A survey of manual lifting tasks in different occupations

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Abstract: This paper encapsulates a vital survey of the manual lifting activities in industries by industrial workers developed over the years, emphasizing the significance of analyzing their extractions as a way to stimulate the evolution of new approaches that develop the search capabilities of on designing & modifying manual lifting tasks. Low back pain is a disorder that usually affects the industrial workers. Industrial repetitive and heavy lifting is a known risk factor for the development of low back pain. Each technique is briefly described with its degree of applicability. This paper can be used as a quick view of all research works for further research in industrial lifting tasks. Biomechanical loading in terms of Peak Compression & Shear forces at low back joint, posture of lifting, size of object, position of objects are studied. The effect of stress on physiological parameters like heart rates, oxygen consumption and Psychophysical approach is assessed also. The primary motivation for these research efforts has been to model human capabilities so that the demand of manual material handling tasks can be designed at or below the worker capacity to perform the task.

1 Introduction

Across India, many workplaces are experiencing an increase in the number of Health Hazards. Statistics from around the world shows that nearly one-quarter of the working population falls victim to manual handling injuries especially low back injuries [8,12]. Manual lifting is the highest classified cause (19.6%) of mishap incidence and also the highest classified cause (31.1%) of injury on the job as per the Kansas department of human resources (2000). Controlling injuries associated with MMH can signify a considerable economic benefit to employees, employers, and society in general, and a significant reduction in pain and suffering for workers. Researchers from diverse fields have focused manual material-handling (MMH) tasks to reduce manual handling injuries which led to the development of guidelines such as National Institute for Occupational Safety and Health (NIOSH) work practices guide and lifting equations [23,28]. In Indian context, the laborers are continuously over-exhausted without the protection of any constraint law. These workers are employed temporarily by the labor contractors on daily wage basis, not as the direct payee of the organization. No records are maintained on their health or industrial accidents. The Factory Act, 1948, does not indicate the safe load limit for Indian population.

2 Methodology and Results

The Restricted workspaces may cause to change the compression force at low back joint and cause the low back pain. Elfeituri et al. [5] analyzed the manual lifting tasks

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performed in restricted workspaces for the selected combinations of limited head room heights and twisting angles by using a three-dimensional dynamic biomechanical model in terms of peak compression and shear forces at the L5/S1lumbosacral joint and concluded that both compression and shear forces are affected by the increase in twisting angle. A three-dimensional biomechanical model is also used by Anil Mital & Sudlyono Kromodihardjo [20] deduce that the spinal stresses generated are, in general, significantly higher in when lifting loads asymmetrically or in bigger boxes or when handling boxes without handles than when lifting loads symmetrically or when handling boxes with han-dles. Chiuhsiang J. Lin et al. [15] developed a nine-link whole body joint model based on the ratio of joint moment to joint capacity to evaluate the physical stress of manual lifting in truck loading job. The moment ratio was found to have a high correlation with the NIOSH lifting index. Marie Authier et al. [1] discussed about the importance of job habit of doing tasks in industries. He differentiated the ability to lift the boxes based on techniques used by them. The position and location of hands, hand grips, back, knees, feet and pelvis is observed during beginning of transfer, during transfer and during deposit for both Expert and Newcomer handlers. Allan T. Wrigley et al. [29] analyzed the lifting techniques used by discriminated the difference in lifting techniques for individual who in due course develop low back pain compared to those that do not while employed in manual material handling industry based on Principal component analysis describing the two-dimensional motion of the trunk and load. But whether experienced or non experienced the subject is, it is always demand of industry the repetitive lifting. Changes in kinematics as a function of lifting weight and frequency was investigated in sagital symmetric repetitive lifting by K B Hagen et al.[9]. For every lift cycle, the maximum angular displacement of the thigh and lower-trunk body segments was recorded. The lifting weight or frequency did not influence the motion ranges in stoop and squat lifting while significant gradual decrease in the thigh motion range and corresponding increase in the lower-trunk motion range were seen for a majority of the subjects during squat lifting when lifting frequency increased and so the variation in motion ranges was greater in squat lifting than in stoop lifting. A study following the psychophysical methodology is done by Rina Maiti [17] to determined maximum acceptable weight of lift for adult Indian female workers. Working heart rates, just after lifting and pause heart rates were collected for the entire duration by the equation for the particular time period. She concluded that NIOSH equation failed for non western population as the Indian adult females have less aerobic power than the value used by NIOSH (1991) [24] to develop their lifting equation. Again Rina Maiti & G.G. Ray [16] worked on female workers and developed an equation for the evaluation of maximum load limit for manual load lifting and normalized heart rate is calculated with the help of heart rate (maximum and working) and results average NHR deviates from stabilized as lifting frequency increases. Several metabolic parameters like Oxygen consumption, caloric cost, heart rate were compared by Trish G. Sevene et al. [26] found for dominant hand, non-dominant hand and both hands. To determine the MAWL, Jorge Hidalgo et al. [10] designed a new comprehensive lifting model to determine limits for manual lifting by using the psychophysical data, physiological and biomechanical data. Waldemar Karwowski [11] compared 3 observational techniques for assessing postural load, based on working postures different industries. Based on the grand score of its coding system, four action levels, which indicate the level of intervention required to reduce the risks of injury due to physical loading on the worker, were suggested.

In addition, William S. Marras et al. [19] concluded that Patients with LBP experienced greater spine compression and shear forces when performing lifting tasks compared with asymptomatic individuals. J.C.E. Vander Burg et al. [27] evaluated the effects on low back of lifting an unexpectedly heavy object and loss of balance by studying moments, torques, reactionary forces and all body mechanics by using a two dimensional dynamic model. W. S. Marras et al. [18] studied that how well a previously reported low-back disorder risk assessment model could predict changes in injury rates as the physical conditions to which employees are exposed were changed. KaiWayLi et al. [14] concluded that both task frequency and lifting & lowering heights influence oxygen uptake, heart rate, and the RPE. Gary S. Nelson et al. [22] presented the facts of development of Revised NIOSH equation [24] which explains the biomechanical, physiological, and psy-chophysical criterion used for its development, and provides a description of the derivation of its individual components. Dianne A.C.M. Commissaris et al. [2] studied anticipatory postural adjustments (APA) i.e. Balance of body in a dynamic multi-joint movement, in which the legs play an important role. The electromyogram (EMG) of eight superficial leg muscles on the left side of the body were telemetrically obtained. Tzu-Hsien Lee et al. [13] compared the asymmetric lifting with symmetric lifting and showed that the asymmetric lifting with trunk rotation decreased the MAWL and MWL by 9.1 and 17.3%, respectively, and asymmetric lifting with body turn decreased MAWL and MWL by 6.1%. A fuzzy representation the human operator decision-making process of selecting the maximum acceptable weight of manual lift is developed by W. Karwowski [11] in terms of membership functions which describe the degree to which the combined effect of biomechanical and physiological stresses is acceptable to the human operator based on psychophysical method.

H.vanDien et al. [4] compared the stoop lifting technique with squat lifting technique and found squat lifting is more efficient to prevent the low back pain. Spinal compression due to intra-discal pressure (IDP) [21] and spinal shrinkage [3] was not significantly different but Shear force and bending moments acting on the spine appeared lower in squat lifting. Only when combined in a model using information on muscle length and shortening velocity relating the EMG data to calibration data on an individual level can valid estimates of back muscle force in dynamic lifting tasks be attained. A.M. Genaidy [7] provided provides two models for males and females to assess the psychophysical maximum acceptable weight of lift. This was on the basis of lifting frequency, height of lift, sagittal or asymmetrical lifting, task duration, container size in the sagittal plane, presence or absence of container couplings. Sean Gallagher et al. [6] concluded the effects on lifting capacity, metabolic costs and EMG of trunk muscles of miners psychophysically and physiologically. MAWL and lifting capacity were lower while heart rate and oxygen consumption were higher in Kneeling posture in comparison to Stoop lifting posture.

4 Discussion and Conclusion

This literature review contains updated information on the physiological, biomechanical, psychophysical, and epidemiological aspects of manual lifting. The MSDs became the reason to survey all the happenings in the field of Manual Material Handling Tasks. The cause of developing the LBP and metabolic diseases were tried to find out and relevant solutions

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and researches in this area are discussed. Different techniques of lifting and how it affects the working capability of workers are studied. More emphasis on training observers and more exact definitions of exposure factors will probably improve the reliability and validity of observations. As a means of synthesizing the current understanding of measures, this paper describes a set of intervention and observation nodes for which relevant workplace indicators prior to, during, and after mechanical exposure reduction can provide useful information. Our approach, which includes many of the features of rigorous methodologically relevant intervention evaluation, should provide evidence for the effectiveness of workplace ergonomic intervention that speaks to the majority of cultures of evidence that we described earlier. The primary motivation for these research efforts has been a desire to understand human capabilities so that tasks can be designed such that the demands of the task are at or below the capacities of the workers performing the task. Various criteria for defining acceptable task demands have been developed from the principles of biomechanics, physiology, and psychophysics. This paper presents critical review of MMH criteria, the shortcomings of and conflicts between the various criteria, and the areas needing further examination.
More recently a study compared range of motion of trunk and pelvis during an asymmetric lifting task of a box between a group with a history of low back pain and a group with no history of low back pain [26]. It also detailed out the implications for studying lifting paradigms at sub-maximal effort over longer periods of time. Most of these studies have occurred in Europe and North America and the data were obtained from Caucasian populations.

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