

# Green Ergonomics: Understanding MSD Hazard Exposures Within the Wind Energy Sector

5/28/2020



UNIVERSITY OF WATERLOO  
FACULTY OF APPLIED HEALTH SCIENCES



OCCUPATIONAL  
BIOMECHANICS &  
ERGONOMICS LAB  
Optimizing Human Performance

# GREEN JOBS AND THE NEED FOR HFE

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*“It can be anticipated that over the next decade, there will be a significant expansion in green jobs, including in the renewable energy sector...”*

*With these jobs come both known and new HFE challenges.”*

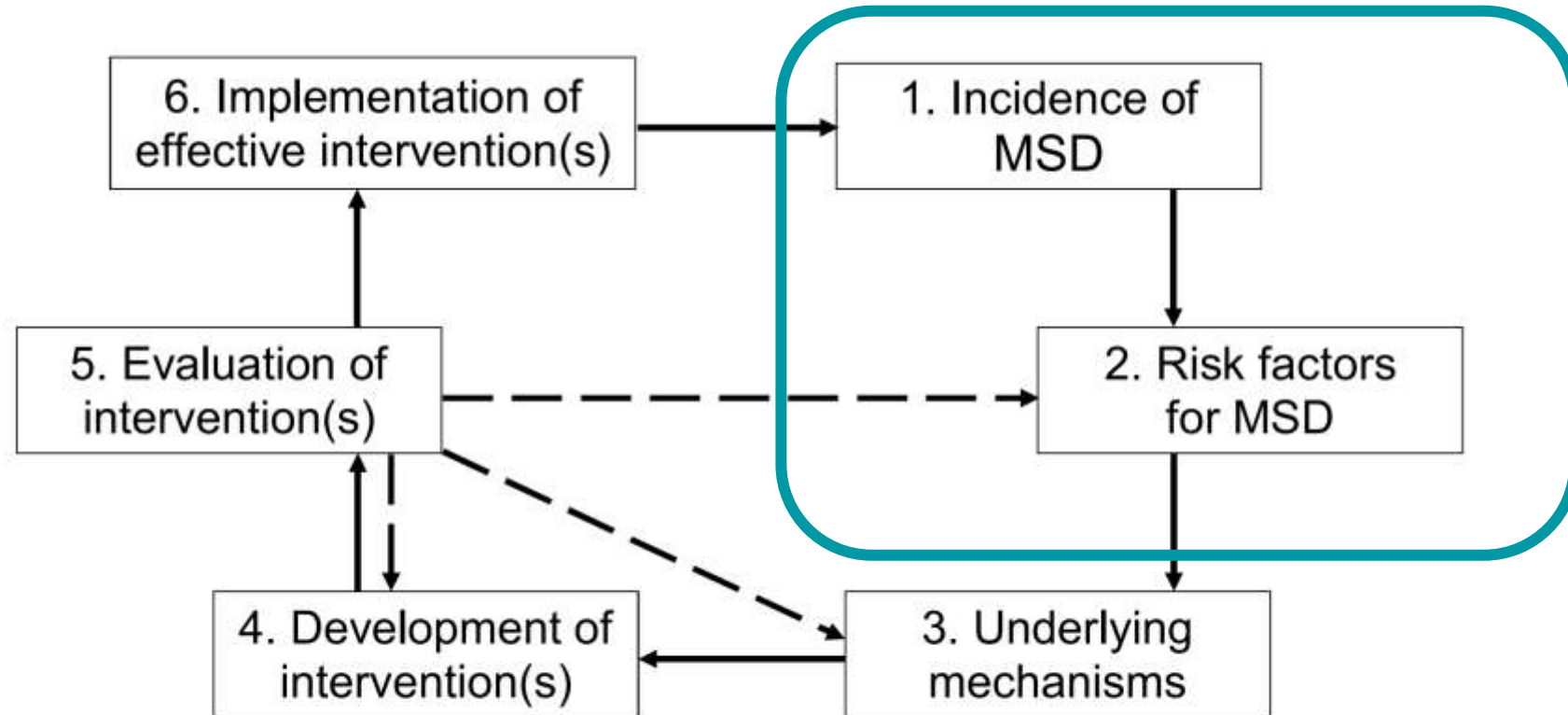
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**Margaret Hanson (2010). Donald Broadbent Lecture given at the Institute of Ergonomics and Human Factors Annual Conference**



<https://canwea.ca/blog/2020/01/23/wind-energy-has-lots-more-to-offer-in-ontario/>

# A process to identify and address HFE challenges



Van der Beek et al., 2017. A research framework for the development and implementation of interventions preventing MSD. *Scand J Work Environ Health*.



# Survey Objectives and Project Goal:

**Objectives:** Gather information about wind turbine technicians'

- ✓ demographics;
- ✓ pain and discomfort;
- ✓ perceived exertion; and,
- ✓ job task feedback.

**Goal:** identify what job tasks should be prioritized for proactive hazard identification and risk assessment; and, identify emergent intervention possibilities.



# Designing the survey: [www.msdpreservation.com](http://www.msdpreservation.com)

- Have you had pain or discomfort during the last year that you feel is job-related?
  - Yes
  - No (if no, stop here)
- If Yes, please rate the level of discomfort over the last month by checking off the appropriate box using the scale of 0 to 10, with 0 being no discomfort and 10 being the worst discomfort experienced.

No Discomfort ↓ 0	1	2	3	4	5	6	7	8	9	10 ↓ Worst Discomfort Ever		No Discomfort ↓ 0	1	2	3	4	5	6	7	8	9	10 ↓ Worst Discomfort Ever	
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Do any of your job tasks require you to:

Repeat the same movements or actions more than a few times a minute for more than 30 minutes at a time?

Y  N

If yes, list the three most "repetitive" tasks:

- 1) \_\_\_\_\_
- 2) \_\_\_\_\_
- 3) \_\_\_\_\_

lift, push, pull, or move heavy items?

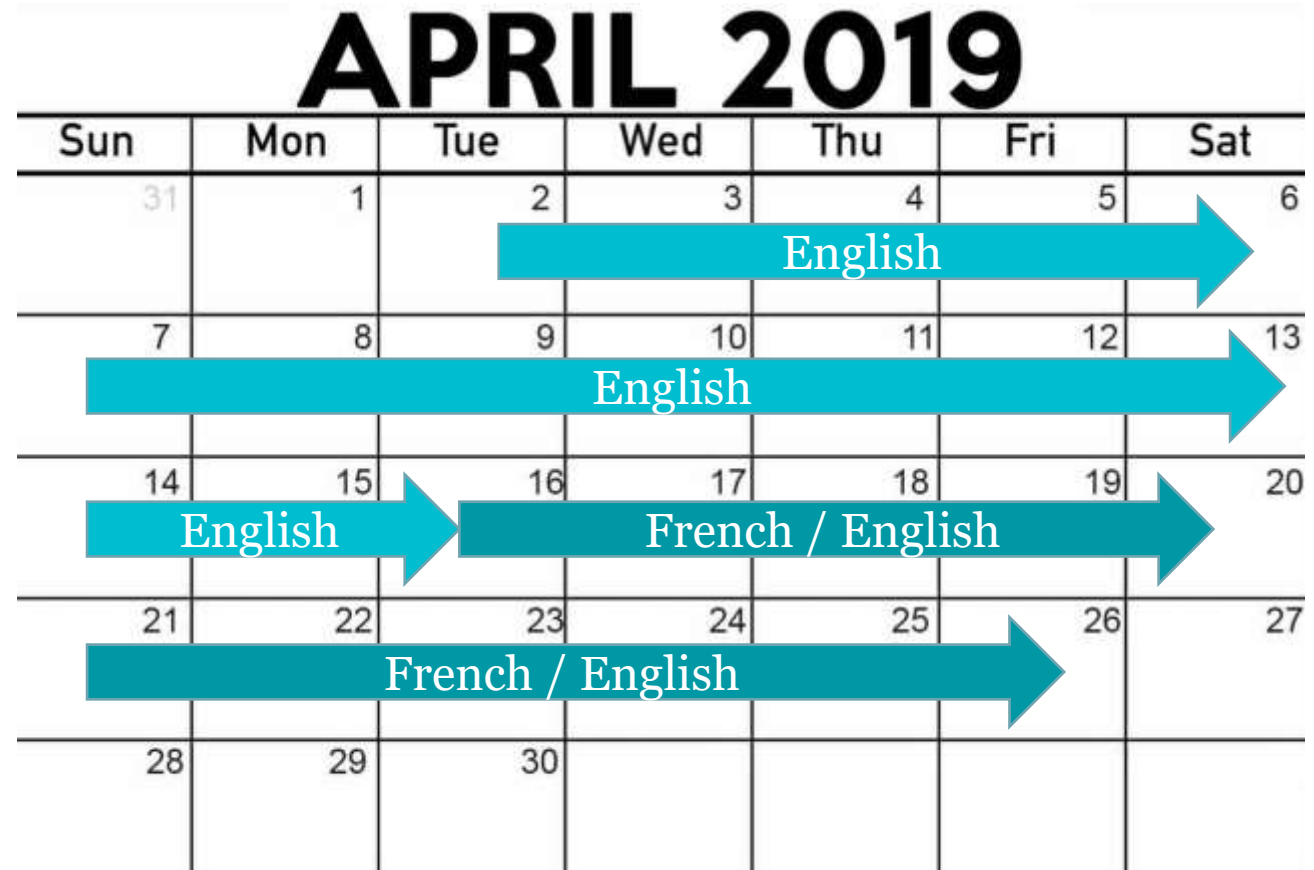
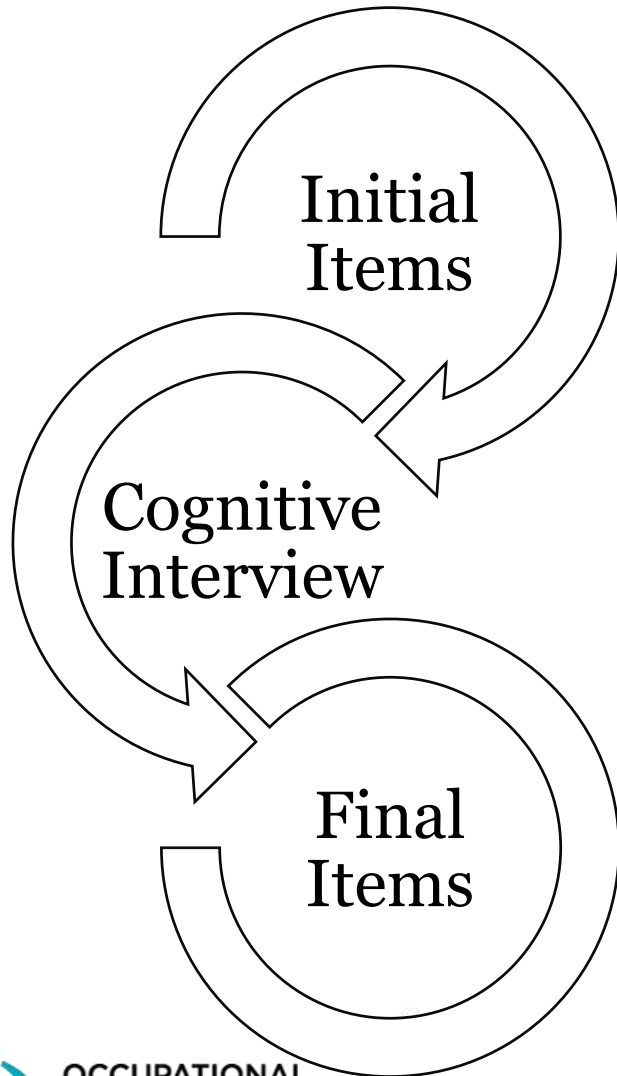
Y  N

If yes, list the three heaviest items you lift, push, pull, or move:

- 1) \_\_\_\_\_
- 2) \_\_\_\_\_
- 3) \_\_\_\_\_



# Survey refinement and response period



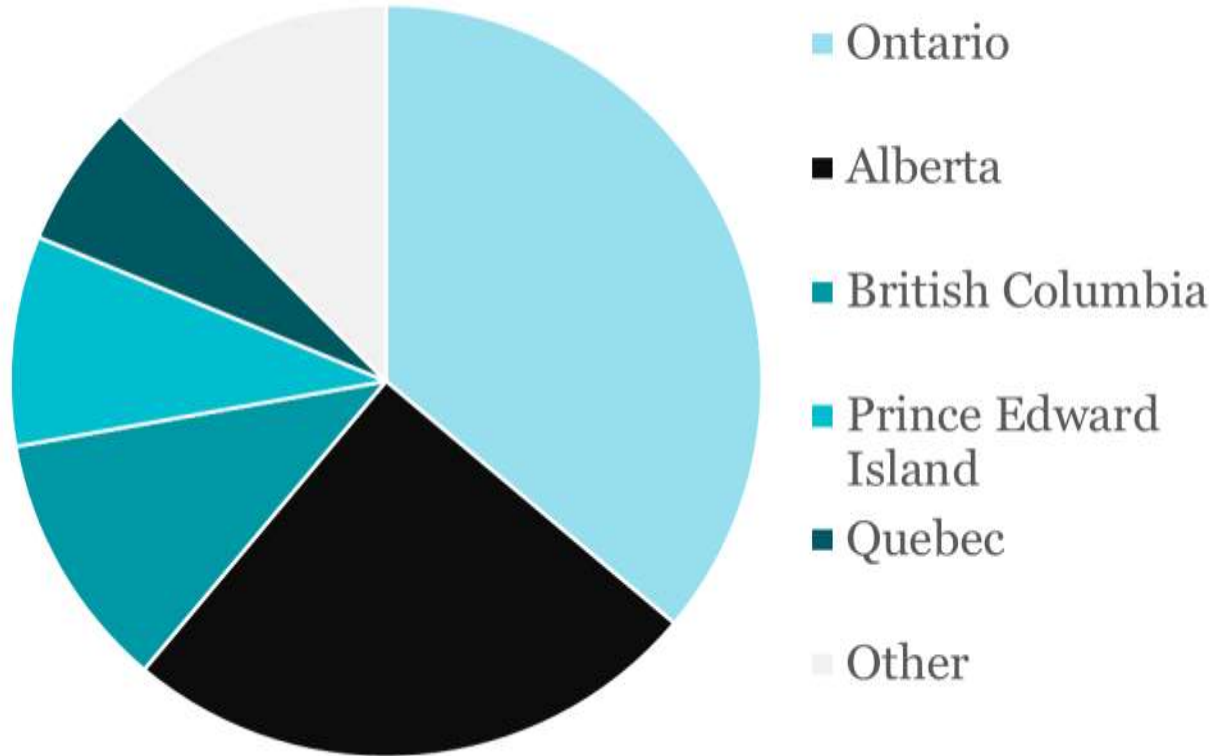
# RESULTS

# **LOCATION AND EXPERIENCE OF RESPONDENTS**

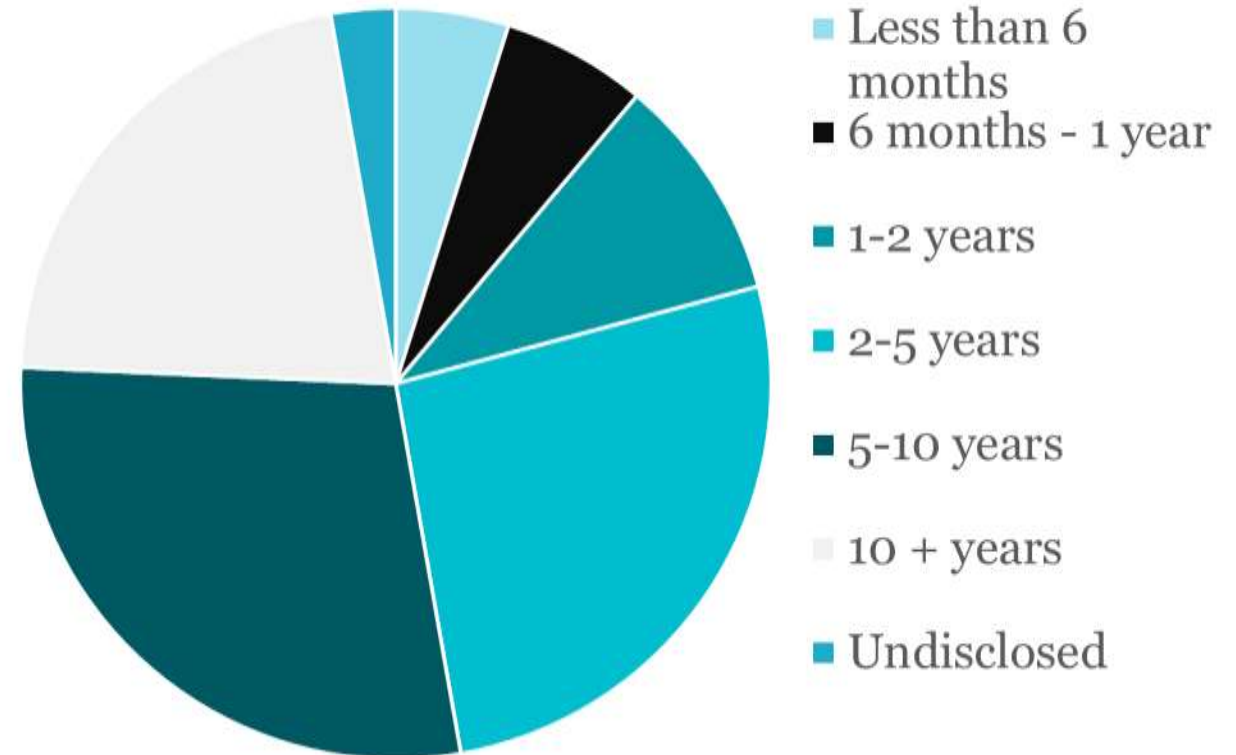


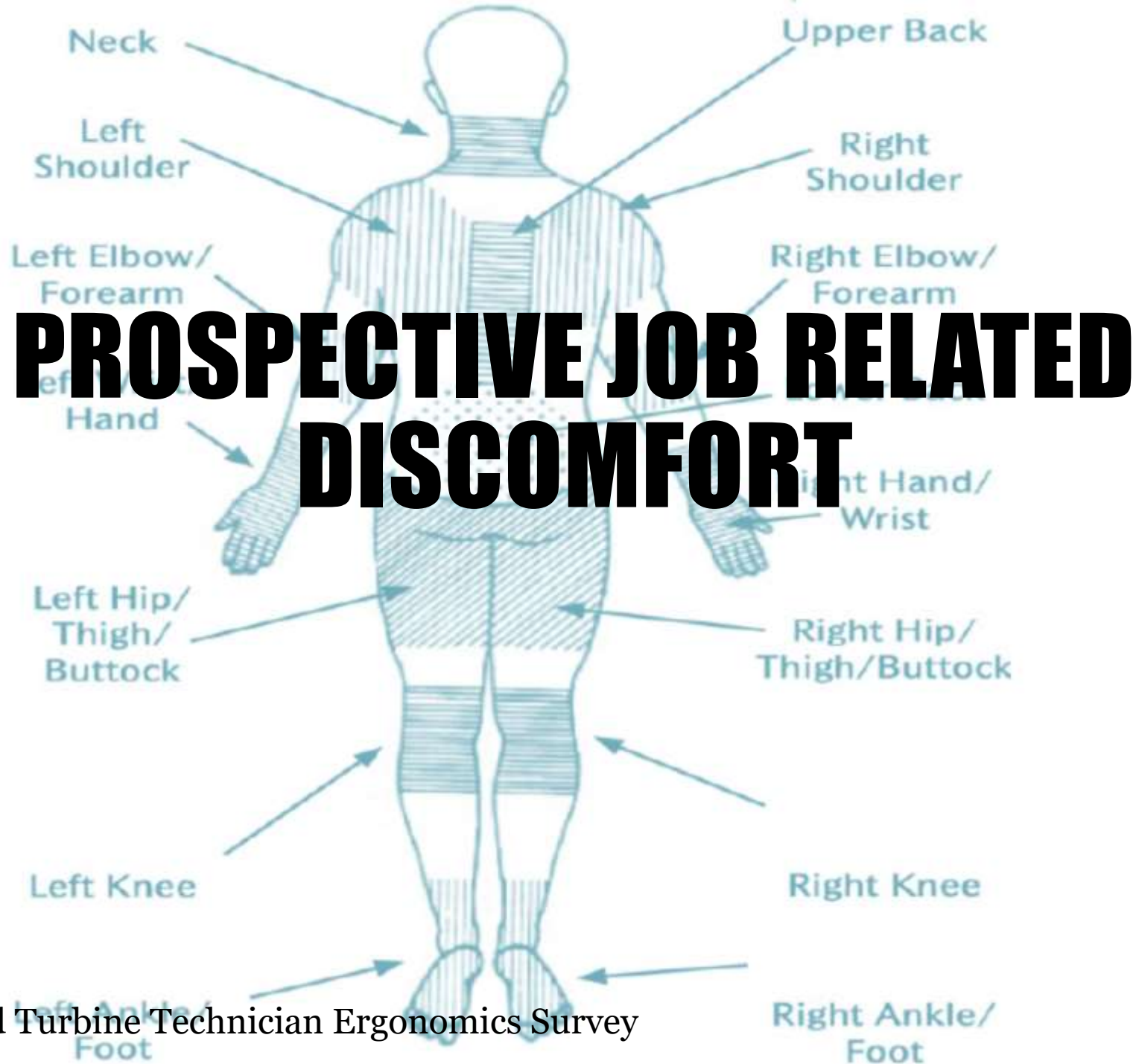
**A**

### Province of work

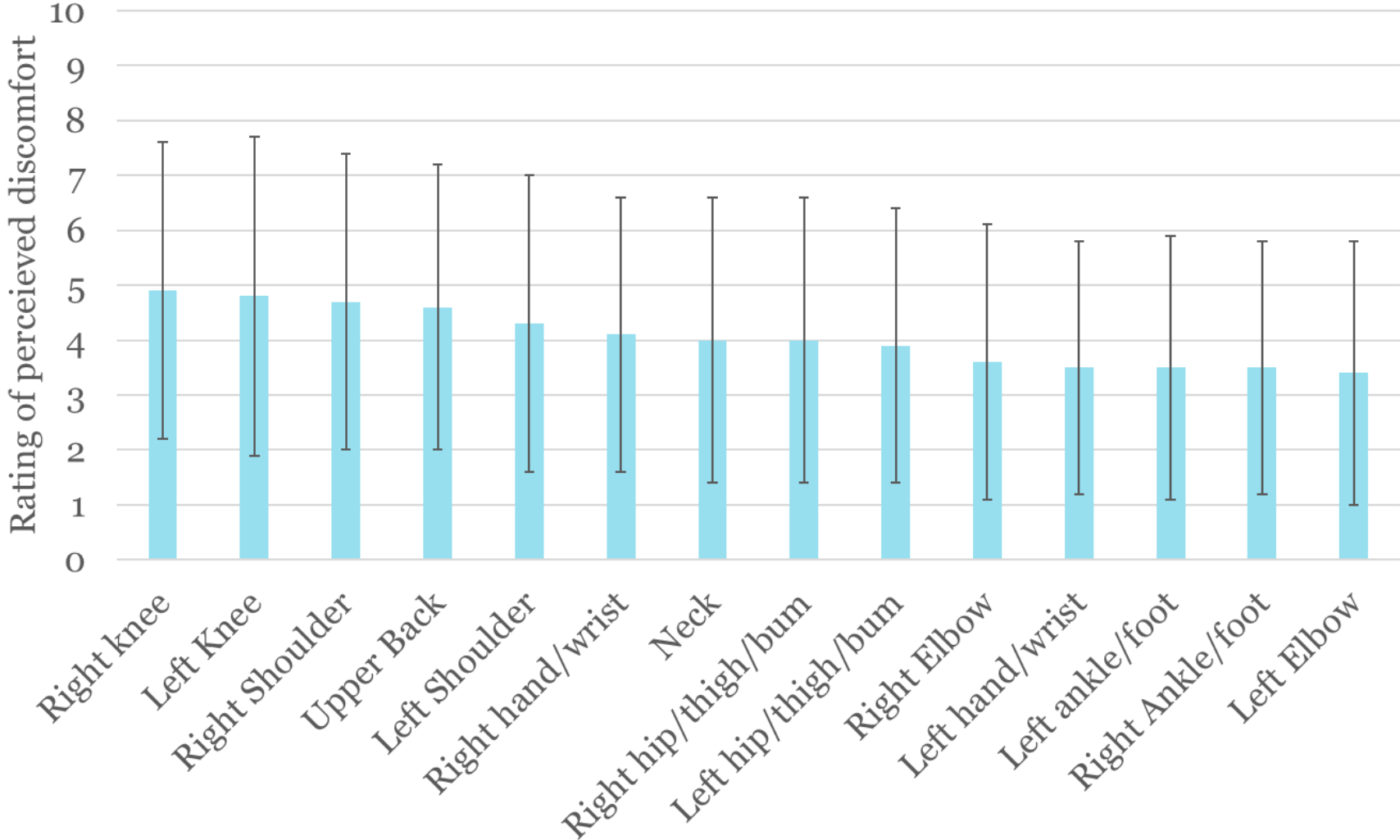
**B**

### Years of experience as a wind turbine technician

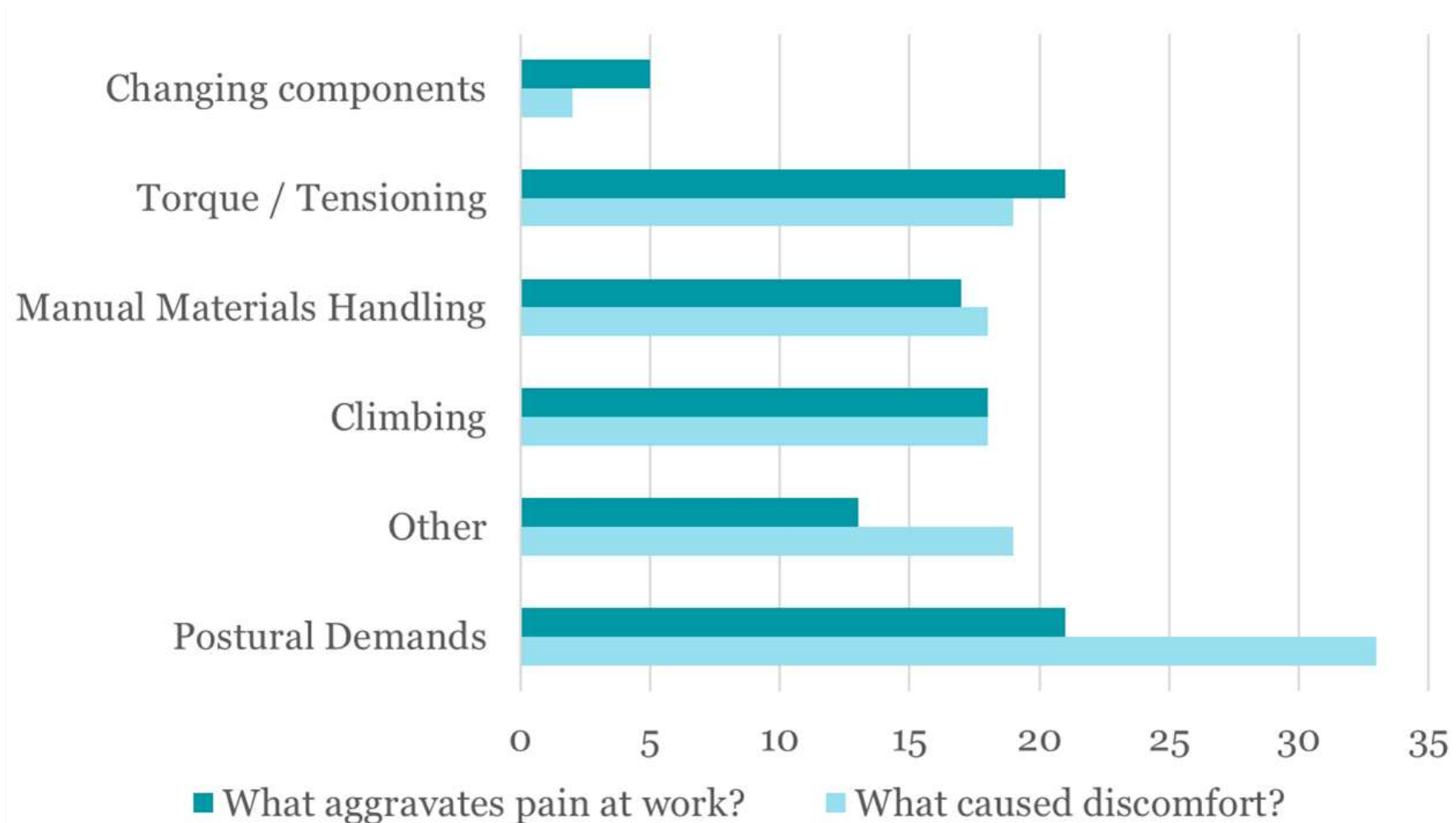




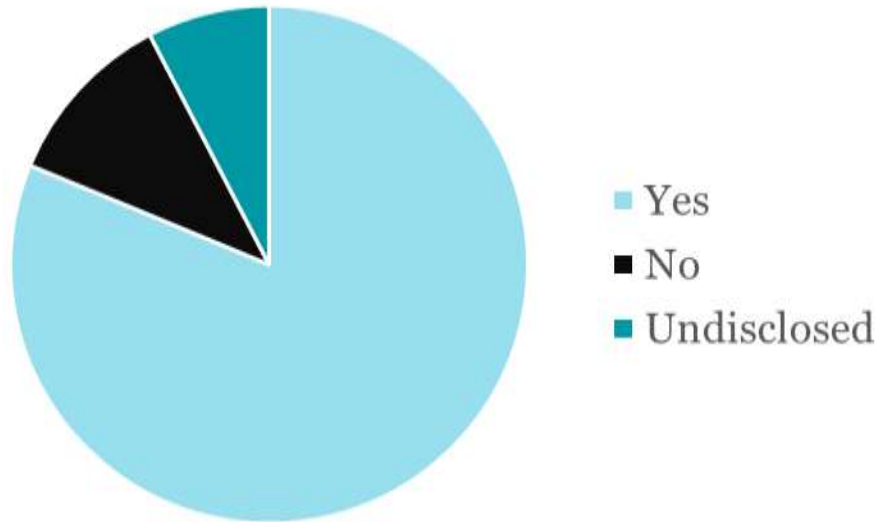
# Considering the last year, rate your discomfort at each location with 0 being no discomfort and 10 being the worst discomfort experienced.



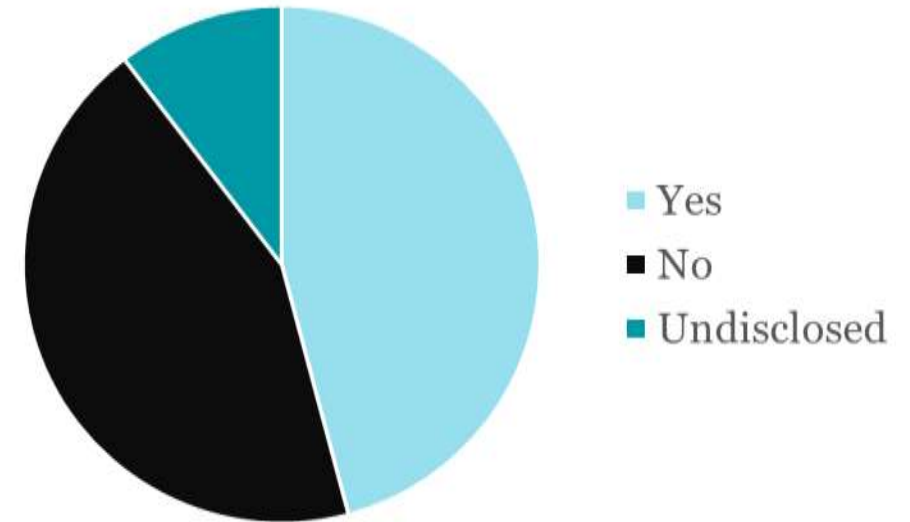
# What likely causes or aggravates your discomfort?



# Have you had pain or discomfort during the last year that you feel is job related?

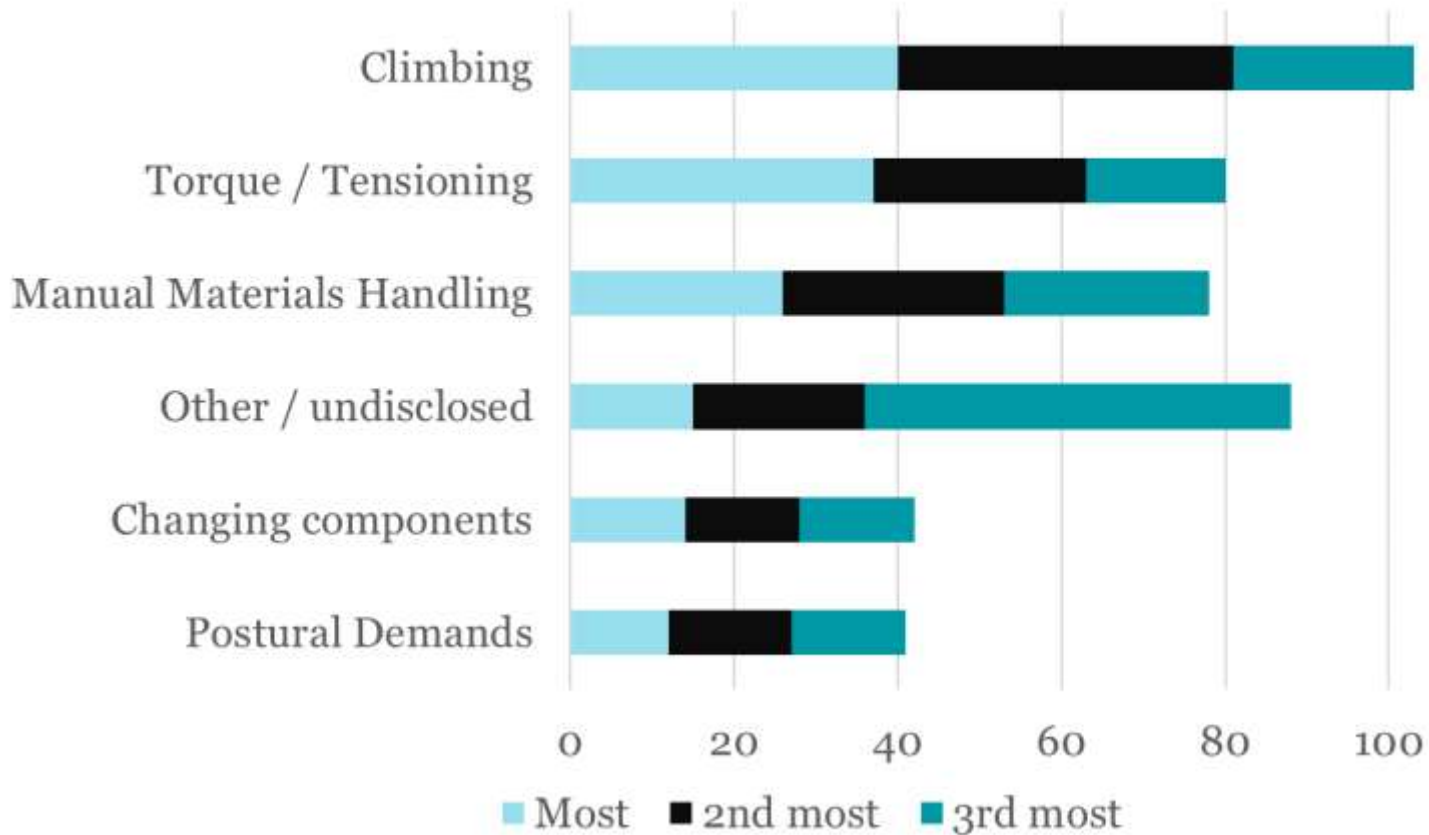


# Do you consider your discomfort to be a problem?



# **PHYSICALLY DEMANDING JOB TASKS**

What are the top three physically difficult task you perform at work ranked?



**Open ended response (examples below) were recoded into 1 of six themes**

*“Climbing with safety gear on (50 lbs of gear)”*

*“Yaw spring pack torquing”*

*“Lifting bags through crane hatch and into the nacelle.”*

*“hub work”*

*“changing main component gear box, main shaft , blades, blade-bearings”*

*“working in awkward positions, i.e. above head”*

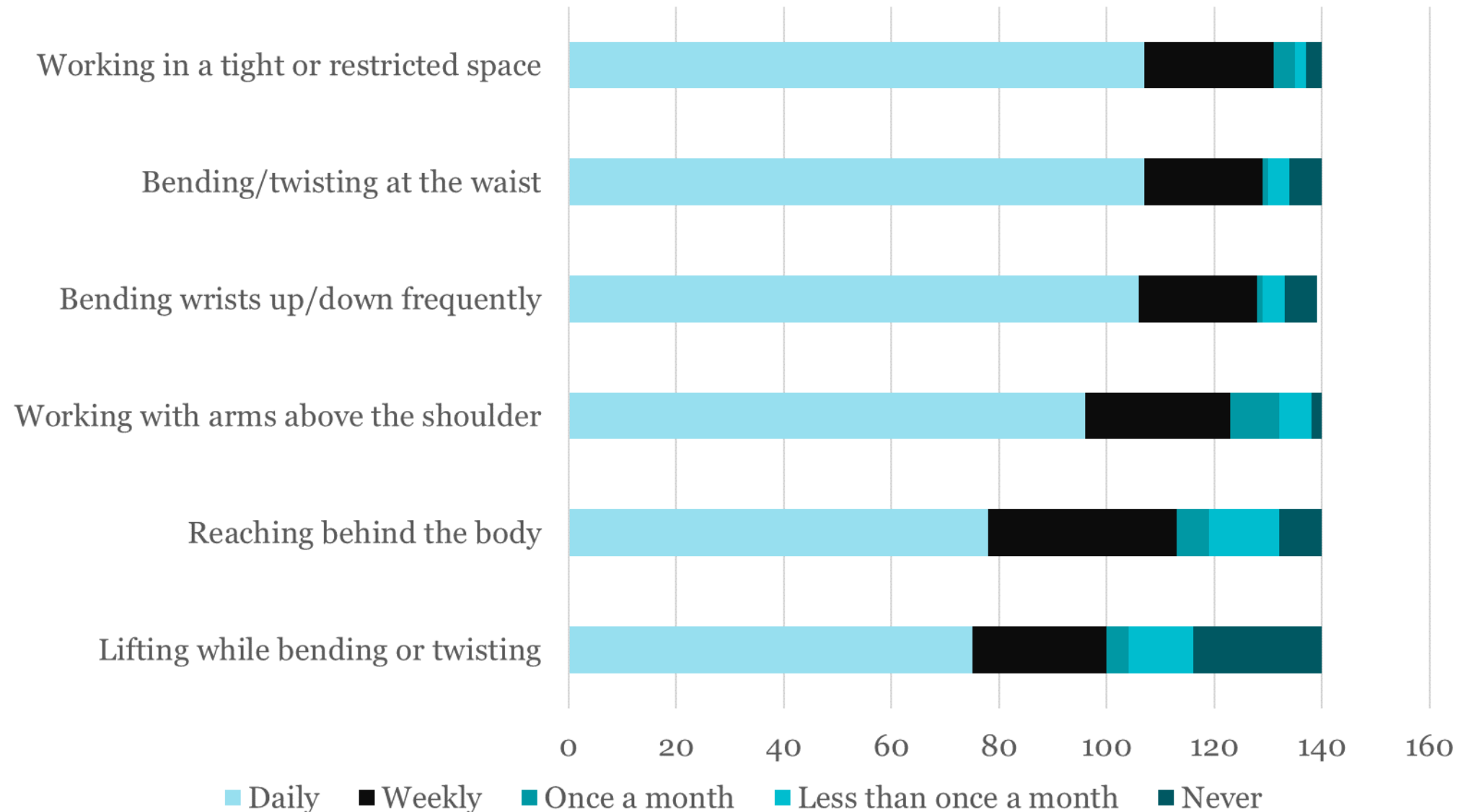
# Some torqueing / tensioning examples



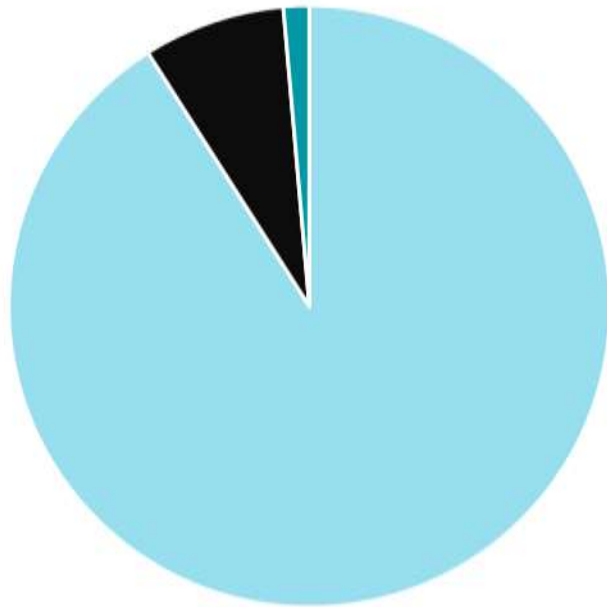


# **ERGONOMIC HAZARD IDENTIFICATION**

# How often do you perform any of the following tasks as a part of your job?

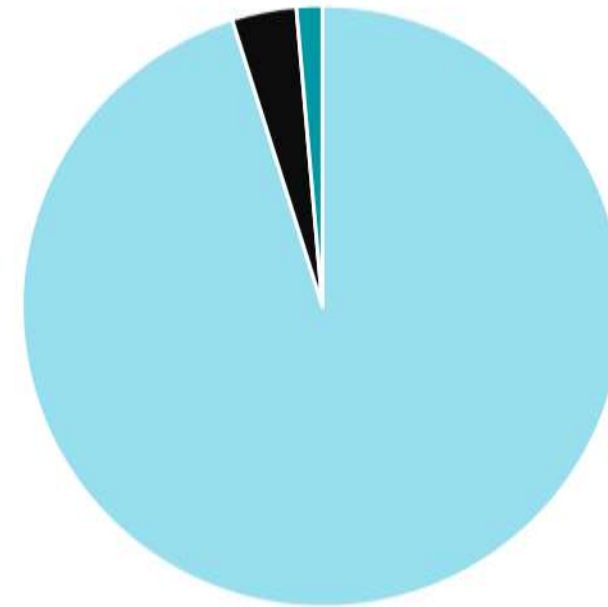


**Do any of your job tasks require you to repeat the same movements or actions more than a few times a minute for more than 30 minutes at a time?**



- Yes
- No
- Undisclosed

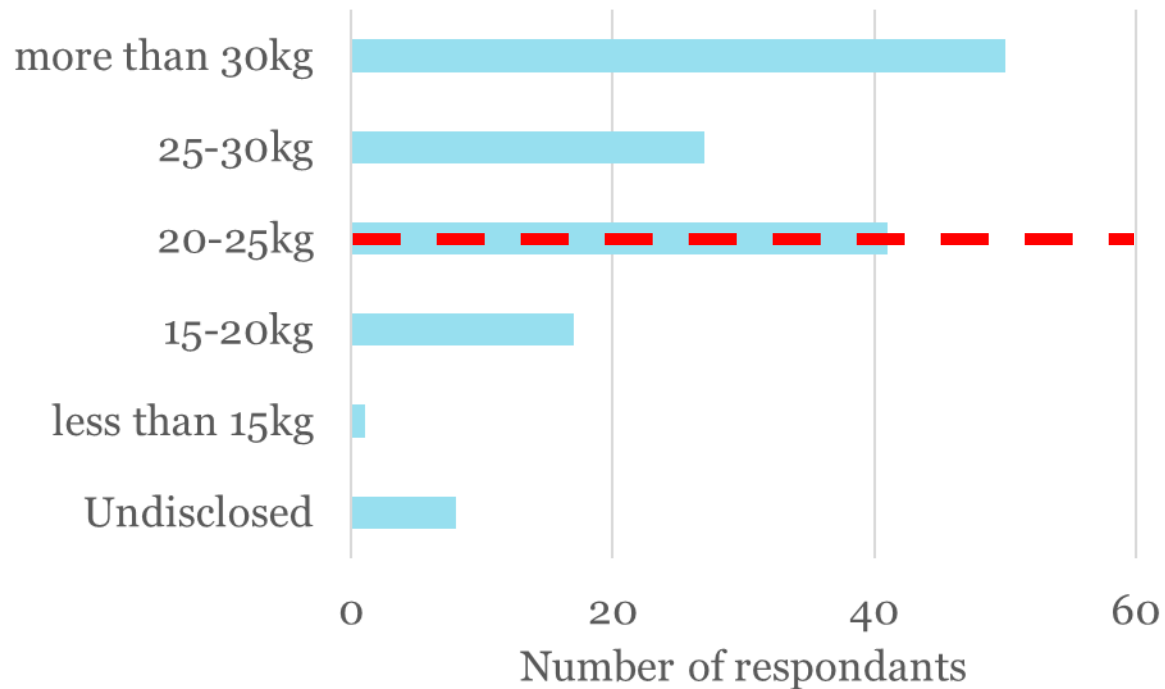
**Do any of your job tasks require you to lift, push, pull, or move heavy items?**



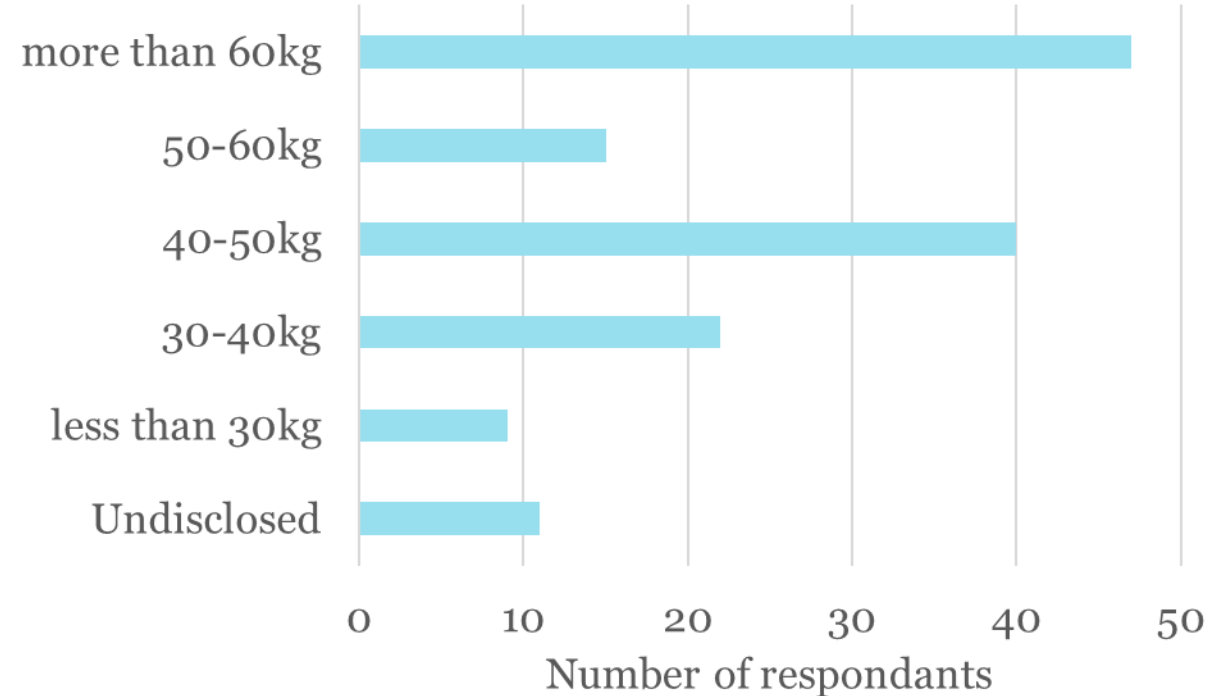
- Yes
- No
- Undisclosed

# What is the approximate weight of the heaviest thing you lift, push, pull, or move:

by yourself



as a team

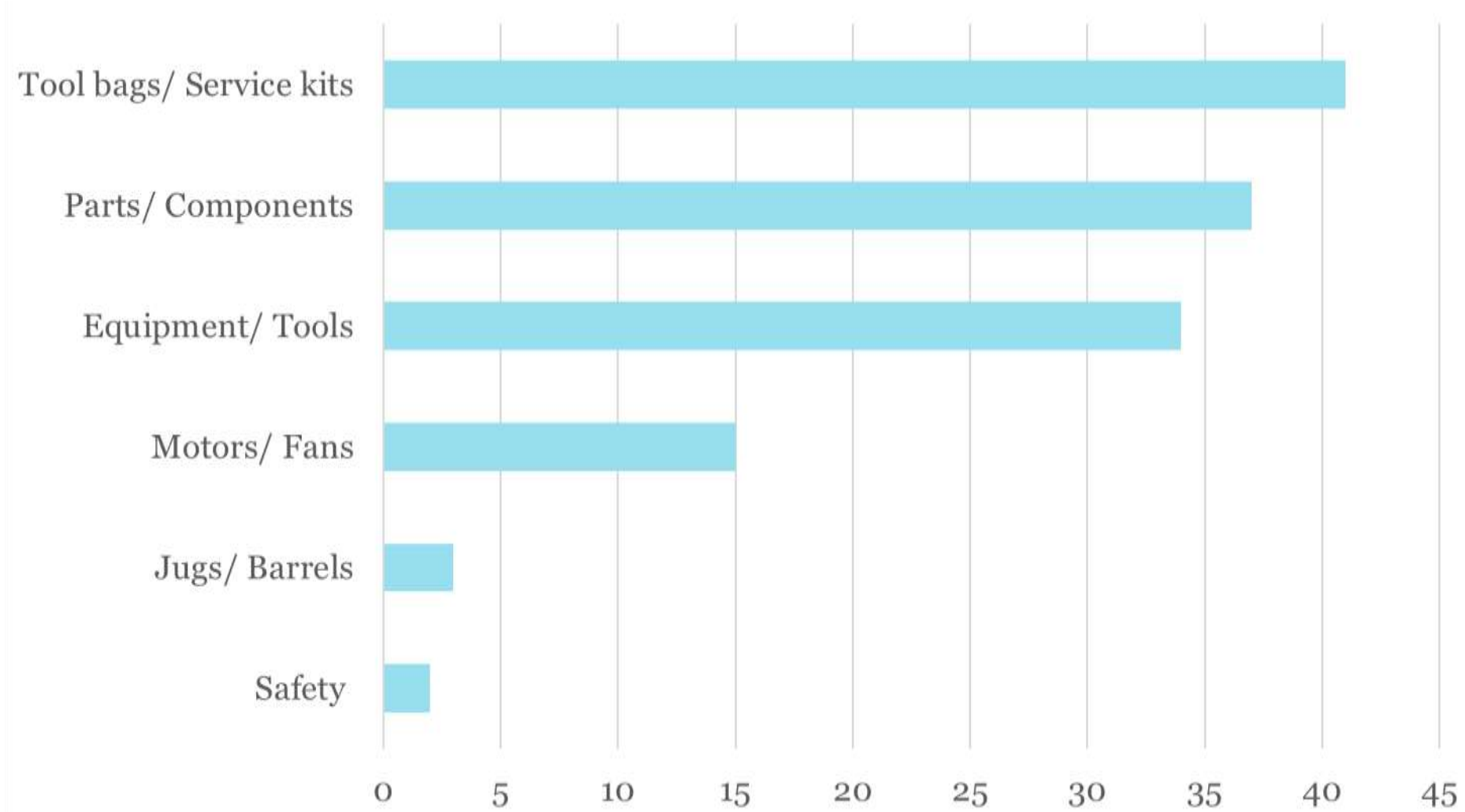


Under ideal conditions the maximum recommended weight limit for a single person lift is 23 kg

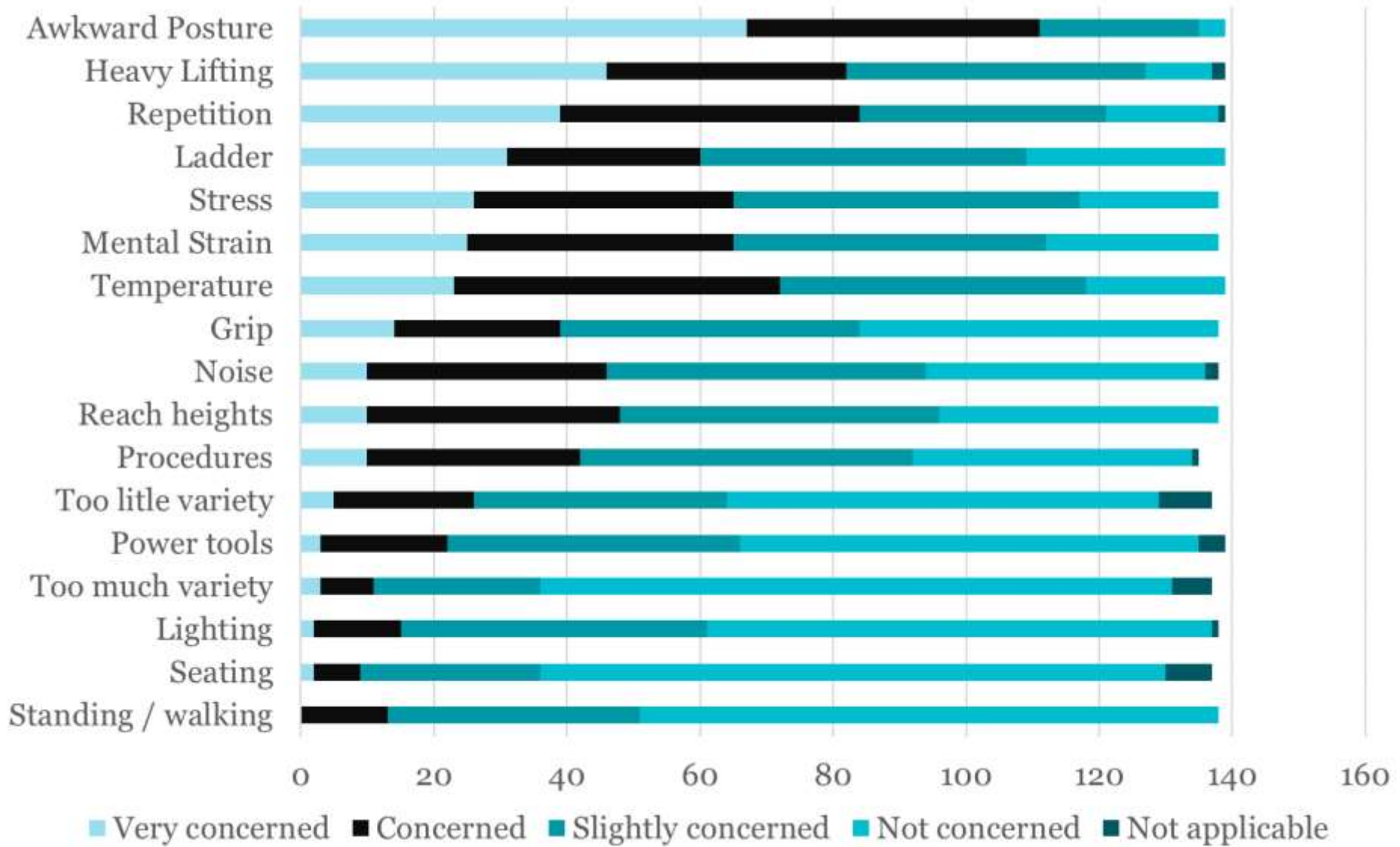
<https://www.msdpreservation.com/resource-library/niosh-lifting-equation.htm>



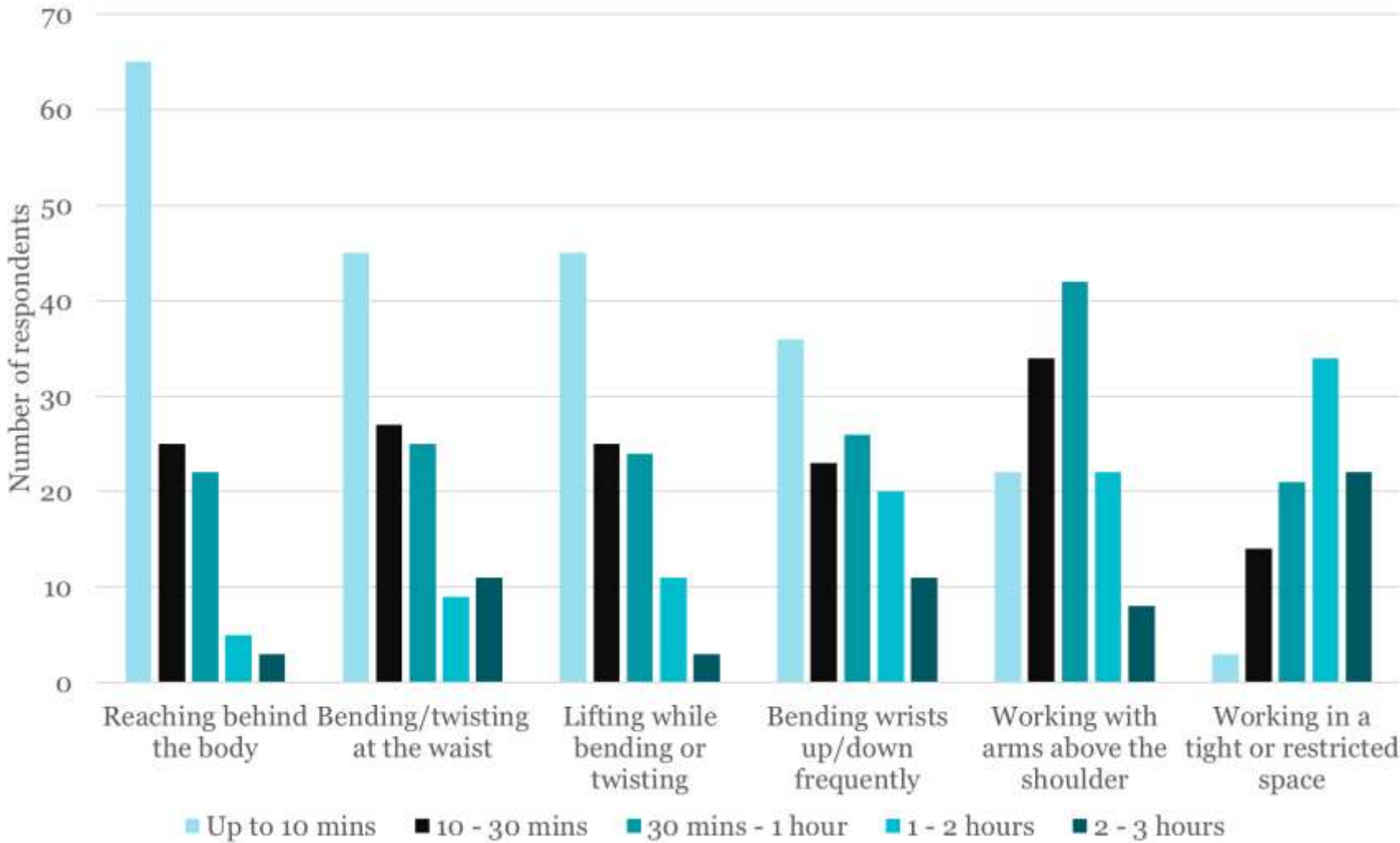
# List the heaviest item that you lift, push, pull or move by yourself.



# Rank your level of concern for injury related to each of the following activities.



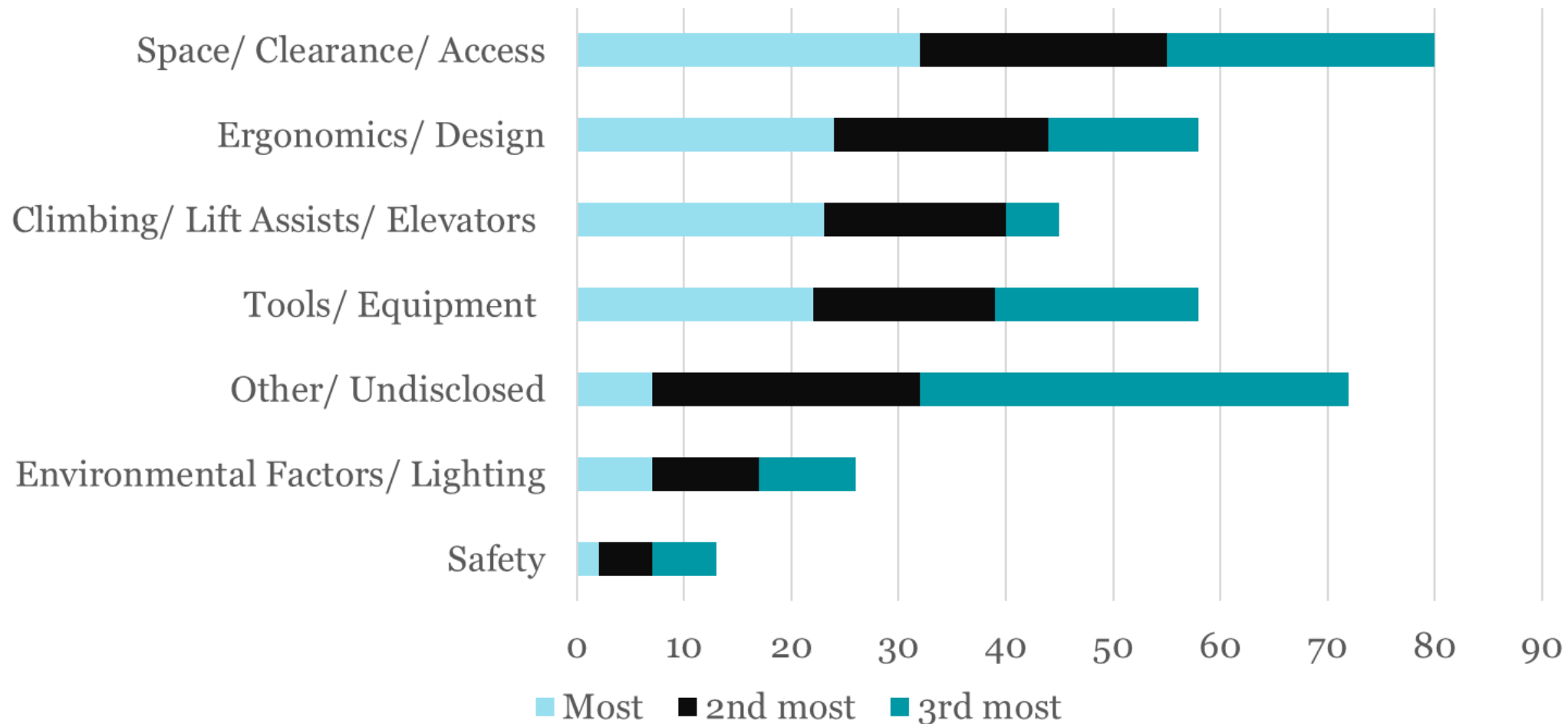
# Duration of exposure to ergonomic hazards.



# **OPPORTUNITIES FOR CONTROLLING ERGONOMIC HAZARDS**



# List three things you would most like to see changed in the design, set-up or organization of the wind turbine.



# Suggestions for changes to the design, set-up, or organization of the wind turbine.

## Space / Clearance / Access

- *“More space to work” / “design systems with techs in mind that they will somehow need to access some hard to reach components” / “larger nacelle so there’s less tight locations” / “Adequate space for work in nacelle”*

## Ergonomics / Design

- *“A different way to get tool bags into the nacelle” / “Locking pin pump location to allow better posture and to use both hands” / “Better designed anchor points for hoisting components”*

## Climbing / Lift Assist / Elevators

- *“Service Lifts Installed in Towers to eliminate Climbing” / “easier to load unload internal crane” / “Service lift mandatory for all new towers”*

## Tools / Equipment

- *“Lighter Tensioning tools” / “more power assisted tools” / “Lifting tools in the nacelle”*

# **WHAT WE'VE LEARNED**

# Physical demands of onshore wind techs share similarities with off shore

## Milligan et al., 2019

1. Transfer from vessel to the turbine
2. Ascent of the tower
3. Manoeuvring through hatches
4. Torque tensioning
5. Hauling a casualty up the turbine

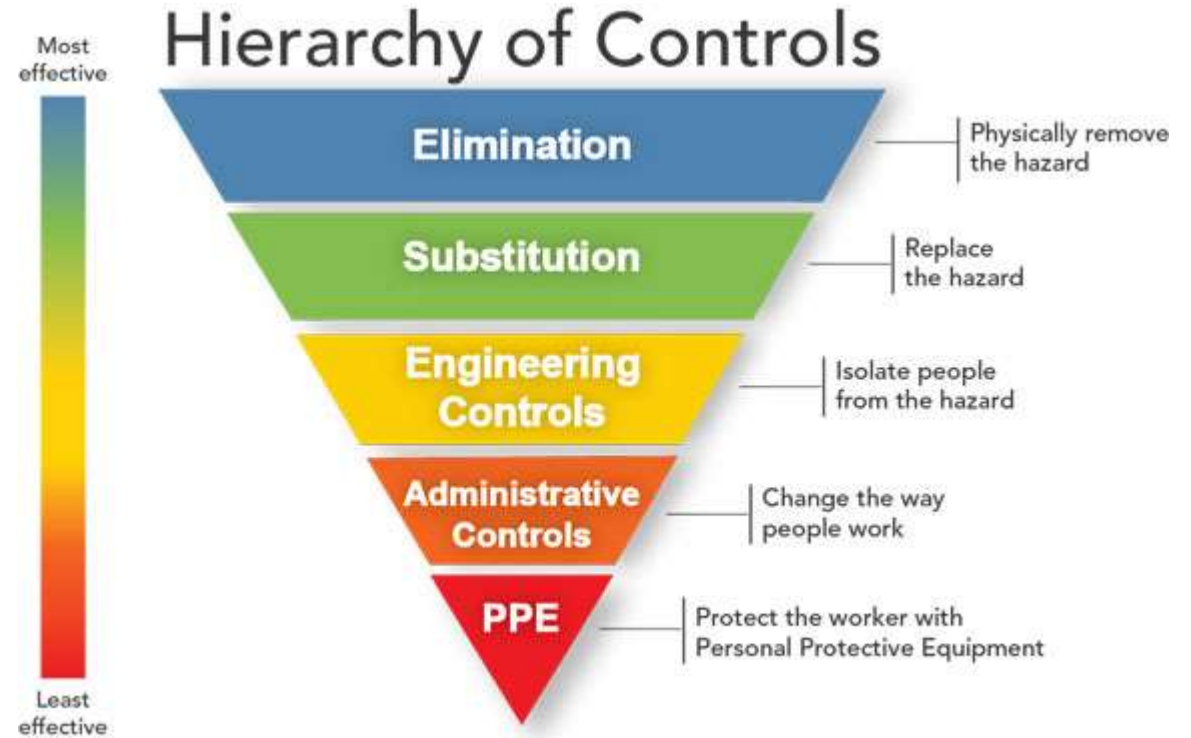
## CanWEA Ergo Survey 2019

1. Climbing
2. Torque tensioning
3. Manual materials handling
4. Changing components
5. Postural demands



# Physical demands + hazard exposure help to prioritize

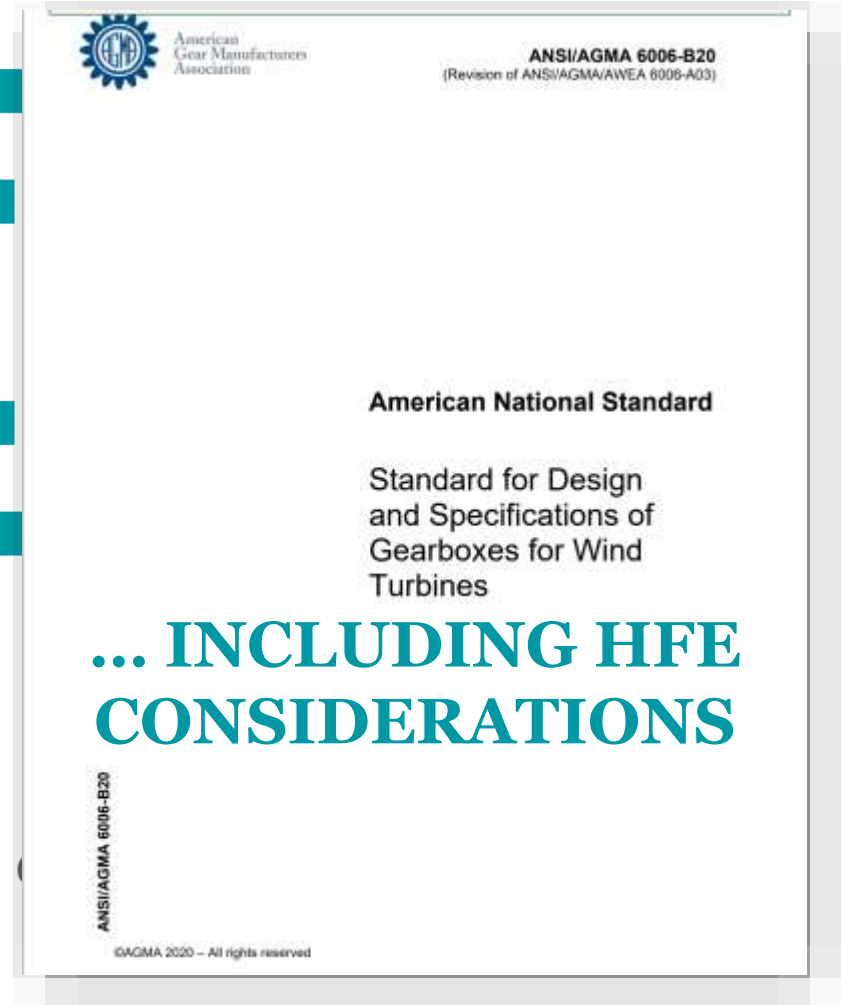
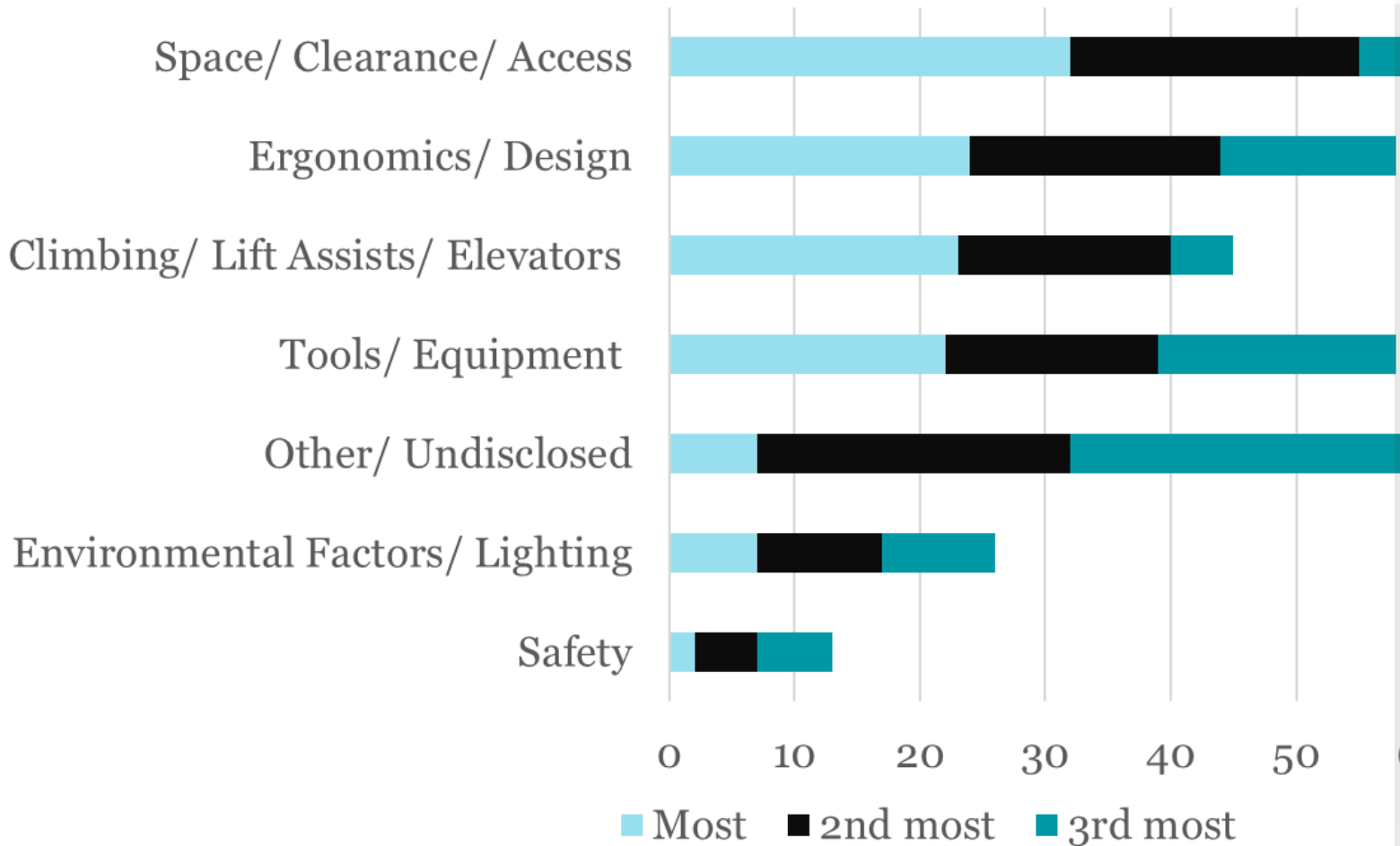
1. Workspace layout and design
2. Torqueing and tensioning tasks
3. Manual materials handling
4. Climbing



<https://www.cdc.gov/niosh/topics/hierarchy/default.html>



# Elimination through better workspace design



# **LESSONS LEARNED #1**

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Wind turbine workspace layout and design is problematic for wind techs.

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## **Opportunities:**

- 1. Review design standards to identify HFE gaps**
- 2. Include OHS and HFE personnel on Standards development committees**

# Engineering lighter torqueing and tensioning tools

Tension head mass (kg)	Lifting requirement
8.5	The 8.5 kg and 9 kg tension heads are often used in line with the shoulder (approx. 1.6 m).
9	This can often require the tension head to be held in a single hand.
13	Generally used horizontally from chest height (approx. 1.5 m). This can sometimes require the tension head to be held in a single hand.
19	These are predominantly used at the Tower Tower section (Fig. 1) of the turbine. The tension head is normally lifted to chest height, using an upright row movement.

Milligan et al., 2019. A job task analysis for technicians in the offshore wind industry. Work.





## **LESSONS LEARNED #2**

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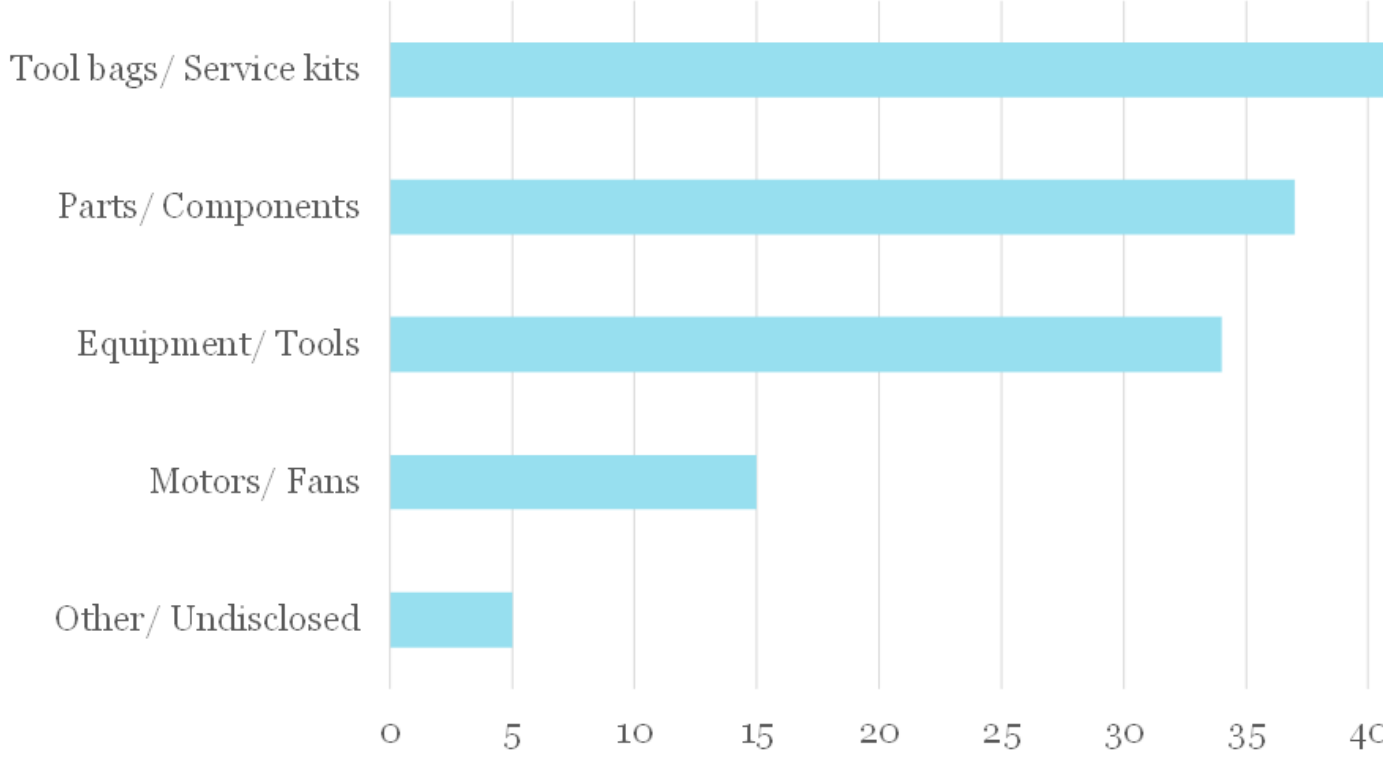
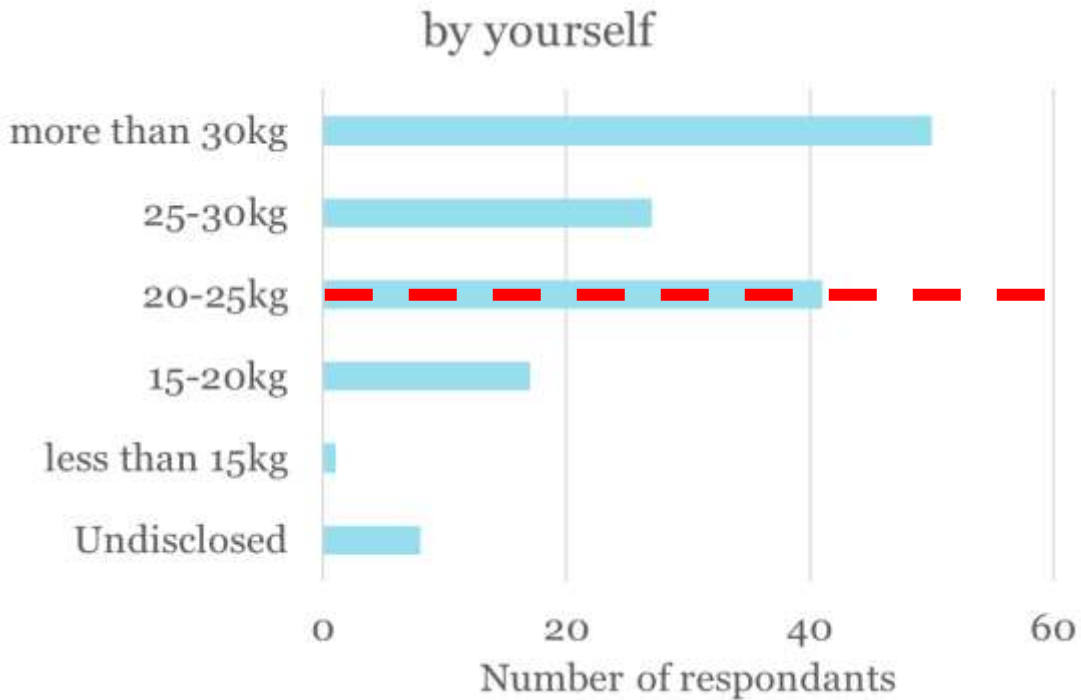
Torqueing and tensioning is problematic for wind techs, possibly due to the mass of the equipment and the physical requirements and MSD hazard exposures associated with use.

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### **Opportunities:**

- 1. Prioritize detailed analysis of torqueing tensioning activities to identify root causes**
- 2. Explore and innovate new tool designs or tool support systems**

# Engineering and Administrative Controls to reduce MMH



## **LESSONS LEARNED #3**

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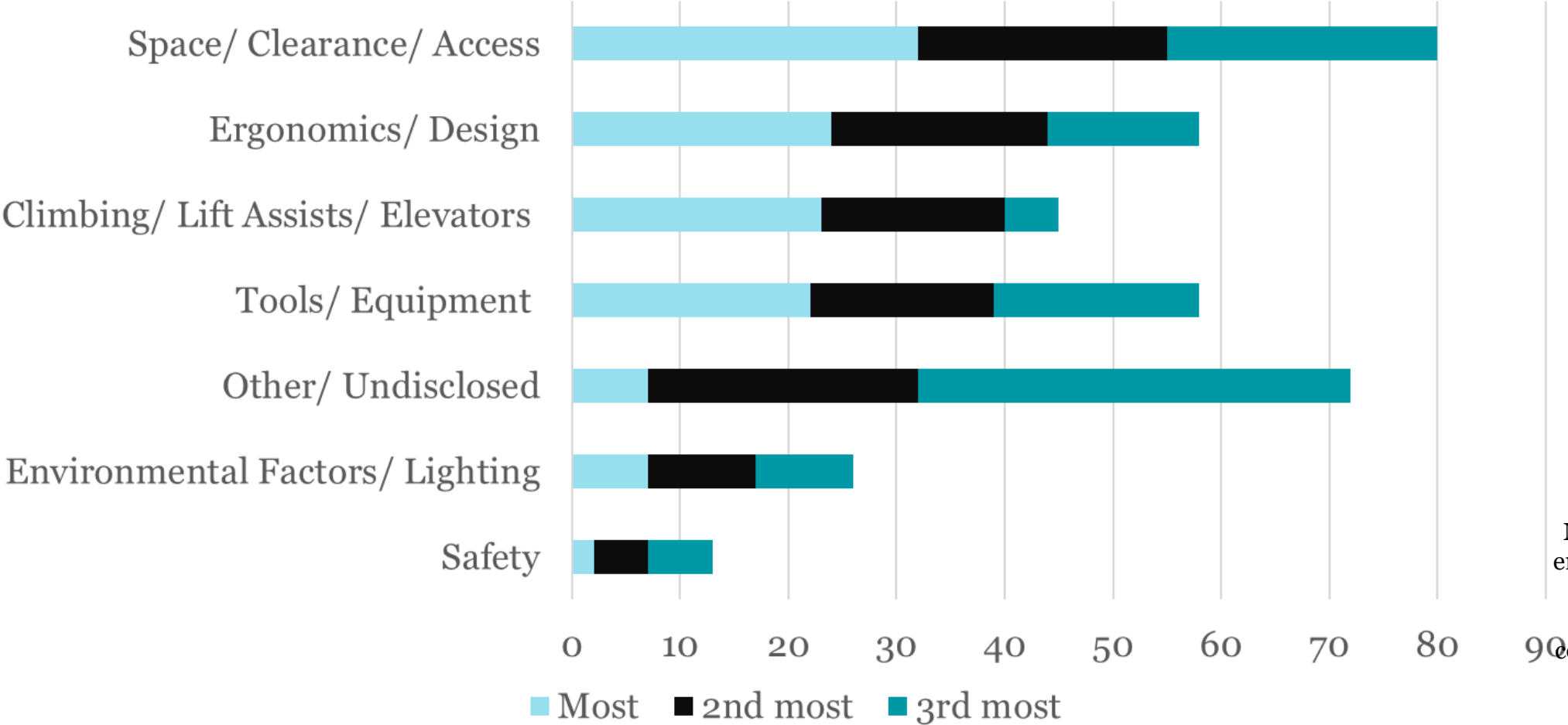
Manual materials handling (MMH) requirements expose wind techs to heavy physical demand and in some cases MSD hazards.

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### **Opportunities:**

- 1. Detail MMH requirements and identify controls to manage risk**
- 2. Explore and innovate new tool designs or tool support systems**

# Elimination and Administrative controls to inform climbing



Milligan et al., 2020. An ergonomics assessment of three simulated 120 m ladder ascents: A comparison of novice and experienced climbers. Applied Ergonomics.

## **LESSONS LEARNED #4**

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Climbing is physically demanding for wind techs.

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### **Opportunities:**

- 1. Explore potential for more elevators / climb assist devices**
- 2. Explore movement coaching and fitness training approaches**

# The work of a wind tech is challenging. How can we help?

1. Review design standards to identify HFE gaps
2. Include OHS and HFE personnel on Standards development committees
3. Prioritize detailed analysis of torqueing tensioning activities to identify root causes
4. Explore and innovate new tool designs or tool support systems
5. Detail MMH requirements and identify controls to manage risk
6. Explore potential for more elevators / climb assist devices
7. Explore movement coaching and fitness training approaches

# Back to Phil for concluding thoughts



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UNIVERSITY OF WATERLOO  
FACULTY OF APPLIED HEALTH SCIENCES