Safety Hazards

Exoskeletons

On this page

What are exoskeletons?

Exoskeletons are wearable devices that can enhance, augment, or assist the user's posture, motion, or physical activity. Exoskeletons can reduce muscular stress in frequently affected body regions, such as the lower back or shoulders, and ease operator discomfort and fatigue. More precisely, exoskeletons would work together with the user's physical abilities to:

- Reduce biomechanical load on the user's joints, muscles, and soft tissues – reducing risk of musculoskeletal disorders (MSDs)
- Reduce the user's metabolic exertion – reducing worker fatigue and risk of overexertion

Exoskeleton systems can be divided into two categories, active and passive.

> **Active exoskeletons** use force and torque-generating elements such as electric motors, pneumatics, or hydraulics to provide additional strength to the user.
>
> **Passive exoskeletons** use levers, springs, counterbalance forces, and other non-electrical means to support the user's posture or movement. Passive exoskeletons redistribute forces to protect specific body regions. The change in user performance results not from additional physical strength, but from the ability to maintain positions over a longer period (e.g., overhead work).

Research on exoskeleton use in the workplace has examined its ability to provide:

- Lower back support: to aid manual material handling tasks including lifting, lowering or carrying heavy loads while maintaining a variety of postures.
- Upper body or upper extremities support: to aid manual above the shoulders work including sustained postures in forearms and upper arms.

- Lower body or knee support: to aid manual ground level work including sustained body postures involving the legs.

Exoskeletons can be considered an ergonomic control measure because they have the potential to address the mismatch between physical demands and human strength or endurance capabilities. Because exoskeletons are wearable, they can also be considered as personal protective equipment (PPE). At the same time, exoskeletons can also be categorized as an engineering control because, similar to material handling equipment, it aims to reduce the user's physical effort in executing a task.

Potential workplace applications of exoskeletons include improving manual material handling and tool use in industrial, construction, healthcare, and personal care industries. Exoskeletons also have the potential to help first responders move larger objects and carry more equipment to facilitate rapid response.

Are there safety standards for exoskeletons?

There is currently no technical or safety standards focused exclusively on exoskeletons. An existing international standard, ISO 13482:2014, "Robots and robotic devices — Safety requirements for personal care robots" addresses safety requirements for personal care robots, some of which may be considered as exoskeletons.

Are there hazards associated with using exoskeletons?

While exoskeletons have the potential to improve certain human abilities and protect worker safety, their use may also introduce new hazards. Potential risks of using exoskeletons include friction and injury from direct contact between the exoskeleton and the user, joint hyperextension, unintended contact, collision, vibration exposure, overexertion, and worker instability. Exoskeletons may also apply uncomfortable pressure on the body or be too heavy for workers to wear comfortably. For example, upper body exoskeletons that are helpful when the worker is performing overhead work may add extra weight that strains the worker's back when they need to bend down.

Some exoskeletons redistribute forces to other parts of the body so workers can hold a posture longer. It is important to make sure that the force redistribution does not cause new health hazards to other parts of the body.

The long-term health effects of exoskeleton use are still being researched. Therefore, it is important for workplaces to be cautious and thoroughly assess the hazards and risks involved when deciding to use exoskeletons.

The additional strength or endurance provided by wearing exoskeletons could potentially encourage workers to take more risks. Workers may try to work for longer periods without breaks or try to handle heavier loads. Workplaces may also be tempted to increase their production targets knowing that exoskeletons can help workers handle heavier loads or work longer before fatiguing.

Exoskeletons can be considered as a type of personal protective equipment (PPE). As with all PPE's, exoskeletons should not be the only control measure considered. Following the hierarchy of controls , PPE's should only be used when other controls such as elimination, substitution, engineering controls, and administrative controls are not possible, or to supplement the protection of other control measures. For example, consider using exoskeletons in combination with job rotation (an administrative control measure) to provide extra protection against musculoskeletal injuries.

What should be considered for exoskeleton safety?

Using exoskeletons requires technology to be in very close proximity to the worker's body.

Avoid over-relying on exoskeletons

Also consider the potential for overreliance on exoskeleton technology. One way to address this risk is developing policies stating that exoskeleton use is not an opportunity for increasing workload or productivity that might negate the additional safety provided by the exoskeleton.

Use exoskeletons in parallel with other control measures

It is also important not to neglect other levels of hazard control. Exoskeleton should not be the only control measure used to create ergonomic work environments. Combine exoskeletons with control measures at the source, engineering controls, and administrative controls to provide a full and layered approach to workplace health and safety. Focus on making the workplace a safe place to work, not only augmenting the worker. When in doubt, follow the hierarchy of controls principle. This hierarchy help workplaces prioritize control methods from the most effective level of protection to the least effective level of protection. Prioritize control measures higher up in the hierarchy before deciding to equip workers with exoskeletons.

At the same time, when work is not tied to a specific location, or when the employer has limited control of the work environment, exoskeleton use supported by safety operating procedures and appropriate work-rest schedules may be helpful. This could apply to workers who predominantly operate at client sites or homes, emergency response services, or even furniture delivery workers.

Involve your workers

Because using exoskeletons could drastically change the way workers perform their jobs, it is important to involve workers in the exoskeleton planning and implementation process. Workers who will be using exoskeletons on a regular basis may have unique insights into what hazards they can help with and what new hazards they may unintentionally create. Workers can also help identify tasks that are best suited for using exoskeletons. Involving workers in the planning and implementation process and giving everyone a chance for input can also encourage positive perception and acceptance of exoskeletons.

Follow continuing research

There is a lot of research that is currently being done to make wearable exoskeletons safer. For example, researchers are developing methods to evaluate the degree to which an exoskeleton can reduce user overexertion and musculoskeletal injury risks. These evaluation methods can allow workplaces to compare between similar exoskeletons based on how much enhancement or augmentation each provides. This research could help workplaces understand the limitations of the exoskeleton and provide information for determining how to work with them in a safe way.

Fact sheet first published: 2022-09-22 Fact sheet last revised: 2022-09-22

Disclaimer