Lifting Equation is a valuable tool used to evaluate industrial lifting. Back injury is the most common cause of occupational injury for child care providers (CDC 1997); lifting children of increasing weight and age is difficult for child-care providers as well as non-compliant with the Revised NIOSH Lifting Equation. Finding a suitable, economic, and feasible solution to this problem is of utmost importance. To determine the most appropriate way to achieve compliance, this study compares and contrasts the sanitation, ergonomic, and cost-effects of all relevant regulations. An extensive literature review was done as well as experimental gathering of the horizontal distance data as care providers lifted children from the floor. Cost estimates were found through the Bureau of Labor Statistics. The data show that the current practices of lifting children pose unacceptable levels of risk to the providers. This risk should be minimized.

128.

WHERE SHOULD THE BOX BE LOCATED WHEN LIFTING? K. Davis, University of Cincinnati, Cincinnati, OH; W. Marras, The Ohio State University, Columbus, OH.

As ergonomics takes hold in industries dominated by manual material handling, there is an increasing need for more comprehensive knowledge of workplace layout. While there is a plethora of knowledge on the impact of box weight, few investigations have attempted to understand the importance of workplace layout on the mechanical response during lifting. Thus, the objective of the current study was to investigate the impact of box location at the start and end of the lift on the spine loads. Eight females and seven males lifted boxes from a starting shelf to a destination shelf. The starting and destination shelf positions were defined by height (elbow, knee, and shoulder) and asymmetry (60° clockwise, sagittally symmetric, 60° counter-clockwise). Lifts were completed from all combinations of the shelf positions. The results indicated that the height of both the starting and destination shelves and starting task asymmetry had significant impact on the compressive (between 500 and 1800 N) and lateral shear (100 to 150 N) forces while the destination shelf height impacted the anterior-posterior shear forces (up to 400 N). While the magnitude of the loads was primarily dependent upon the starting height, the magnitude was also dependent upon the relative position of the destination shelf (e.g. an interactive effect). The results of the current study provide further indication of the importance of proper ergonomic design, specifically identifying the significance of starting box position as well as the destination. It is important to note that adjustment of the starting shelf will impact the three-dimensional spine loads while the destination height and task asymmetry influenced the shear forces. The take home message is workplace layout factors directly influence the loads on the spine with starting position being most important.

129.

A METHOD FOR EVALUATING MULTI-LIFT TASKS IN MANUAL MATERIAL HANDLING JOBS. B. Faville, Clayton Group Services, Seattle, WA.

Many job tasks that involve manual material handling require employees to lift varying weights and shapes from a variety of locations. The NIOSH Lifting Equation is a popular method for assessing manual material handling tasks and provides a way to calculate a "Lifting Index" for "multi-lift tasks." However, the NIOSH equation can be very difficult to use for multi-lift tasks. The Washington State Ergonomics Rule provides a simpler method for evaluating lifting tasks, but the criteria may not be as protective as desired and is only adequate for assessing multi-lift tasks. This presentation will discuss a method developed to analyze jobs requiring lifts of varying weights and shapes from a variety of locations. The tool was developed by combining the protective characteristics from the NIOSH Lifting Equation with the simplicity of the Washington State Rule to provide a simple but effective tool for assessing multi-lift tasks. Any health and safety professional evaluating lifting tasks may find this method useful in evaluating the relative risk of the lifting task. The method will be demonstrated in a case study of a warehousing job.

130.

EFFECTS OF TORSO FLEXION ON FATIGUE FAILURE OF LUMBAR MOTION SEGMENTS. S. Gallagher, NIOSH, Pittsburgh, PA; W. Marras, A. Litsky, D. Burr, The Ohio State University, Columbus, OH.

Bone mineral content, density, and vertebral body area measurements were made of 12 cadaver lumbar spines, whose motion segments (24 were studied) were later subjected to a fatigue loading regimen simulating lumbar loads when lifting a 9 kg box in three angles of torso flexion (0, 22.5, and 45 degrees). Motion segments were loaded every 3 seconds using a loading profile (compression, shear, and load rate) appropriate for each torso flexion angle. A maximum of 10,020 cycles was employed. Specimens surviving the entire number of cycles were treated as censored observations. A survival analysis (Cox regression analysis) was used to evaluate the impact of torso flexion and bone mineral characteristics of the motion segments on the number of cycles to failure. Results of the Cox regression analysis demonstrated that, compared to the referent condition (0 degrees torso flexion), 22.5 degrees of torso flexion had a relative risk of 15.1 (95% CI: 2.7–83.5), while the 45 degree torso flexion condition had a relative risk of 29.4 (95% CI: 4.6–185.9). Bone mineral content was found to have a protective influence with respect to the number of cycles to failure (RR = 0.917; 95% CI: 0.85–0.99). Results suggest that torso flexion, especially extreme flexion, leads to rapid fatigue failure of lumbar motion segments. Increases in bone mineral content were found to extend the fatigue life of motion segments. Findings suggest that torso flexion should be avoided in lifting tasks, and that aging workers may be particularly vulnerable to fatigue failure of spine tissues, due to the loss of bone mineral content (particularly among women) that occurs with aging.

131.

A STUDY FOR MEASUREMENTS OF GRIP STRENGTH AND COEFFICIENT OF FRICTION AT THE INTERFACE BETWEEN THE HAND AND DRYWALL. C. Pan, R. Dong, C. Warren, T. Kau, S. Chiou, D. Welcome, NIOSH, Morgantown, WV.

The objective of this study is to measure the grip strength used in lifting drywall, and to measure the coefficient of friction (COF) at the interface between hand skin and a gypsum drywall sheet. An additional objective of this study is to assess lifting forces applied during glove use. Ten healthy male construction workers (mean age = 42 ± 3.12 years) who had at least 6 months experience in handling drywall sheets were recruited from the area surrounding Morgantown, West Virginia. The human subjects needed to complete the maximum grip strength (TekScan, 5101) and coefficient of friction (friction-measurement meter) tests. The maximum grip strength measures were collected repetitively for eight experimental conditions including treatment combinations of hand (left, right), drywall thickness (1/2", 3/4"), and glove wearing (bare or gloved hand). For the COF test, normal force and COF were collected repetitively for four experimental conditions including treatment combinations of hand (left, right) and glove wearing (bare or gloved hand). Glove wearing ($F = 6.87$, $p = 0.0278$) and drywall thickness ($F = 17.67$, $p = 0.0023$) both showed a significant impact on grip strength. For COF measurement at the palm, the associated F and p-values were $F = 17.90$, $p = 0.0022$ for glove wearing. Findings from the univariate analyses indicated that the finger COF measurements were 0.46 ± 0.15 and 0.47 ± 0.14 for the right and left hand, respectively; the palm COF measurements were 0.41 ± 0.1 and 0.43 ± 0.12 for the right and left hand, respectively. Findings from the univariate analyses also showed that wearing PVC-dot gloves increased friction and lifting capacity. The maximum grip/lifting strength findings will further be used to compare with the required lifting force results for this lifting method with the previous study data. Analysis of this comparative data will be used to recommend task duration and rest periods.

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