Ergonomics

MSD Risk Factors – Forceful Exertions

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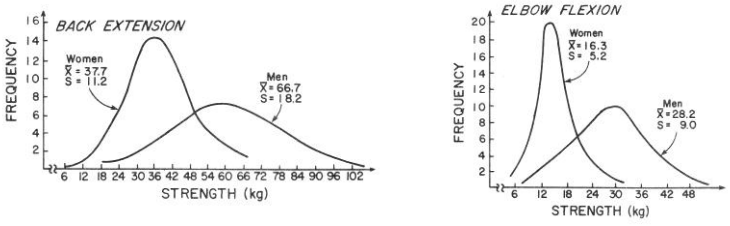
Definition

In the last newsletter, manual tasks were described as any task that requires workers to ***lift, push, pull, carry, move, manipulate, hold, pound, or restrain*** an item. Forceful exertions, which may occur when these manual tasks are done, occur when a lot of physical effort is needed to do a task.

For exertions to be considered forceful, the magnitude of the force must be compared to the maximum capabilities of the specific body part exerting the force. For example, the small muscles of the hand and forearm may be injured by relatively small forces, especially if the task is executed at extremes of the range of movement at a joint, as compared to the force level resulting in injuries to larger muscle groups, such as the leg or back muscles.

Also, the capability of the individual performing the work must be taken into consideration when assessing the MSD risk. In general, muscle strength varies among individuals, with women having less strength than men, although there is some overlap, as shown in the graph below.



Back extension and elbow flexion strength of males and females (Kamon E and Goldfuss AJ (1978). In-plant evaluation of the muscle strength of workers. *Am Ind Hyg Asssoc J* 39:801-807.)

Therefore, overexertion depends on the magnitude of the force being generated relative to the capabilities of the body structures, which will vary among individuals because of individual differences in strength capabilities.

Indicators of Forceful Exertions

Because it is not possible to establish specific force levels that would be classified as forceful exertions, it is necessary to be aware of indicators of forceful exertions. One such indicator is fatigue. If the exertion cannot be sustained and fatigue occurs quickly, then the exertion is probably a forceful exertion. Usually, the faster fatigue occurs, the greater the exertion. This happens quickly when static postures are required.

High speed or jerky movements, such as hammering or throwing objects, are an indication of elevated risk. High speed implies high acceleration, which in turn implies high force, especially if the speed is achieved or stopped in a short time. Such movements are an indication of initial high exertion of the body parts involved. This also includes rapid changes in the direction of movement. If a worker combines a high-speed or jerky motion with a manual task, then the exertion probably is near or exceeds the maximum ability of the worker, particularly if the high speed is needed to complete the task. For example, when a worker is lifting an object that is near his maximum lifting ability, he may throw or swing the object instead of using controlled movements.

Another indicator of forceful exertions is using a technique that is not typical for performing that manual task. An example would be using a knee to help support an object when lifting. Also, if a person uses their back muscles rather than their leg muscles to lift a heavy object, this may be an indicator that his/her leg muscles are not strong enough to perform the lift.

Indicators of Forceful Exertions

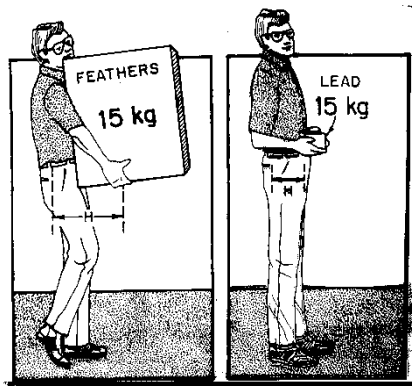
- Fatigue
- High Speed or Jerky Movements
- Inappropriate Techniques

QA Tech swings sample bucket to compensate for a lack of muscle strength needed to lift the bucket into the truck.

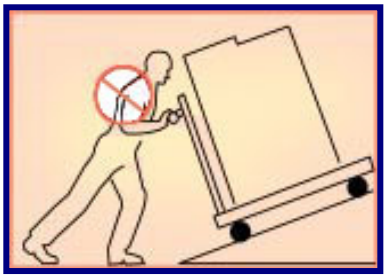
Worker using his knee/ thigh to lift a 100 pound bag.

Factors Affecting Force Levels

The weight of an object is usually a good indicator of the force needed to lift an object. Generally, the higher the weight, the greater the exertion required. Another important factor in determining how much force is needed is where the hands have to hold the object relative to the lower back muscles. The greater the distance the hands are from the back muscles, the greater the exertion. For example, is more force required to lift 15 kilograms of feathers or 15 kilograms of lead? One would think the same force level would be exerted, but

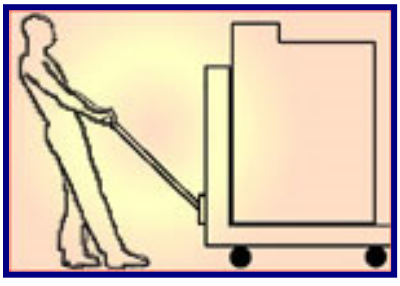


because the box of feathers is much larger than the box of lead, the distance from the back muscles to the hands is much longer for the box of feathers, and greater exertion is needed to lift and hold the box of feathers. If the distance from the back muscles to the hands holding the box of lead was 10 inches, the force exerted by the back muscles would be 75 kilograms, or 165 pounds. On the other hand, if the distance for the box of feathers was 20 inches, then the force exerted by the back muscles would be 150 kilograms, or 330 pounds!



Similarly, if the task involves pushing or pulling a load, the force needed to complete this manual task will depend not only on the weight of the load being moved, but also on the frictional properties of the load and the surface. If the surface has bumps and depressions, greater force will be required to move the load. Another factor affecting the force needed to push or pull a load is the slope of the surface. Obviously, more force is needed to push a load uphill than on a level surface or downhill.

Other factors that affect the level of exertion when lifting includes the presence/type of handles, the vertical distance of the lift, the vertical location of the hands at the start of the lift, how far the object is displaced from the center of the body, the frequency of the lifts, and the stability or slipperiness of the object being lifted. Additional information about these factors can be found in *Applications Manual for the Revised NIOSH Lifting Equation (http://www.cdc.gov/niosh/docs/94-110/)*.



Remember – To reduce forceful exertions:

- ***Reduce object weight***
- ***Hold the object close to your body***
- ***Push carts on smooth, level surfaces***
- ***Make sure there are easy ways to handle the object***
- ***Get help – use another person to help lift***
- ***Organize storage areas to reduce heavy lifting***
- ***Use leverage and/or gravity when possible***

Forceful Exertions and Mining Tasks

Pulling / Pushing
Using a bar to manually open or close a rail car hopper

Lifting
Placing supplies on a hand cart

Hammering
Using sledge hammer to loosen bolt

Lifting
Placing 100-pound bag of sand on scale

Pulling
Removing power connector from shredder

Carrying
QA Tech carrying a sample for testing

What's Next?

The next newsletter will discuss awkward postures. While awkward postures can lead to the development of musculoskeletal disorders, combining awkward postures with another risk factor, such as forceful exertions, significantly increases the risk of developing an MSD. Details about awkward postures, including examples of awkward postures found during mining tasks, will be presented.

The content for this newsletter is from DHHS (NIOSH) Publication No. 2009-107, Information Circular 9509, Ergonomics Processes: Implementation Guide and Tools for the Mining Industry (in press), Authors: Janet Torma-Krajewski (currently Colorado School of Mines, formerly NIOSH, jtorma@mines.edu), Lisa Steiner (NIOSH, Lsteiner@cdc.gov), Robin Burgess-Limerick (University of Queensland, robin@hms.uq.edu.au).