

Workplace Physical Demands and Musculoskeletal Injury Surveillance

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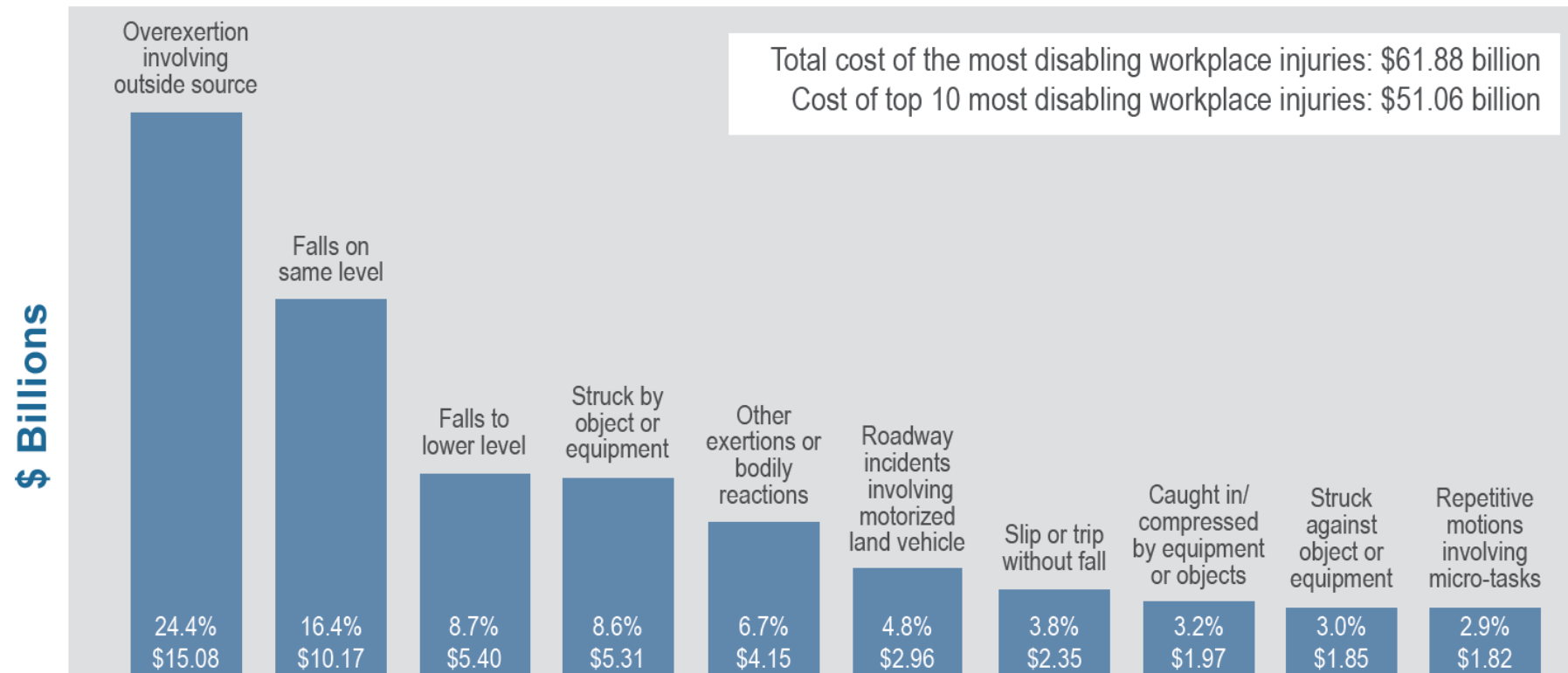


Objectives

- Provide industrial exoskeleton developers, users, policy-makers, and stakeholders with background on data sources characterizing occupational musculoskeletal/overexertion injury burden.
 - Surveillance-driven approach to workplace intervention
 - Exoskeletons as an injury prevention control technology
- Emphasis on the data sources

Background - All Industry Injury Cost Summary

Top 10 Causes and Direct Costs of the Most Disabling U.S. Workplace Injuries^{1,2}



2016 Liberty Mutual Workplace Safety Index (based on 2013 injury data)

Background

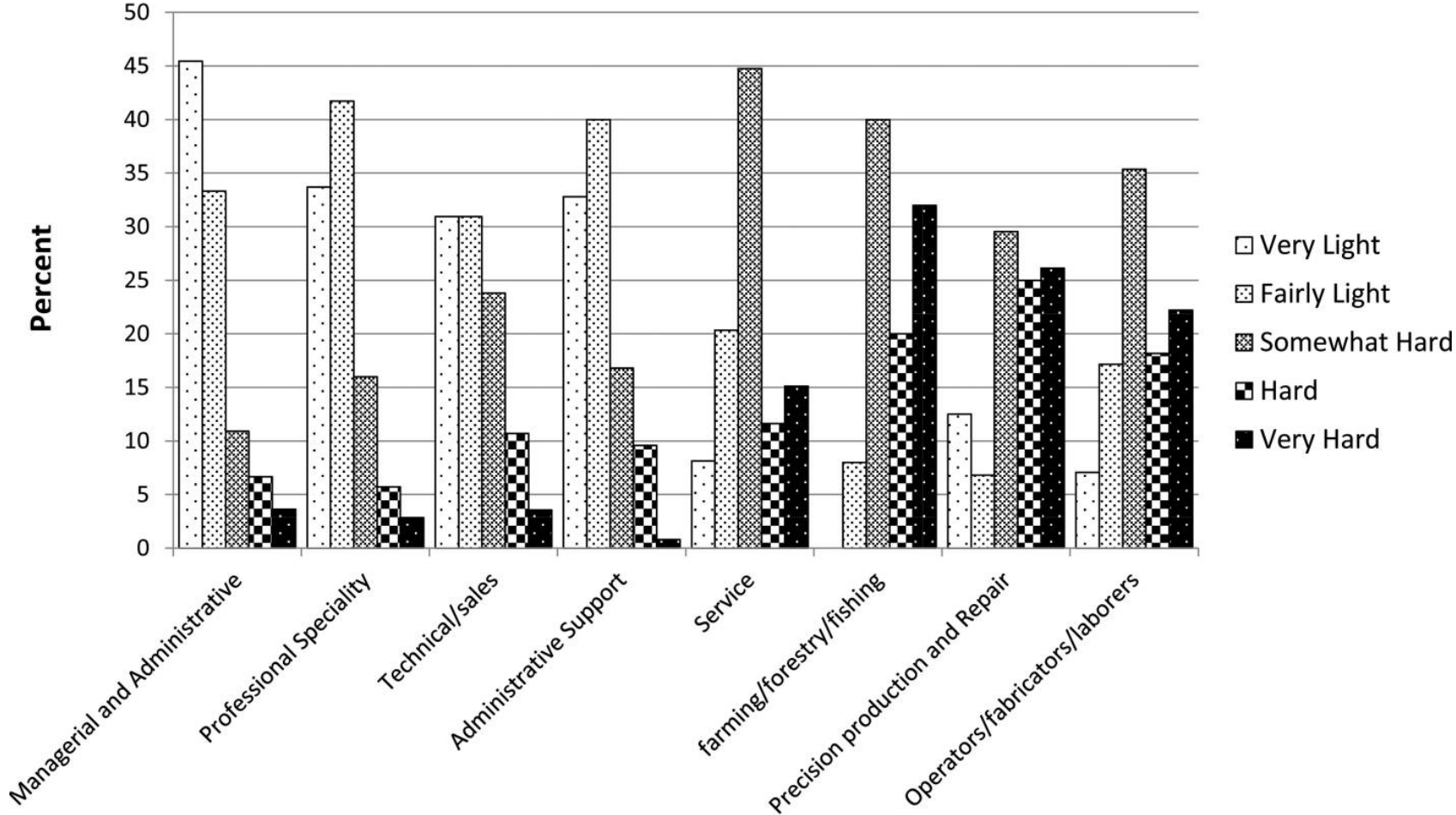
Where (in what industries, occupations) is greatest injury burden in which to apply exoskeleton technologies?

- Injury burden \cong musculoskeletal symptoms, pain, lost work time, medical costs. Also include job physical demands as risk factors.
- Data Sources:
 - Symptoms/Pain ➤ NIOSH Quality of Work Life (QWL)
 - Lost work time ➤ Workers Compensation Systems (state based systems, examples: OH, WA)
 - Medical costs
 - Job physical demands ➤ Occupational Requirements Survey (BLS-ORS)

Quality of Work Life (QWL) Survey

- NIOSH survey of risk factors for musculoskeletal disorders (MSDs)
- Supplement to the General Social Survey (GSS) of U.S. residents
- In-person interview by National Opinion Research Center
- U.S. adults over 18 years, random selection, English speaking
- $N \cong 1,500$
- GSS survey methods: <http://gss.norc.org/About-The-GSS>

QWL - ratings of physical effort by occupation



QWL (musculoskeletal) – symptoms of back pain/arm pain

Occupation	“Back Pain” %				“Pain in Arms” %			
	2002	2006	2010	2014	2002	2006	2010	2014
Construction and extraction	38.3	28.2	40.9	32.0	37.0	38.5	38.6	36.0
Transportation and material moving	33.3	30.4	27.1	31.3	33.3	45.6	33.9	35.9
Production occupations	30.1	30.0	24.1	24.0	34.6	33.6	33.3	28.8
Installation, maintenance, and repair	33.9	36.9	32.3	29.0	30.8	30.8	32.3	26.3
Service occupations	33.5	29.9	30.4	25.5	30.0	28.1	31.9	25.6
Sales and related	21.5	33.3	27.3	21.7	20.9	30.2	22.7	23.6
Office and administrative support	25.4	35.7	26.8	24.5	26.0	36.1	30.0	23.1
Professional and related	23.6	20.7	19.8	17.0	26.7	18.6	19.8	19.2
Management, financial and business	25.5	21.8	21.9	20.3	24.5	17.5	26.6	18.6
Overall	28.1	28.0	25.8	22.8	28.1	27.8	27.7	23.9

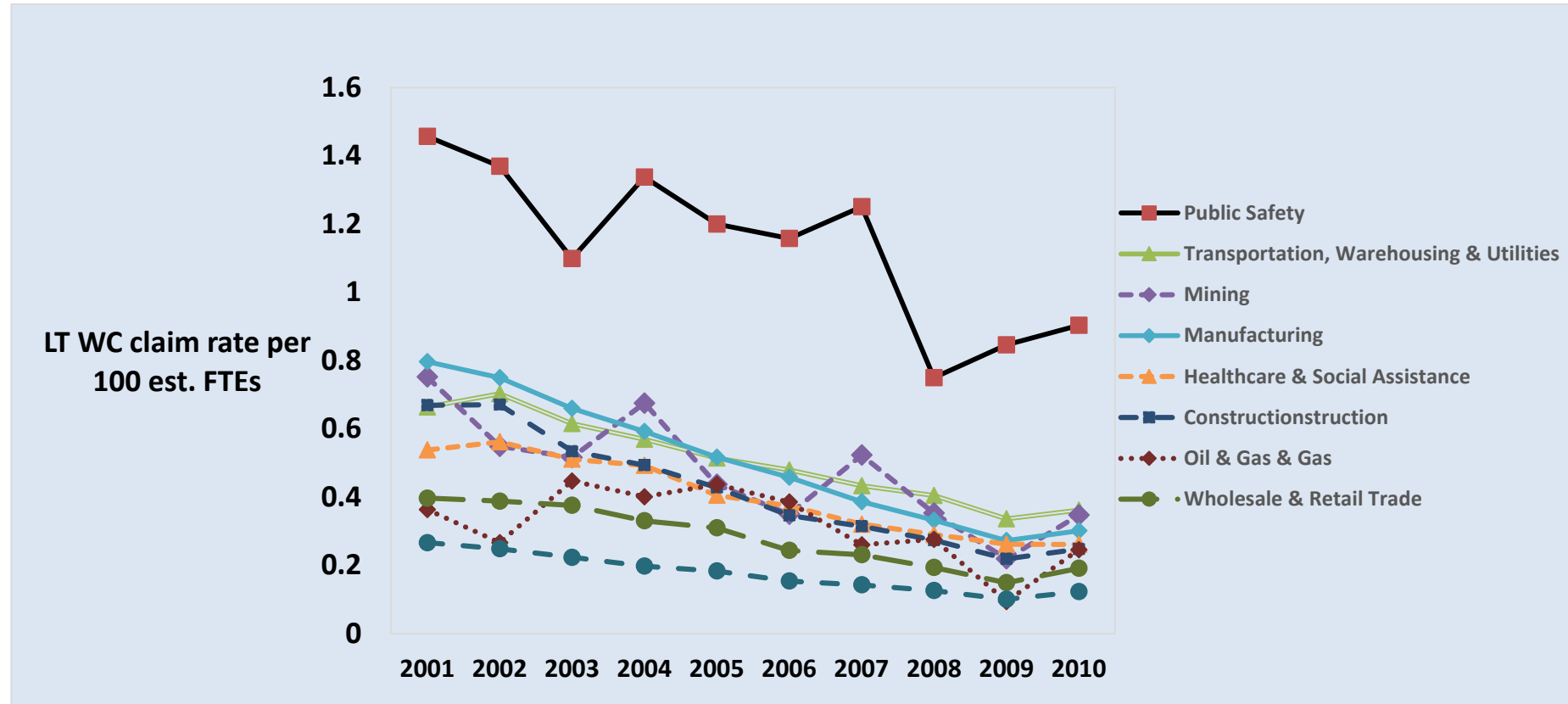
Workers' Compensation (WC) - Injury Causation/Outcomes

- Automated text mining approaches to code WC claims
- NIOSH method
 - Based on claim narrative, injury/illness category (ICD diagnoses)
 - Fast, accurate, reliable
 - Codes claims as three causation types
 - *Ergonomic* (ERGO) - Musculoskeletal disorders caused by one or more ergonomic risk factors: excessive force, awkward postures, repetitive motion, contact stress, vibration
 - *Slip/Trip/Fall* (STF) - Fall from height, on level
 - *Others* (OTH) - Struck by/against, caught between, motor vehicle, etc.
- NIOSH will share SAS code (contact: cwcs@cdc.gov)

Top 10* Lost Time (LT) Injury Categories for ERGOs by cause, 2001–2011 (Ohio WC)

LT Claim Count	% LT Claims	Injury Category	ERGO	OTH	STF
44,713	14.91	Sprains-Back	66%	12%	22%
34,175	11.4	Sprains - upper extremity	58%	16%	26%
23,565	7.86	Disc Disorders	63%	14%	23%
17,443	5.82	Soft tissue/Enthesopathy	66%	14%	20%
7,283	2.43	Hernia of abdominal cavity	96%	1%	3%
5,510	1.84	Carpal Tunnel Syndrome	95%	3%	2%
30,419	10.14	Sprains - lower extremity	14%	8%	79%
13,649	4.55	Dislocation	23%	8%	69%
8,485	2.83	Sprains - Neck	29%	50%	21%
2,208	0.74	Sprains - other	86%	5%	9%

ERGO injury claim rates (Lost Time) by Industry* (2001–2010, OH)



Top 10* NAICS subgroups for Lost Time ERGOs (OH)

1. 6231-Nursing Care Facilities
2. 3363-Motor Vehicle Parts Manufacturing
3. 6233-Community Care Facilities for the Elderly
4. 3315-Foundries
5. 6219-Other Ambulatory Health Care Services
6. 4931-Warehousing and Storage
7. 3262-Rubber Product Manufacturing
8. 4248-Beer, Wine, and Distilled Alcoholic Beverage Merchant Wholesalers
9. 4841-General Freight Trucking
10. 4842-Specialized Freight Trucking

*Among single-location, private employers

WA State, 2002-2010 WC, Overexertion claim injuries (by Industry classification)

Industry	NAICS		# Claims	Claim Rate*	Median Cost	Median days TL	Severity TL	Rate Rank	Count Rank	Overall PI Rank
CON	2381	Foundation, Structure, and Building Exterior Contractors	425	30.9	\$9,134	46	5,042	2	3	1
CON	2361	Residential Building Construction	474	25.4	\$7,922	42	4,050	5	1	2
CON	2383	Building Finishing Contractors	379	23.5	\$8,453	42	3,559	9	4	3
TWU	4841	General Freight Trucking	218	24.3	\$7,993	43	3,348	7	10	4
TWU	4842	Specialized Freight Trucking	152	32.5	\$6,521	33	3,029	1	19	5
CON	2389	Other Specialty Trade Contractors	270	21.9	\$9,350	47	3,507	13	7	5
CON	2382	Building Equipment Contractors	472	17.1	\$8,428	34	2,232	20	2	7
SER	5617	Services to Buildings and Dwellings	323	16.8	\$6,582	41	2,425	22	5	8
CON	2362	Nonresidential Building Construction	190	17.4	\$7,983	32	1,610	19	14	9
MNF	3371	Household and Institutional Furniture and Kitchen Cabinet Manufacturing	97	23.7	\$6,184	19	2,548	8	29	10

*rate per 10,000 FTE

Source: *Prioritizing Industries for Occupational Injury and Illness Prevention and Research, Washington State Workers' Compensation Claims Data, 2002-2010.* (Technical Report Number 64-1-2013).



WA State, 2002-2010 WC, Overexertion claim injuries (by Occupational Risk Class)

Risk Class	WIC Industry	# Claims	Claim Rate	Median Cost	Median days TL	Severity TL	Severity Cost	Rate Rank	Count Rank	TL days rank	cost rank	PI rank	Expanded PI rank
0510	Wood Frame Building Construction	417	42.1	\$ 7,243	43	6,963	\$1,443,499	11	2	11	10	1	1
0302	Masonry Construction	83	60.0	\$ 9,082	43	13,392	\$3,606,536	4	44	1	1	11	2
0507	Roofing Work - Construction and Repair	112	47.4	\$ 6,283	54	8,403	\$1,637,653	7	31	6	9	6	3
0516	Carpentry, N.O.C.	171	33.5	\$ 6,869	38	5,238	\$1,173,373	15	13	15	15	2	4
7117	Temporary Help - Machine Operation	70	76.8	\$ 5,371	29	12,136	\$2,094,603	1	52	2	5	12	5
0540	Wallboard Installation - Discounted Rate	64	66.6	\$ 8,723	53	12,098	\$2,644,363	3	56	3	2	16	6
0518	Non Wood Frame Building Construction	173	32.3	\$ 6,799	54	3,841	\$1,362,659	19	11	25	12	3	7
0217	Concrete Work - Foundations and Sidewalks	119	31.7	\$ 7,393	44	7,213	\$1,384,313	20	26	10	11	10	7
6907	Moving and Storage Companies	88	69.1	\$ 5,524	33	5,309	\$1,040,169	2	39	14	17	7	9
1102	Trucking, N.O.C.	245	30.2	\$ 7,629	43	4,017	\$831,636	27	4	23	27	5	10

Occupational Requirements Survey (ORS)

- Commissioned by Social Security Administration
- Conducted by the Bureau of Labor Statistics' (BLS) National Compensation Survey program
- Collection of job-related estimates: *physical demands*, environmental conditions, mental and cognitive demands, vocational preparation requirements
- Purpose is disability adjudication. Also a resource of occupational requirements
- 654 total estimates

ORS – Data Collection

- ORS is establishment-based survey; national sample design
- # of occupations and occupational detail to increase until full sample size (~30,000 establishments)
- Data in 2016 release - 5,800 private industry and 600 state and local government establishments First full data release in three phases
 - First - December 2016 (187 occupations)
 - Second - November 2017
 - Third - October 2018
- BLS estimates 450 occupations after three years (~80% of occupations in the national economy)
- After first 3-year collection cycle BLS will start the second cycle

Potential Relevance to Exoskeleton Use

(Note: down-select of potentially relevant variables done by the presenter)

- sitting vs. standing/walking at will is (not) allowed
- reaching overhead
- reaching at/below the shoulder
- pounds maximum weight lifted/carried, mean
- lifting/carrying none is required
- lifting/carrying > 10 lbs and ≤ 20 lbs required
- lifting/carrying > 20 lbs and ≤ 50 lbs required
- lifting/carrying > 50 lbs and ≤ 100 lbs required
- lifting/carrying > 100 lbs required
- pushing/pulling with hands/arms
- pushing/pulling with feet/legs
- stooping
- crawling
- pushing/pulling is required, one hand/arm
- pushing/pulling is required, both hands/arms
- pushing/pulling is required, one foot/leg
- pushing/pulling is required, both feet/legs
- pushing/pulling with feet only
- pushing/pulling with feet only required, one foot
- pushing/pulling with feet only required, both feet
- strength is required, sedentary
- strength is light work, medium work, heavy work, very heavy work

Preliminary data for illustrative purposes only.

Example – Physical demands, *reaching overhead*

	hours of <i>reaching overhead</i> , mean	% of workers where <i>reaching overhead</i> is required, both hands
Electricians (SOC 47-2111)	1.63	96
Bus and Truck Mechanics and Diesel Engine Specialists	1.61	92.9
Construction and Extraction Occupations	1.34	81.8
Emergency Medical Technicians and Paramedics	1.06	98.2
Middle School Teachers, Except Special and Career/Technical Education	0.82	47.6
First-Line Supervisors of Construction Trades and Extraction Workers	0.78	69.3
Dishwashers	0.75	66.3
Cooks, Restaurant	0.73	62.8
Bartenders	0.64	39.9
Shipping, Receiving, and Traffic Clerks	0.61	62.5

Preliminary data for illustrative purposes only.

Example – Physical demands, *maximum weight lifted/carried*

	<i>maximum weight lifted/carried, mean (lbs)</i>
Emergency Medical Technicians and Paramedics (SOC 29-2041)	128
Police Patrol Officers	91
Telecommunications Equipment Installers and Repairers, Except Line Installers	76
Protective Service Occupations	74
Construction Laborers	72
Carpenters	71
Construction Carpenters	70
Bus and Truck Mechanics and Diesel Engine Specialists	69
Maintenance and Repair Workers, General	67
Construction and Extraction Occupations	66

Preliminary data for illustrative purposes only.

Example: Physical demands that *might* preclude technology, *crawling required*

	Percent of workers where <i>crawling</i> is required*
Police Patrol Officers (SOC 33-3051)	95.7
Telecommunications Equipment Installers and Repairers, Except Line Installers	88.4
Bus and Truck Mechanics and Diesel Engine Specialists	79.8
Carpenters	74.3
Electricians	70.6
Maintenance and Repair Workers, General	67.5
Childcare Workers	62.5
Maintenance Workers, Machinery	61.3
Installation, Maintenance, and Repair Occupations	60.1
Construction and Extraction Occupations	52.1

*But, few reported mean hours of crawling

Preliminary data for illustrative purposes only.

ORS - Lifting/carrying, load and frequency

- Interaction of load/frequency to define risk

<i>Seldom</i> (up to 2% of the day)	<i>Occasionally</i> (2% up to 1/3 of a day)	<i>Frequently</i> (1/3 up to 2/3 of a day)	<i>Constantly</i> (2/3 or more of a day)
< 10 lbs	< 10 lbs	< 1 lbs	None
11 – 20 lbs	11 – 20 lbs	< 10 lbs	< 1 lbs
21 – 50 lbs	21 – 50 lbs	11 – 25 lbs	< 10 lbs
51 – 100 lbs	51 – 100 lbs	26 – 50 lbs	11 – 20 lbs
> 100 lbs	> 100 lbs	> 50 lbs	> 20 lbs

Summary/Further Consideration

- Surveillance data (injury/illness) to define injury prevention needs
- Difficult to get data across industries/occupations
- Leverage existing and forthcoming data sources
 - Workers' Compensation Systems – Injury causation, outcomes, burden
 - Occupational Requirements – Physical demands
- ORS physical demands – identify stakeholder groups (occupations) and system requirements

Comments/Suggestions/Other input ?

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