



The cost of workplace injuries:

Learning from 25 years of the Liberty Mutual Workplace Safety Index

Jesse Jacobs, PhD

Product Director, Science & Research
Risk Control Services, Liberty Mutual Insurance



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Publish Internal
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Workplace
Safety Index



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Risk Control Services



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Agenda

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What is the Workplace Safety Index and how is it done?

2

Insights from the Workplace Safety Index

3

Actions to help reduce top causes of loss



What is the Liberty Mutual Workplace Safety Index and how is it done?



25

Years of the Workplace Safety Index

U.S. businesses **lose more than \$1 billion a week** to serious, nonfatal workplace injuries.



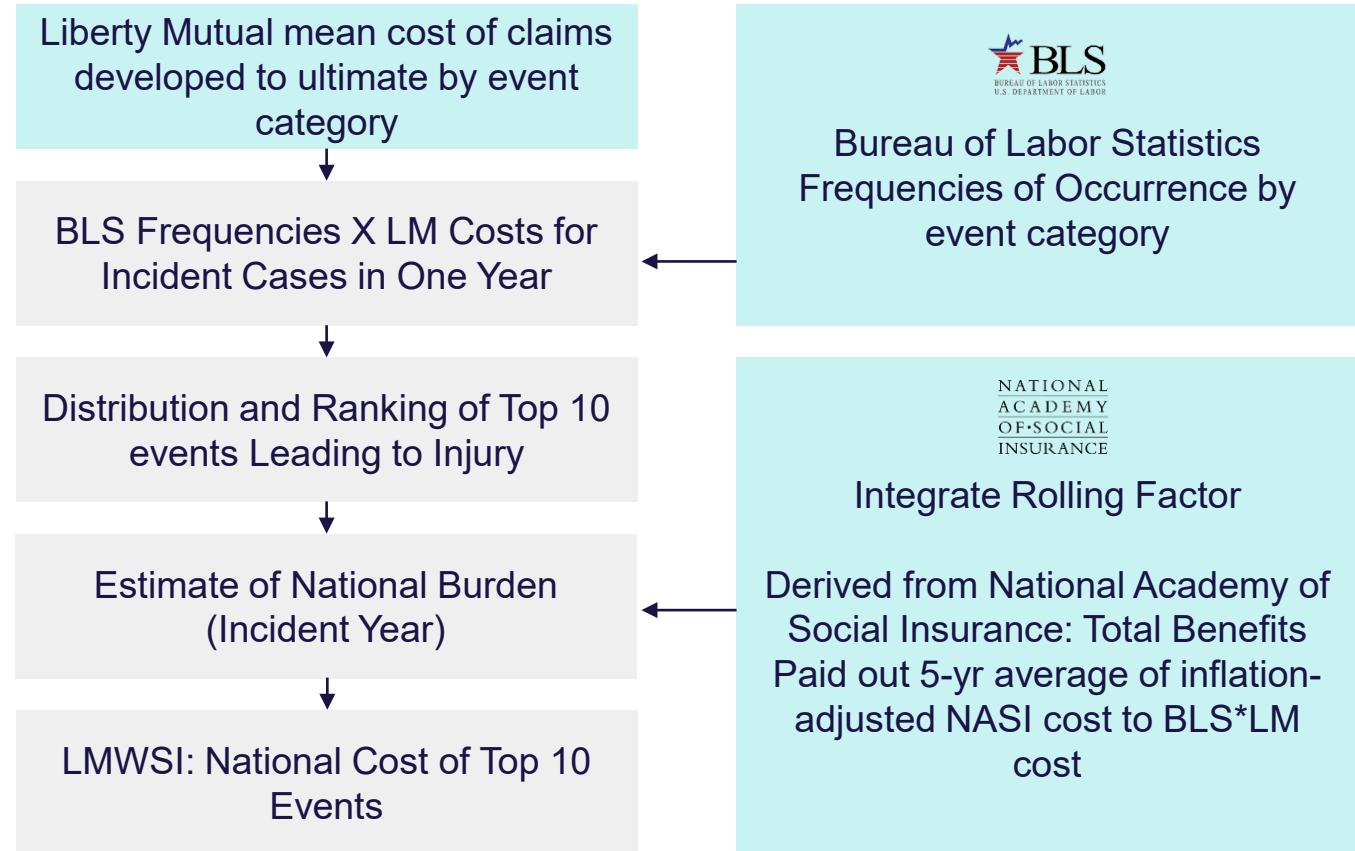
U.S. businesses spend more than \$1 billion per week on workplace

injuries, for a staggering total of more than \$58 billion per year. The top 10 causes cost U.S. businesses \$50.87 billion per year or 86.55% of total.

The top 10 causes			
		Cost in billions	Percent of total
1	 Overexertion involving outside sources (handling object) — This event category includes injuries related to lifting, pushing, pulling, holding, carrying, or throwing objects.	\$13.70	23.31%
2	 Falls on same level	\$10.52	17.89%
3	 Struck by object or equipment (being hit by objects)	\$5.81	9.88%
4	 Falls to lower level	\$5.78	9.84%
5	 Other exertions or bodily reactions (awkward postures) — include bending, reaching, twisting, climbing, crawling, kneeling, sitting, standing, walking, and running.	\$3.90	6.63%
These top five injury causes account for 67.55 percent of the total cost.			
The rest of the top 10 injury causes combined for 19 percent of the total direct cost of disabling injuries.			
6	 Roadway incidents involving motorized land vehicle (vehicle crashes)	\$2.84	4.83%
7	 Slip or trip without fall	\$2.60	4.43%
8	 Caught in or compressed by equipment or objects (running equipment or machines)	\$2.16	3.68%
9	 Repetitive motions involving microtasks	\$1.83	3.12%
10	 Struck against object or equipment (hitting in-place objects)	\$1.73	2.94%

Creating The Workplace Safety Index

Combine
Liberty Mutual claims cost
with
Bureau of Labor Statistics injury frequencies
then scale to the
National Academy of Social Insurance total burden



Marucci-Wellman et al. Journal of Safety Research. 2015;55:53-62.



Why is this a Data Science Project?

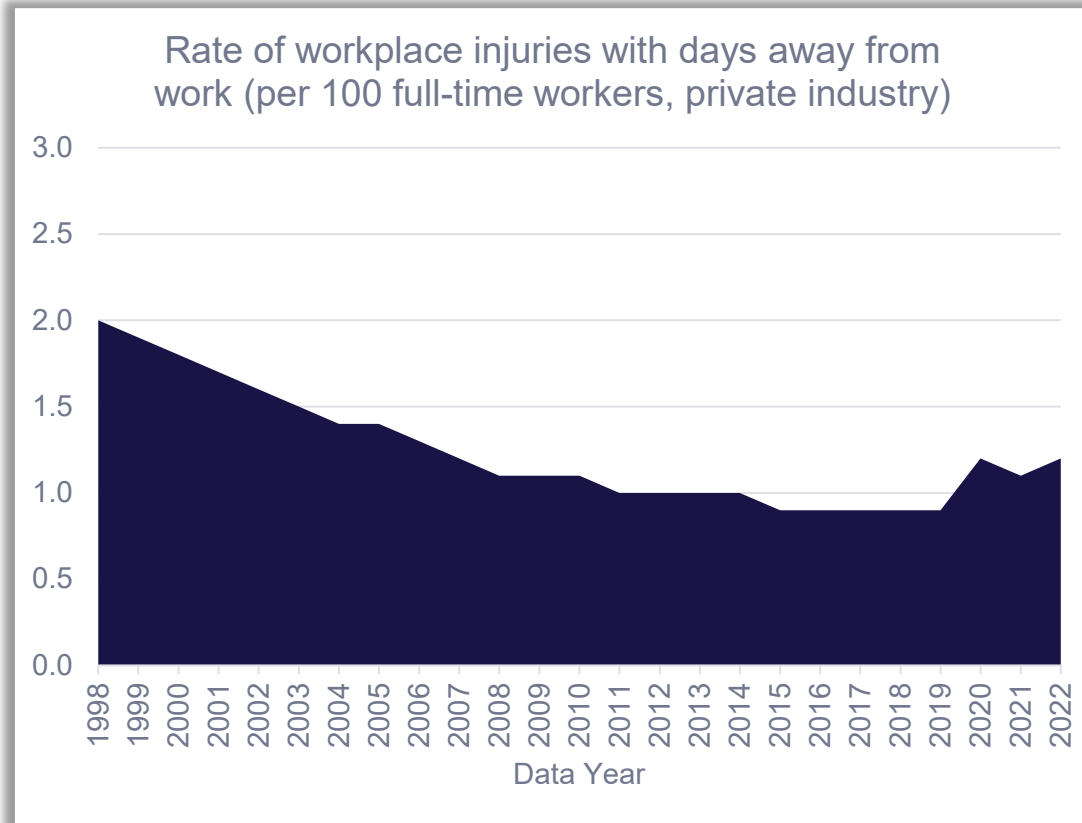
We leverage Natural Language Processing and Machine Learning to translate our internal claims into the standard categories of the BLS

LM Code	Accident Description		BLS 2-Digit Event Type
LM CODE 1	When associate lifts motors from racking and/or boxes, there is pain in his left shoulder		Overexertion involving outside sources
LM CODE 2	Employee was taking care of a patient and tripped over a monitor cord caught herself and twisted left foot		Slip or trip without fall
LM CODE 2	Employee fell on wet floor, striking head, elbow and thumb		Falls on same level
LM CODE 3	Employee loading package to the floor when a 40# package fell from above		Struck by object or equipment
LM CODE 4	Combative client hit her with remote		Intentional injury by person
LM CODE 5	Employee was involved in motor vehicle accident		Roadway incidents involving motorized land vehicle
LM CODE 6	Employee was bit by an insect on right upper chest area		Animal and insect related incidents

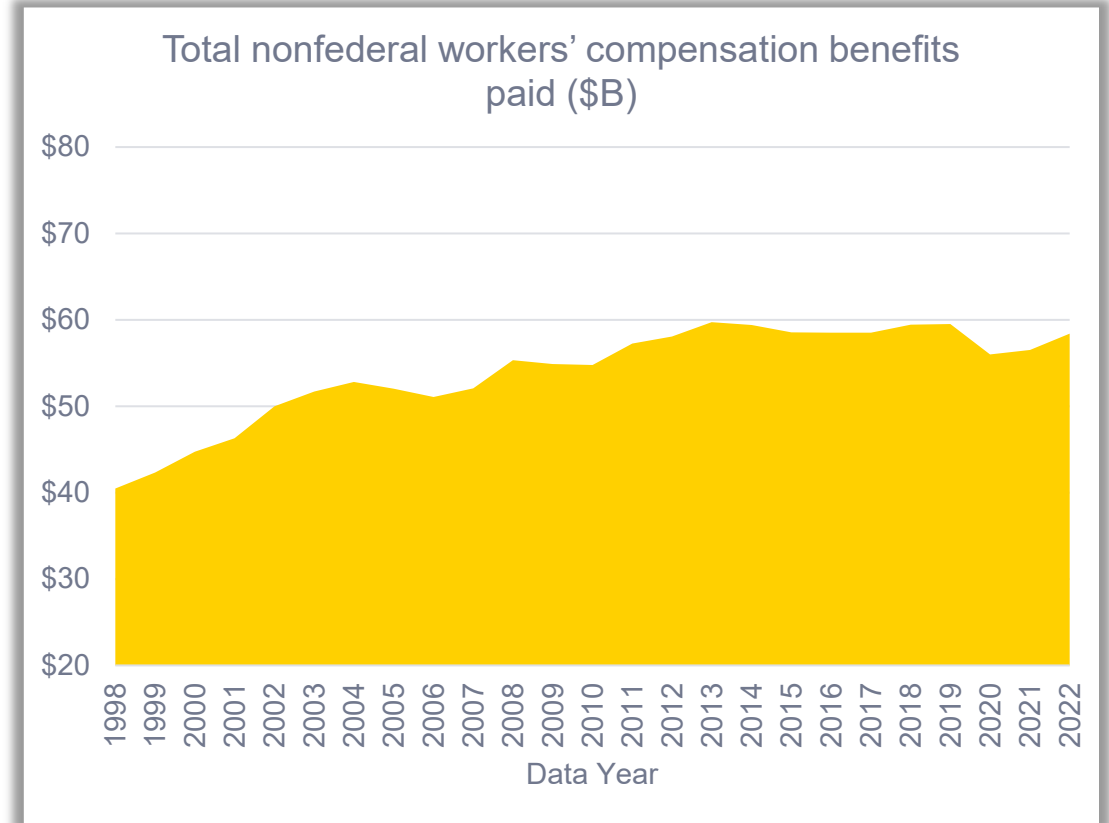


Insights from the Liberty Mutual Workplace Safety Index (WSI)

Injury rates have fallen but total costs have risen in the U.S.



SOURCE: U.S. Bureau of Labor Statistics. Work-related-injury and illness incidence rates, private industry, United States, 1973-2023



SOURCE: National Academy of Social Insurance. Workers' compensation: benefits, cost, and coverage. Table 9.



Top-10 causes of loss are relatively stable

Most differences from this year's top 10 attributed to a coding change in 2013 or to COVID-19 in 2023
(WSI publication years represent data from 3 years prior)

	YEAR																												
CAUSE	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Times included			
Overexertion involving outside sources	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	25			
Falls on same level	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	25			
Falls to lower level	4	4	4	4	4	4	3	3	3	5	3	4	4	4	3	3	3	3	4	4	3	4	3	3	4	25			
Struck by object or equipment	5	5	5	5	5	5	5	5	5	4	5	5	3	3	4	4	4	4	3	3	4	3	4	4	3	25			
Other exertions or bodily reactions	3	3	3	3	3	3	4	4	4	3	4	3	5	5	5	5	5	5	5	5	5	5	5	5	5	25			
Roadway incidents involving motorized land vehicle	7	7	7	7	7	6	6	7	6	6	6	8	6	6	6	6	6	6	6	6	6	6	7	6	6	25			
Slip or trip without fall													7	7	7	7	7	7	7	7	7	7	9	7	7	13			
Repetitive motions involving microtasks	6	6	6	6	6	7	7	9	8	9	9	7	8	9	10	10	10	10	9	8	10			10	9	23			
Caught in or compressed by equipment or objects	9	9	8	9	9	9	9	8	7	7	7	9	10	8	8	8	8	8	8	10	9	8	8	8	8	25			
Struck against object or equipment	8	8	9	8	8	8	8	6	9	8	8	6	9	10	9	9	9	9	10	9	8	9		9	10	24			
Intentional injury by person			10	10	10	10	10	10	10	10	10	10																	10
Exposure to temperature extremes	10	10																						2					
Non-roadway incidents involving motorized land vehicle																						10				1			
Exposure to other harmful substances																						6			1				
Pedestrian vehicular incidents																						10			1				



Costs of falls are on the rise



	2001 to 2005		2021 to 2025	
Average Cost	\$5.5B	➡	\$10.1B	
Average proportion of total cost	12.4%	➡	17.2%	
Top-10 rankings (NR = not ranked in top 10)	2, 2, 2, 2, 2	➡	2, 2, 2, 2, 2	



Costs of repetitive motions have fallen

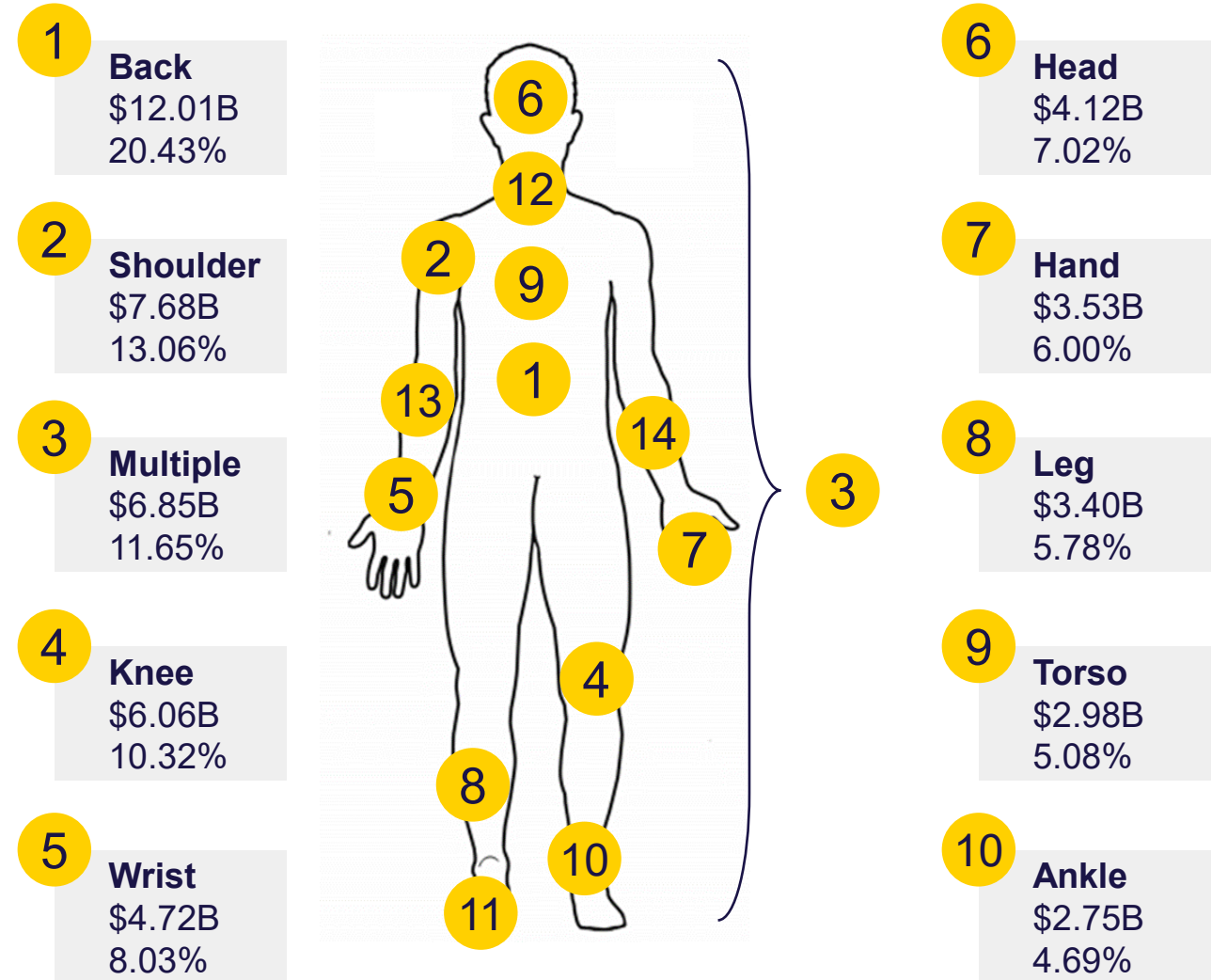


	2001 to 2005		2021 to 2025	
Average Cost	\$2.7B		➡	\$1.5B
Average proportion of total cost	6.2%		➡	2.9%
Top-10 rankings (NR = not ranked in top 10)	6, 6, 6, 6, 6		➡	10, NR, NR, 10, 9



Back Injuries Account for the Highest Costs

- Back injuries align to overexertion and falls as a high-frequency and potentially high-severity concern
- Shoulder and knee injuries often align to overexertion and other-exertion injuries
- Multiple body parts often align to more severe injuries such as motor vehicle incidents



Each Industry Sector Faces Unique Concerns



Construction

Cause	Cost (\$B;%)
Falls, to lower level	\$2.34; 22.4%
Overexertion, outside sources	\$1.93; 18.5%
Struck by object or equipment	\$1.41; 13.6%
Falls, same level	\$1.27; 12.2%
Other exertions or bodily reactions	\$0.78; 7.5%



Healthcare

Cause	Cost (\$B;%)
Overexertion, outside sources	\$1.60; 31.4%
Falls, same level	\$1.29; 25.3%
Intentional injury by person	\$0.50; 9.8%
Slip or trip without fall	\$0.27; 5.3%
Other exertions or bodily reactions	\$0.26; 5.2%



Manufacturing

Cause	Cost (\$B;%)
Overexertion, outside sources	\$1.77; 23.7%
Falls, same level	\$1.27; 17.0%
Struck by object or equipment	\$0.83; 11.2%
Caught in or compressed by equipment or objects	\$0.65; 8.8%
Repetitive motions involving microtasks	\$0.58; 7.7%



Professional Services

Cause	Cost (\$B;%)
Falls, same level	\$1.62; 19.6%
Overexertion, outside sources	\$1.47; 17.8%
Falls, to lower level	\$0.96; 11.7%
Roadway incidents, motorized land vehicle	\$0.64; 7.8%
Struck by object or equipment	\$0.59; 7.1%



Retail

Cause	Cost (\$B;%)
Overexertion, outside sources	\$1.49; 29.2%
Falls, same level	\$1.13; 22.1%
Struck by object or equipment	\$0.56; 10.9%
Falls, lower level	\$0.37; 7.3%
Other exertions or bodily reactions	\$0.37; 7.2%



Transport & Warehouse

Cause	Cost (\$B;%)
Overexertion, outside sources	\$1.45; 30.1%
Falls, same level	\$0.68; 14.2%
Other exertions or bodily reactions	\$0.43; 9.0%
Falls, to lower level	\$0.41; 8.5%
Roadway incidents, motorized land vehicle	\$0.41; 8.4%



Wholesale

Cause	Cost (\$B;%)
Overexertion, outside sources	\$1.35; 31.6%
Falls, same level	\$0.60; 14.1%
Struck by object or equipment	\$0.51; 11.8%
Falls, to lower level	\$0.43; 10.0%
Other exertions or bodily reactions	\$0.33; 7.6%



Leisure & Hospitality

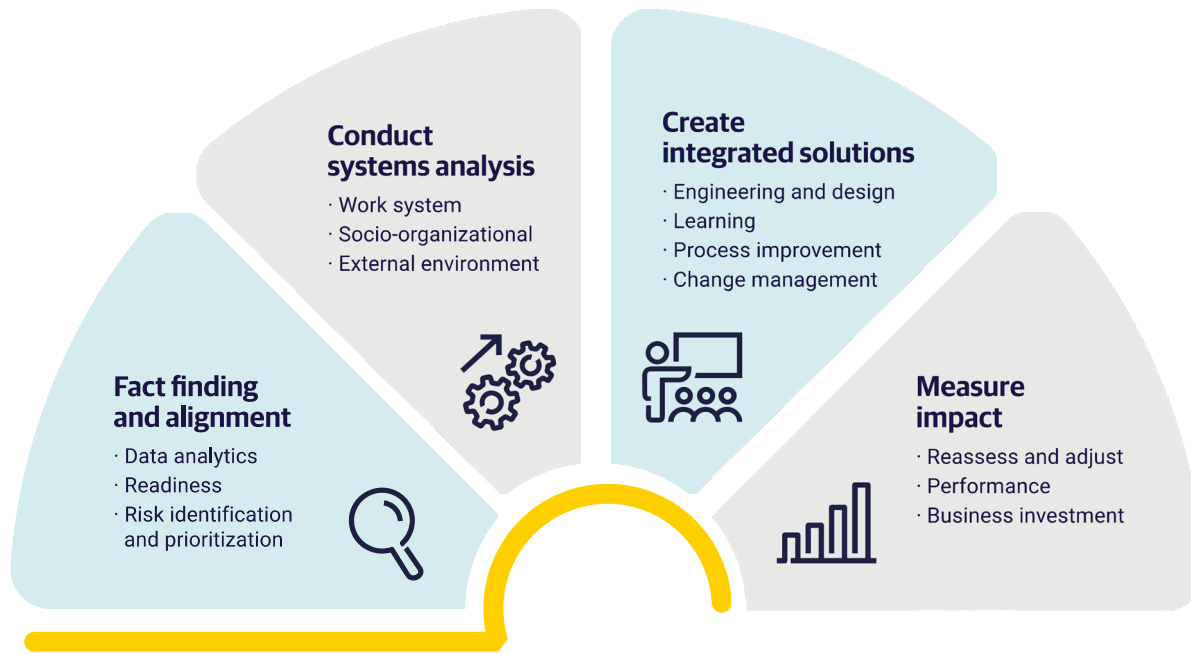
Cause	Cost (\$B;%)
Falls, same level	\$1.11; 31.1%
Overexertion, outside sources	\$0.59; 16.6%
Struck by object or equipment	\$0.41; 11.6%
Slip or trip without fall	\$0.18; 4.9%
Other exertions or bodily reactions	\$0.18; 4.9%



Actions to help reduce top causes of loss



Reducing the risk of overexertion



Adhere to the hierarchy of controls when feasible

Elimination, substitution, engineering control, administrative control, personal protective equipment

-  Assess the system and the task for risk.
-  Address concerns related to safety climate, staffing, scheduling, layout and material flow, productivity incentives, etc.
-  Design work processes to minimize heavy lift/lower, push/pull, carry, and awkward postures.
-  Use mechanical aids like lifts, hoists, conveyors, and carts with proper casters to minimize demand.
-  Provide continuous employee training and reinforcement.

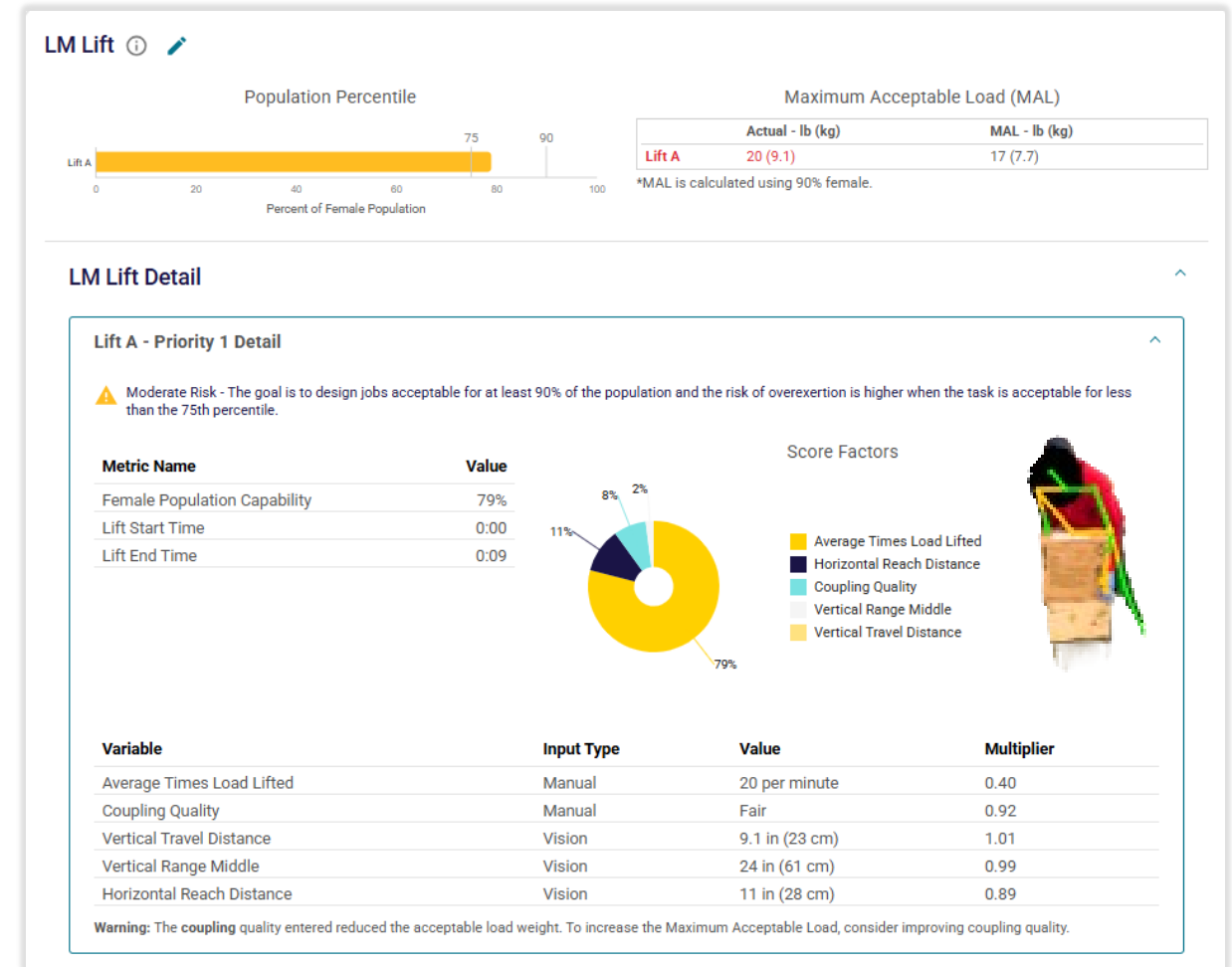


Technology may help reduce overexertion risk



AI-assisted assessment

- Increased throughput, reliability, objectivity
- Still requires intervention on assessed risk
- Can support intervention value estimates to help obtain buy-in



Technology may help reduce overexertion risk

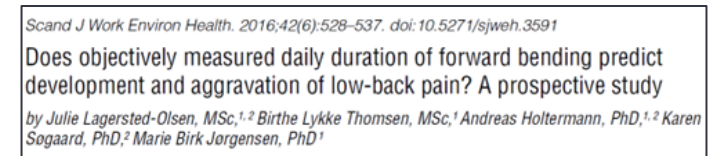
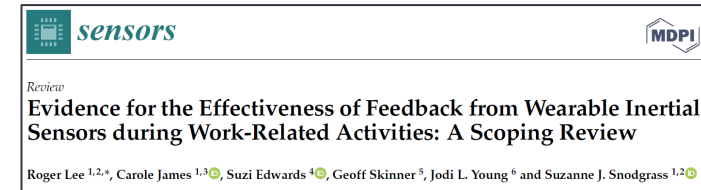
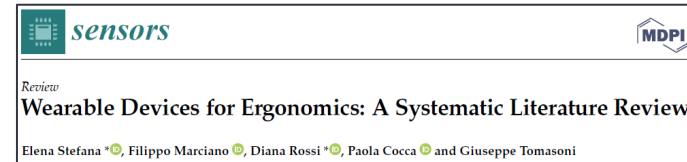
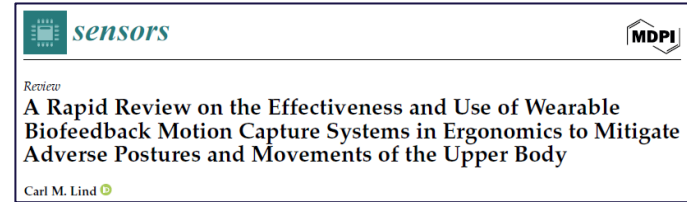


Sensing wearables

Effectiveness an open question

Posture-based, at best, not optimized or the effect is through other mechanisms

- Most studies are lab studies. More studies needed in work environments.
- Posture-based biofeedback may change posture, but not pain.
- Changes in posture may not last
- Time spent in forward bend angle does not relate to future back pain.
- Single trunk sensor does not relate well to injury risk unless load also measured.



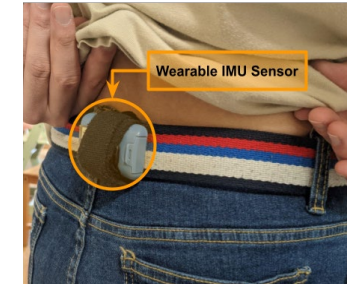
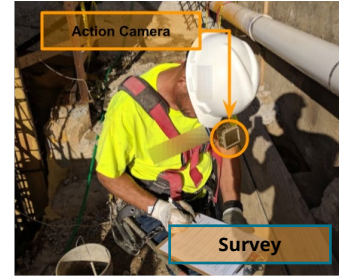
Technology may help reduce overexertion risk



Sensing wearables

Analyzing fatigue and heat stress may also help, beyond looking directly at lifting tasks

Monitoring still requires intervention



**1.28
pts**

Avg. error with self-rated whole-body fatigue (out of 10)

**0.08
°C**

Avg. error of core body temperature from ingestible pill*

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journal homepage: www.elsevier.com/locate/apergo



Wearable heart rate sensing and critical power-based whole-body fatigue monitoring in the field

Gaang Lee^a, JuHyeon Bae^b, Jesse V. Jacobs^c, SangHyun Lee^{d,*}

*Unpublished data; manuscript in process



Technology may help reduce overexertion risk



Exos

Where possible, prioritize controls that reduce exposure.

Ensure a good match of the exo to the job:

- Risk and safety outcomes that demonstrate need
- Task characteristics that align to the exo's function
- Compatibility with other job activities beyond the primary task of concern

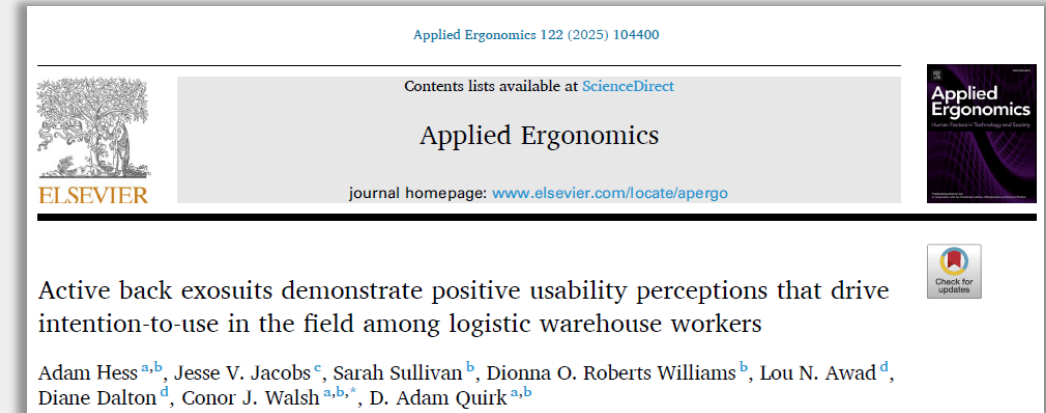
Address employee concerns for comfort and perceived need.

Ensure the organization is supportive:

- Strong safety climate
- On-site promoters/troubleshooters

Ensure a robust exo program and personnel:

- Policy, job analysis, implementation, communication, training, maintenance and cleaning, storage and access, etc



Technology may help reduce overexertion risk, but also introduce other risks



Automation

Verify the need for robotics over simpler solutions.

Ensure a comprehensive risk assessment.

Develop design requirements for safety during conception.

Develop a robotics/machine safety program that addresses:

- Safeguarding, installation requirements, maintenance, risk assessment, and training.

Control hazardous energy when performing maintenance or troubleshooting, minimize employee activity under energized conditions.

Consider how materials are delivered to and exit the automated work area.

Require Health & Safety and Facilities review during procurement, planning, install, and operation.



52%

Caught-in injuries

36%

Struck-by injuries

4%

Fall from height

46%

During operation

43%

During maintenance

11%

During installation or preparation



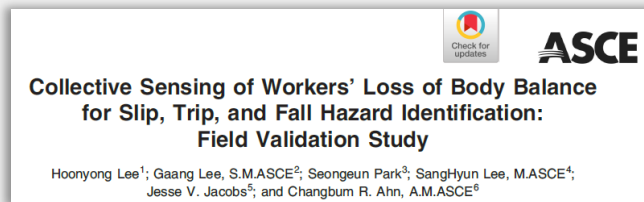
Reducing the risk of falls



Technology may help reduce the risk of falls



Sensing wearables

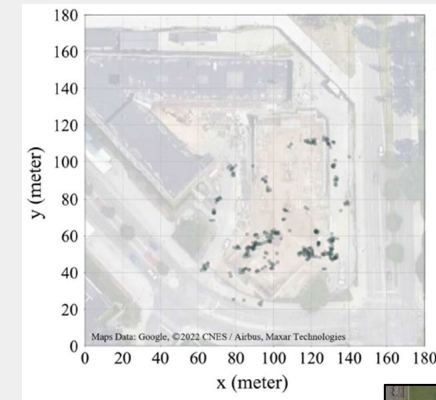


93%

Accuracy to identify walking with or without exposure to fall hazards at construction worksites; geolocation feasible

88.8%

Accuracy to identify negligible vs. significant fall hazards during daily life; geolocation feasible*



*Unpublished data; manuscript in process



Technology may help reduce the risk of falls



Computer vision

Systems typically identify:

- Environmental hazards, such as spills, clutter, uneven surfaces
- Desired and undesired behaviors (e.g., safe stair use, use of PPE, climbing on equipment or structures)
- Slip, trip, or fall events

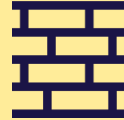


Unique risk: falls to lower level in construction



Fall Protection Program

Leadership Support, Preplanning,
Equipment Selection, Training,
Documentation, Employee Engagement



Prevention

Guardrails, Covers, Warning Lines,
Controlled Access Zones



Fall Arrest Systems

Harnesses, Lanyards, Anchors,
Lifelines



Equipment Priorities

Aerial lifts
Scaffolds with rails and toe guards
Ladders as last resort



Rescue Planning

Suspension Trauma Mitigation,
Emergency Response Coordination



Unique risks: workplace violence in healthcare



Physical Environment

Assess facility design, inspections, security systems, badge access, after-hours controls, and weapon storage



Management and Leadership

Assign responsibilities, demonstrate resource commitment, conduct regular audits



Education

New-employee and annual training, de-escalation/self-defense training, employee assistance program (EAP) availability



Written Programs

Policies for patient/visitor rights, armed security, and media relations, with review that includes employee surveys



Incident Response

Investigate incidents and near misses with tracking metrics; provide post-incident support (EAP, peer, HR).



Unique risk: Caught-in injuries in manufacturing

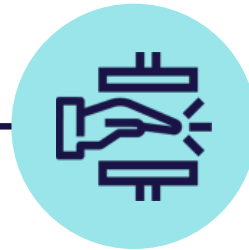
Procurement: Validate safeguards before machine commissioning and ensure procurement protocols include safety standards

Risk Assessment: Evaluate normal use, incidental tasks, and maintenance.

Operator Training: Provide competency-based instruction and skill verification for all machine operators; allow mode control for only authorized users.

Safeguarding Design: Use applicable standards (e.g., ANSI, ISO, NFPA) for barriers, controls, and workspace definition. Ensure safeguards cannot be circumvented.

Emergency Stop Systems: Equip machines with visible, unobstructed, standards-compliant emergency stop features



Energy Control: Emphasize zero-energy state and alternative protection methods for tasks requiring power

Maintenance Planning: Schedule proactive maintenance and validate reliability of safeguarding systems

Control Reliability: Ensure safety-related systems prevent hazardous motion even in case of system faults

Scheduling: Minimize fatigue-related risks through strategic work scheduling and job rotation

Housekeeping: Maintain orderly work area with sufficient space for material storage and so bystanders are not exposed



Unique risk: vehicle incidents in professional services and transportation and warehousing



Fleet Safety Policy

Define the organization's commitment, assign coordinators, and set driver authorization criteria, including licenses and background checks.



Driver Expectations and Distractions

Enforce seatbelt use, adherence to speed limits, and prohibit mobile device use with written acknowledgment of distraction policies.



Training, Evaluations, and Telematics

Provide ongoing training, and annual evaluations, and monitor driving behavior through telematics for coaching unwanted behavior and acknowledging desired behaviors.



Vehicle Maintenance and Incident Response

Enforce maintenance procedures and schedules, crash response and reporting procedures.



Technology may help reduce the risk of vehicle incidents



ADAS & fleet analytics



Real-world benefits of crash avoidance technologies

IIHS and HLDI study the effects of crash avoidance features by comparing rates of police-reported crashes and insurance claims for vehicles with and without the technologies. Results below are for passenger vehicles unless otherwise noted.

July 2023

Automatic emergency and rear braking		Lane departure and blind spot warnings	
↓ 50%	Front-to-rear crashes	↓ 11%	Single-vehicle, sideswipe, head-on crashes
↓ 78%	Backing crashes	↓ 14%	Lane-change crashes



Summary



Rising costs and stagnating injury rates present a call to focus on prevention



Utilize holistic, system-level assessments and interventions

- Engineering and design
- Process improvement
- Policy and training
- Support, safety climate



Safety technology has the potential to improve outcomes

- Comprehensive monitoring
- Real-time insight
- Leading-indicator focused





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