Glove Selection to Minimize Effort and MSD Risk

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A glove must perform its prime function of protection, but poor selection can lead to reduced performance, increase the effort required and increase workers' fatigue and the risk of developing MSD. Manual work with gloves requires greater effort than the same work without gloves. The main reason is decreased maximum grip strength. In fact, when wearing gloves, simply forming a grip can require substantial effort. In the workplace, gloves decrease the duration for which a grip can be maintained. The use of even thin gloves causes a decrease in dexterity and sensitivity, which can result in gripping an object more tightly than with a bare hand. It also increases the time required to perform manual tasks. Gloves change hand posture and effective hand size.

Glove material stiffness and frictional characteristics are key. Thicker gloves are usually stiffer than thinner gloves. One exception is that high friction gloves might allow a person to apply more torque to a smooth metal handle than when wearing cotton gloves. Choosing the thinnest and most flexible glove that still has the required protection is a major goal.

Key Messages

- Manual work with gloves requires greater effort than the same work without gloves.
- Glove material, thickness, stiffness and friction are key determinants of the effort required
- Well-fitting gloves are important for getting the best out of a glove
- Ask why a glove is necessary and where possible redesign the task to be done without a glove

Considerations when designing tasks and processes for gloved users

Concern	Glove Effect	Design Suggestion
Hand protection is required		• Eliminate need for hand protection by changing the environment or equipment
Grip strength decrease & muscle activation increase	↓ Maximum grip strength (70% of max) ↑ Muscle activation	• Design tasks that require lower grip strength: Power grips affected more than pinch grips
Increase in time & effort	↓ Grip duration ↑ Perceived effort	• Minimize the duration of grips required by gloved users. Design tasks that require short exertions with rest breaks in between
Reduced dexterity & sensitivity	↓ Dexterity ↓ Sensitivity	• Design tasks that do not require high dexterity or fine sensitivity, for example, controls with large buttons and switches. • Allot more time for detailed work to be completed.
Handle diameter	↑ Effective handle size Changes hand postures	• Consider smaller diameter handles for thicker gloves.
Bulk	Increases effective size of glove	• Clearances will need to be increased • Length of handles should be increased
Thickness	Thickness magnifies these effects	• Choose the thinnest, least stiff gloves that still offers the required protection
Poor hand-object interface	Gloves change hand-object friction	• Choose gloves that help the user perform manual tasks. • For example, choose leather or rubber gloves that help workers turn a smooth, metal handle if required.
Rubber glove allergies	Contact dermatitis	• Choose powder-free alternatives with similar mechanical properties. • Limit exposure, use cotton liners or wash hands after wearing
Cut and puncture resistance in rubber gloves	Contact with harmful chemicals or pathogen transmission	• Wear double gloves, triple gloves, indicator gloves or knit liners between layers of gloves
Cold exposure	↓ Hand temperature ↓ Dexterity ↓ Tactility	• Choose thicker, more insulating gloves but recognize their impact on fatigue and capability. • Consider gloves with liners, heated gloves, or heating the body during exposure. • When little finger temperature reaches 15ºC, warm hands.
Vibration exposure	HAVS, VWF ↑ Numbness and pain ↓ Sensation	• Consider tools with less vibration. • Choose ISO approved anti-vibration gloves that reduce transmission at the relevant frequency. • Expect changes in vibration absorption with age. • Remember that gloves do not eliminate vibration exposure.

Glove fit is important and plays a role in effort. Poorly fitting gloves, especially if too small, can cause additional strength loss over and above that of the glove alone. Fit at the fingertips is considered critical for precision work and becomes more important with thick gloves. People may choose smaller gloves than is desirable to get a better fit at the fingertips. Layering may improve protection but simultaneous increases thickness which leads to a decrease in capability. This effect can be further compounded by the poor fit of one glove over another.

Implications for the Prevention of MSD

- The grip force required to perform a task is the primary risk factor for development of MSD of the hand and forearm
- Reducing the effort required of a worker by careful selection of a glove is an appropriate MSD preventive action

Surgical gloves are worn to protect both the patient and the clinician from cross infection. Thicker (orthopaedic) gloves, double and triple gloving, glove liners, knitted gloves and indicator gloves may be worn. A single orthopedic glove is equivalent to a double standard glove. Glove liners can be engineered to resist cuts – and may include, polypropylene, Kevlar or fine stainless steel woven fibres. For all types of liner, a glove ½ to one size larger should be used for the outer latex glove. Thicker gloves do appear to affect sensory feedback more than motor performance. Where sensory feedback is less critical, thicker gloves may be more tolerated. Discomfort due to sweat may be reduced by wearing well-fitting, thin cotton gloves /liners underneath the latex glove. Textured gloves, especially those that are powder-free, have been found to offer improved handling of instruments and sutures over standard smooth glove in both wet and dry conditions[2].

For cold exposure, insulating gloves, gloves with liners, mitten style gloves, fingerless gloves with a retractable mitten cover, heated gloves, and heating the body during exposure may be considered. Considering the entire hand and forearm, the little finger is most susceptible to reduced temperature with cold exposure. Hand skin temperatures of 15ºC have been associated with a marked decrease in dexterity while skin temperatures of 5-7ºC are associated with extremely cold pain sensation and temperatures of 0ºC lead to a risk of freezing cold injury[3]. Correct sizing is important. Even with these precautions, breaks to warm the hands when they get cold are necessary.

Use of vibrating hand tools has been associated with hand-arm vibration syndrome (HAVS) including vibration-induced white finger (VWF). Anti-vibration gloves have been shown to reduce changes in finger blood flow and surface temperature with vibration exposure[5]. Matching the frequency of vibration of the tool being used to properties of the glove can help to minimize vibration transmission. Anti-vibration gloves have different effectiveness at the fingers and the palm, reducing the transmission of vibration approximately 20% more at the fingers. As anti-vibration gloves age, their ability to reduce the transmission of vibration decreases. Vibration transmissibility of gloves is addressed by ISO 10819:1996[5].

Conclusion

Designing tasks for a gloved user and wearing the most appropriate glove will reduce fatigue, risk of developing MSD and increase a worker's capability.

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