Lifting and Back Stress

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Low Back Pain

- Low back pain occurs in 80% of adults at some point in their lives
- Low back pain is second only to upper respiratory infections as a cause for absence from work.
- Back symptoms are among the 10 leading reasons for patient visits to emergency rooms, hospital outpatient departments, and physicians' offices.
- Low back pain often recurs, 12 and in 5- 10% of patient's low back pain becomes chronic.
- Back symptoms are the most common cause of disability for persons under age 45.

Low Back Pain

- Low back pain costs approximately $24 billion per year in direct medical expenses and another $27 billion per year in lost productivity and compensation. Total annual costs for back pain increase from $35 to $56 billion when disability costs are included.
- Almost 90% of all cases of low back pain are due to sprains and strains and by definition almost always improve.
- Low back pain from herniation of a disk affects only a small percentage of workers.

The Human Spine

The Flexible Spine

Lumbar spine and dorsal nerves

Vertebrae, Spinal Cord and Nerve Roots

Structure of the Vertebral Unit

Lumbar disc structure

Posture and Lumbar Disc Pressure

(Wilke *et al.*, 1999)

- Lumbar intradiscal pressure can be recorded at L4-L5 during different standing, sitting and lifting postures.

Posture and Lumbar Disc Pressure

(Wilke *et al.*, 1999)

Intervertebral disc structure

Nucleus Pulposus

- NP allows for the different planes of intervertebralmovement.

Intervertebral discs

- Vertebrae differ in size in different regions of the spine.

Intervertebral discs

- NP position and size differs in different regions of the spine.

Intervertebral disc forces

- Compressive forces exert the major influence on low back injury risks.

Spinal forces

- Flexion-Extension - asymmetric compression of the intervertebral disc from forwards/backwards bending movements.

Spinal forces

- Lateral bending - asymmetric compression of the intervertebral disc.

Spinal forces

- Axial rotation - torsional deformation of the intervertebral disc.

Spinal forces

- Shear - displacement of one vertebra over the over.

Spinal forces

- Tension - stretching (elongation) of the spine results in elongation of the intervertebral discs.

Lumbar Disc Motion

Spinal disc forces

- Discs do not have a blood supply and they rely on pressure changes for the transport of nutrients and waste products.

Spinal Shrinkage - Stadiometer

Stature and Time-of-Day

- Over a day the spine can shrink ~ 22mm (0.9″)

Lumbar disc damage

Lifting Posture

- Many types of industrial task require lifting objects.
- Lifting is often done in a poor posture.

Lifting Injuries

- **Incidence rates** represent the number of injuries and/or illnesses per 100 full-time workers and were calculated as: (N/EH) X 200,000 where:
- N = number of injuries and/or illnesses
- EH = total hours worked by all employees during the calendar year
- 200,000 = base for 100 full-time equivalent workers (working 40 hours per week, 50 weeks per year).

NIOSH Lifting Equation (1981)

Action Limit (AL) = 90 lbs. X (6/H)(1-0.1[V-30])(.7+3/D)(1-F/Fmax)

Where:

H = horizontal location (inches) forward of he midpoint of the ankles at the origin of the lift
V = vertical travel distance (inches) between origin and destination
F = average frequency of lifts (lifts/minute)
Fmax = maximum frequency which can be sustained (from table).

Maximum Permissible Limit (MPL) = 3(AL)

NIOSH Lifting Equation (1991)

Recommended Weight Limit (RWL) = LC x HM x VM x DM x AM x FM x CM

Where:

LC = load constant (51 lbs.)
HM = horizontal multiplier = 10/H
VM= vertical multiplier = (1-(0.0075[V-30])
DM = distance multiplier= (0.82+1.8/D)
AM = asymmetric multiplier = (1-(0.0032A))
FM = frequency multiplier (from table)
CM = coupling multiplier (from table)

{H,V,F,D same as 1981 equation}
A = angle of asymmetry = angular displacement of the load from the sagittal plane

NIOSH Lifting Equation (1991)

Lifting Index (LI)

The LI is a term that provides a relative estimate of the level of physical stress associated with a particular manual lifting task. The estimate of the level of physical stress is defined by the relationship of the weight of the load lifted and the recommended weight limit. The LI is defined by the following equation:

$$LI = \frac{\text{Load Weight}}{\text{Recommended Weight Limit}} = \frac{L}{RWL}$$

NIOSH Lifting Equation (1991)

Composite Lifting Index (CLI)

- The CLI represents the collective demands of the job
- The CLI equals the sum of the largest Single Task Lifting Index (STLI) and the incremental increases in the CLI as each subsequent task is added. The incremental increase in the CLI for a specific task is defined as the difference between the Lifting Index for that task at the cumulative frequency and the Lifting Index for that task at its actual frequency.
- Consider two tasks (A and B), with a lifting frequency of 1 lift/minute and 2 lifts/minute respectively:

$CLI = LI_{A,1} + (LI_{B,2} - LI_{B,1})$ [$LI_{B,2} - LI_{B,1}$ =incremental increase in LI]

NIOSH Lifting Equation (1991)

- RWL defined for an 8 hours work period.
- RWL set to protect 99% of men and 75% of women workers (in reality it's closer to 95% of men and 85% of women).
- Assumes that lifting task is two-handed, smooth, in front of the body, hands are at the same height or level, moderate-width loads (i.e., <= the body width of the lifter), load evenly distributed between both hands.
- Other manual handling activities are minimal and don't require significant energy expenditure (i.e., holding, pushing, pulling, carrying, walking or climbing).
- Temperatures (66-79°F) or humidity (35-50%). Outside of the ranges may increase the risk of injury.
- http://www.cdc.gov/niosh/94-110.html (manual for NIOSH equation)
- http://hsc.usf.edu/~tbernard/ergotools/ (XL calculator for NIOSH equation)

NIOSH Lifting Equation (1991)

- Equation doesn't apply to one-handed lifts, lifting while seated or kneeling, lifting in a constrained or restricted work space, lifting unstable loads, wheelbarrows and shoveling tasks.
- Assumes that the shoe sole to floor surface coupling provides for firm footing.

- Assumes the same level of risk for low back injuries from lifting or lowering.
- Underestimates the lifting hazard when situations that don't conform to assumptions.
- http://www.safetyinfo.com/medical/lifting-ana-expl.htm (good overview of equation).

Snook Tables

- Weight limit tables developed by Stover Snook and Vincent Ciriello at the Liberty Mutual Insurance Research Center.
- Tables give weight limit values based on:
  - Box width - distance from the front of the body
  - Vertical lift distance
  - Percentage of the industrial population covered by the limit
  - Knuckle height
  - Lift frequency
  - Separate data tables for men and women
  - Separate data tables for lifting, lowering, pushing, pulling and carrying

Other Lifting Solutions?

- Back belts?
- To date, research evidence has failed to show significant reductions in back injury risks with the use of back belts.

Other Lifting Solutions

- Drop the load and roll it.

Other Lifting Solutions

- Make the load too heavy for a manual lift and use lifting equipment.

Other Lifting Solutions

- Make the load too heavy for a manual lift and use lifting equipment.