CRE-MSD Centre of Research Expertise for the Prevention of Musculoskeletal Disorders

Overhead Work – Reduce the Injury Risk

Kayla M. Fewster & Clark R. Dickerson

Overhead work is classified as working with the hands above shoulder height. This type of work is strongly linked to the development of shoulder injuries and pain [1–5]; jobs that require overhead work are 2 to 3 times more likely to have shoulder related injuries. Working at arm elevations of 90 degrees or more for more than 10% of a work shift can double the risk of developing a shoulder injury [6,7]. As well, higher lifetime exposure to overhead work and age strongly relate to increased shoulder injury risk [7,8]. Throughout the scientific literature, overhead work is linked to numerous negative side effects including increased intramuscular pressure, impaired circulation, increased muscle activity and fatigue development [4,9–11].

Key Messages

- Overhead work is a known MSD risk strongly related to the development of shoulder injuries
- Whenever possible, overhead work should be completely eliminated
- When overhead work tasks must remain, careful job design can help lower MSD injury risk

Despite ergonomic improvements within workplaces attempting to control for overhead work exposures, many tasks still require workers to perform overhead work [5,12]. While it is **preferable that all workplaces eliminate overhead work completely**, in instances where overhead work must remain, careful job design and evaluation can help to lower MSD injury risks associated with overhead work.

Reducing MSD Injury Risk

Four main factors have been proposed to modify effects of overhead work and as a result influence injury risk. These include: **(1) Task Design**, **(2) Fatigue Accumulation**, **(3) Bone Motion** and **(4) Muscle Capacity.** Modifying these factors can either increase or decrease the risk of MSD while completing overhead work tasks.

(1) Task Design: Six factors cause changes in demands in the muscle surrounding the shoulder when completing overhead work:

1. **Direction of Applied Hand Force** [13,14]
2. **Vertical Reach Distance** [13,14]
3. **Horizontal Reach Distance** [13–16]
4. **Amount of Arm Elevation** [13–19]
5. **Amount of Applied Hand Force** [20] [21] [18][19]
6. **Precision Required to Complete the Task** [17]

Across all six factors, **direction of applied hand force** is the most influential factor in reducing injury risk during overhead work. Applying forces in-line with gravity (i.e. the downward and vertical direction) results in the lowest muscle demands [14]. The maximum force you can produce is also greatest in this same downward-vertical direction (i.e. you are strongest in the downward direction) [22,23]. Therefore, when overhead work tasks must be completed, changing the direction of applied hand force can be used as a method to reduce injury risk. In addition, decreasing any of the above-mentioned factors in combination with applied hand force direction would decrease injury risk (such as decreasing the horizontal reach distance, or the magnitude of applied hand force required to complete a task).

(2) Fatigue Accumulation: Numerous scientific studies have demonstrated that arm elevation increases fatigue development within the shoulder complex. In addition, increases in the required hand force to complete a task, greater tool masses (i.e. the use of heavy tools) and/or high precision type tasks (e.g., electrical wiring) during overhead work, further increase shoulder fatigue accumulation [21,24]. Within ergonomics, duty cycle is an important metric to highlight cautionary considerations for repetitive work tasks. Duty cycle defines the portion of a task cycle in which effort is exerted, where 1.0 represents 100% of the cycle. So, for example, if you performed a task that required you to grip a tool for 5 seconds out of a task that repeats every 10 seconds, your duty cycle would be 0.5. General guidelines have been developed and state that for two-hour shifts

which require overhead work, **tool masses greater than 1.25 kg should be avoided as well as duty cycles greater than 50%** [20].

Lastly, there is also evidence suggesting that how a task is carried out may influence how quickly fatigue accumulates in the shoulder. Overhead work endurance times can be up to 25% longer when using shorter cycle times [25]. For example, for a repetitive work task that takes 2 minutes total to complete and 1 minute of that time is spent doing overhead work, it may be beneficial to break that one minute of overhead work time into multiple chunks over the 2 minutes rather than completing it all at once [25]. Overall, **decreasing hand force/tool mass**, **duty cycle** or **overall cycle time** during overhead work are all methods that can be used to decrease shoulder MSD risk when completing overhead work tasks.

Implications for the prevention of MSD

When overhead work must be completed:

- apply force in-line with gravity, either up or down
- decrease hand force/tool mass, duty cycle and/or overall cycle time
- keep the upper arm below 60 degrees of elevation
- rest often

(3) Bone Motion: Overhead work postures may cause reductions in the size of the **subacromial space** (i.e. the space between the upper arm bone and the top edge of the shoulder blade). This is an important consideration as the supraspinatus tendon (part of a rotator cuff muscle) must pass through this space. This tendon is the site of most initial rotator cuff injuries, including tears and tendonitis. The subacromial space decreases as the arm is elevated and is smallest when the arm is elevated between 60-90 degrees of elevation [26,27]. Impingement or squeezing of the tendon between the bones (a common consequence of overhead work), is most common between 95-106 degrees of elevation [28]. Therefore, it is recommended that the upper arm is kept below 60 degrees of elevation.

(4) Muscle Capacity: Regardless of task design, overhead work fatigues muscles in the shoulder quicker than non-overhead work. In general, muscles that surround the shoulder complex are less effective when arm elevation exceeds 60 degrees. Thus, completing a task overhead requires more muscle demands than a similar task at a lower elevation and this can lead to faster muscle fatigue development. The shoulder largely relies on muscles for joint stability. Fatigued muscles can influence job performance, decrease joint stability and lead to a greater risk of MSD [9,10,29–35]. Fatigued shoulder muscles, in particular those of the rotator cuff, are less capable of maintaining the position of the upper arm bone in its joint. This results in the upper arm bone moving upwards and further reducing the size of the subacromial space [9,31–34], placing vulnerable tendons at risk [36]. Therefore, resting often when completing overhead work tasks is recommended, so muscles surrounding the shoulder complex have time to recover.

Conclusion

Overhead work is a known MSD risk factor. When overhead work can be eliminated from a job task, it should be. When overhead work must remain, careful job design and evaluation can help lower the MSD injury risks associated with overhead work. Specifically, when completing overhead work tasks, avoid reaching far from the body, keep the upper arm below 60 degrees of elevation, avoid high precision tasks, apply forces in-line with vertical motion, and rest often.

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