative Controls	Job rotation; rest breaks; pace limits; training	Moderate — relies on compliance and management	Low to moderate; requires ongoing enforcement
4 (Last Resort)	PPE	Wrist splints; anti-vibration gloves; back belts	Low — does not reduce exposure; manages symptoms	Low upfront; hidden costs in compliance and replacement

Cost-Benefit Reference

Metric	Reference Value
Median WMSD workers' comp claim (manufacturing)	\$15,000–\$35,000 direct; 4–10x in indirect costs
OSHA General Duty Clause citation (serious)	Up to \$15,625 per violation (2024 rates)
OSHA willful violation maximum	\$156,259 per violation
Revenue required to offset \$35,000 injury cost at 5% margin	\$700,000
Typical adjustable workstation cost	\$800–\$3,000 — vs. one WMSD claim
Cost of RULA/REBA training per person	\$200–\$800 for formal training; free self-study options available

Metric	Reference Value
Estimated WMSD prevention ROI (research literature)	\$3–\$6 return per \$1 invested in ergonomic controls
Median days away from work — WMSDs	12 days (BLS 2022); longer for surgical cases

Final Thoughts — Improvement That Protects

The workforce is not a resource to be optimized. It is the source of every improvement, the holder of every process insight, and — in most organizations — the asset whose replacement cost is incalculable. A kaizen event that leaves workers healthier, more comfortable, and more capable is not just a better kaizen event. It is the only kind that fully delivers on the promise of continuous improvement.

The good news is that ergonomics and process improvement are not adversaries. When properly integrated, they reinforce each other. Ergonomic risk often indicates the same hidden friction, unnecessary motion, and design compromise that Lean analysis seeks to surface. A reach that strains the shoulder is also a reach that wastes time. A force demand that exhausts a hand is also a force demand that slows the cycle. The tools are different; the problems they expose frequently are not.

What this discipline requires is not more time, more budget, or more resources than kaizen already demands. It requires intention. It requires asking the right questions — Does this change make the work safer? Have we assessed the posture? Have we asked the workers how this feels? — at each phase of an improvement event that is already structured to ask hard questions.

The organizations that get this right build something rarer than an efficient process. They build a workforce that trusts the improvement process — because it has demonstrated, repeatedly, that it works for them, not just around them. That trust is worth more than any throughput gain achieved at the expense of the people who produce it.



The Commitment That Changes Everything:

When workers see that ergonomics is a genuine priority in improvement events — that their discomfort is treated as data, that action items get closed, that engineering solutions are funded — they become the organization's most powerful improvement resource. Psychological safety and physical safety are not separate concerns. They are the same concern.

Sources & Further Reading

NIOSH: [niosh.gov/topics/ergonomics](https://www.niosh.gov/topics/ergonomics) • OSHA Ergonomics: [osha.gov/ergonomics](https://www.osha.gov/ergonomics) • ACGIH TLVs: [acgih.org](https://www.acgih.org) • BCPE (Board of Certification in Professional Ergonomics): [bcpe.org](https://www.bcpe.org) • Liberty Mutual Manual Materials Handling Guidelines: [libertymutualgroup.com](https://www.libertymutualgroup.com) • Journal of Occupational and Environmental Hygiene • Applied Ergonomics (journal) • Human Factors and Ergonomics Society: [hfes.org](https://www.hfes.org) • Washington State Department of Labor & Industries Ergonomics: [lni.wa.gov/ergonomics](https://www.lni.wa.gov/ergonomics)