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Different body part discomfort of female construction workers while using ergo tools

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Abstract
In India, most of the materials and equipments are manually handled by women construction workers usually in ergonomically hazardous postures. They are mostly engaged in manual material handling tasks. The method of handling material manually involved the risk of injury to the workers if we do not pay attention to the working conditions. The present study was conducted on 30 female workers from Hisar district of Haryana. The purpose of this study was to assess the body part discomfort of female workers involved in carrying heavy load activity by using different ergo tools and the working environmental conditions. Result revealed that while carrying the heavy load with the help of head load manager, very heavy discomfort was felt in the shoulders (4.67) mean score and moderate discomfort was felt in upper back (3.64) and lower back (3.59). Whereas carrying the heavy load with the assistance of head load harness, moderate discomfort was felt in the upper back (3.50). Personal protective devices should be used.

Keywords: Manual material handling, construction workers, body posture, ergo tools, body part discomfort

Introduction
Construction work is featured by high labor turnover, constantly changing work environment and conditions on-site and different types of work being carried out simultaneously. Construction workers are gradually more affected as compared to other industries. They face different physical, chemical, and biological environments, thereby developing various health problems like respiratory problems, musculoskeletal disorders and pain in different body parts, mostly back and shoulder pain. Their work comprises of hard physical labor under difficult conditions like adverse weather conditions. The nature of work, working hours, low wages, poor living conditions with lack of basic amenities, separation from family, lack of job security and lack of access to proper occupational health services make the situation worse (Shah and Tiwari, 2010; Gaurav *et.al*, 2005, Adsul, 2011) [1, 2, 3].

Health hazards in the construction industry can be grouped under mechanical and non-mechanical hazards. Mechanical hazards include accidental issues from impact, penetration from scrap metal and sharp objects and crushing. Non- mechanical hazards are a major cause of occupational diseases and physical problems. Non-mechanical hazards associated with machinery and equipment can include harmful emissions, contained fluids or gases under pressure, chemicals and chemical by-products, electricity, and noise. All of these can cause serious injury if not adequately controlled. Death and injury from accidents in the Indian construction sector are widespread. India has the world's highest accident rate among construction workers. A survey by the Indian Labour Organization (ILO 2009) found that 165 out of every 1000 workers are injured in the construction sector. Data suggest that the possibility of an accident is five times more likely in the construction industry than in the manufacturing industry, and the risk of a major injury is 2.5 times higher. British Safety Council study revealed that not only the construction workers in India lack legal protection, but the on-site deaths are also 20 times higher than those in Britain with 25% of the deaths happening due to falling from a height, and nearly 80% of the workers working in an unsafe environment. Women perform various unskilled jobs like cleaning building sites, carrying bricks, gravel, mortar, and water up to the skilled carpenters and masons. Irrespective of the number of years they work; they are not upgraded from unskilled to skilled category in

comparison to their male counterpart (Jhabvala and Kanbur, 2002) [4]. As they are unskilled and have no training before the recruitment, they are unaware of the ergonomic risks related to the work. Since they are much more involved in manual material handling (MMH), they are required to work for longer durations without any rest. The study of manual load carrying is an important area of investigation. The emphasis on ergonomics in manual load carrying tasks arises from the potential risks of work-related health problems and injuries. Mitra *et al.* (2012) [7] performed biological analysis of spine during stoop and squat lifting and stated that lifting loads over a prolonged period of time, creates a risk of lower back injury. In India, most of the materials and equipments are manually handled by women construction workers usually in ergonomically hazardous postures. They are mostly engaged in MHH tasks that require lifting, loading, carrying, pushing, and pulling activities (Sahu *et al.*, 2008) [9]. Such activities require frequent bending, twisting and other awkward postures which may predispose them to musculoskeletal disorders (Gangopadhyay *et al.*, 2008) [8]. The study was conducted to analyse the effect of different ergo tools on female workers body that were performing the head load carrying the activity. The present study was conducted with following specific objectives:

- Studying the body part discomfort while performing the activity with the help of ergo tools
- Evaluate the working environment parameter.

Methodology

The present study was conducted in Hisar city of Haryana state. Different construction sites from Hisar city were selected purposively. A minimum of 3-4 female workers working in a project at the construction site was the criteria for the selection of construction sites. A sample of 30 physically fit women respondents falling in the age group of 20-40 years with willingness to cooperate were selected for the study.

Ergo solutions used for the study: Head Load Manager, Head Load Carrier, Head Load Harness.

1. **Head Load Carrier:** HLC was developed by Aprajita Kumari (2014) for transporting fodder.
2. **Head Load Manager:** Mrunalini (2011) developed the technology named Head Load Manager for transporting manure, seeds, harvested grains, vegetables, fodder and biomass fuel from home, farm and handling of sand, cement at the domestic construction sites.
3. **Head Load Harness:** Head Load Harness was developed by Swagatika Jena (2015) and was useful in eliminating the load to be placed on head.

Head Load Carrier Head Load Manager Head Load Harness

Fig. 1: Existing Head Load Managers

The assessment tool for this study was body posture evaluation by use of Human Body map.

Human body map: It is used to measure the localized discomfort, musculoskeletal discomfort, and intensity of pain in different body parts resulting from the postural discomfort. Body part discomfort score (BPDS) was obtained using a modified Human Body Map given by Corlett and Bishop, 1976. In this technique, the body is divided into a number of regions. After performing the work, subjects are asked to indicate discomfort in body parts on a 5-point continuum ranging from 1-5 *i.e.* very mild (1), mild (2), moderate (3), severe (4), and very severe discomfort (5). The weighted mean score are derived to reach the conclusion.

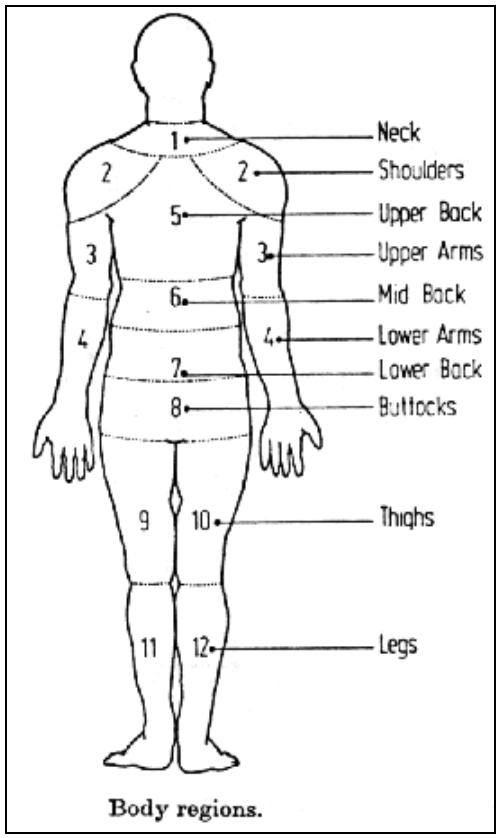

Fig 2: Human Body Map

Environmental parameters

Temperature: It is the degree of hotness or coldness of the atmosphere. For work, the comfortable range of atmospheric temperature is taken to be about 20 °C to 24 °C with an average of 23 °C.

Relative humidity: It is an index of the amount of water vapours in the air. It is simply the percentage saturation of air, which is less than or equal to 100. Relative humidity of 40-50 percent makes one comfortable in winters while in summers 40-60 percent is normal.

Noise: It is an unwanted sound which is not liked by an individual. The sound intensity is the sound pressure level and is measured in units of decibels (dB). The recommended level fall between 60-80dB.

Light: light intensity was measured with the help of lux meter and the unit of measurement of light is lux, and1 lux = 1 lumen per sq. m. The recommended value lie between 250-500lux.

Result

In conventional method, severe discomfort was felt in the head, lower back (4.19 each) mean score, neck (3.93), feet (3.84), shoulders (3.81), buttocks (3.75) and upper back (3.61). Discomfort in the wrists (3.39), upper arms (3.32), mid back (3.20), chest (3.17) and knee (3.16) was moderately heavy whereas light discomfort was felt in the thighs (2.97), legs (2.64), lower arms (2.58) while carrying the load. This is due to the bad posture adopted by workers that they faced problems in their lower back. Moreover, since load was not properly distributed so they felt pressure on their shoulders. While performing the activity with the help of head load carrier, mild discomfort was felt in the legs (2.60), shoulders (2.54), upper back (2.37), feet (2.41), upper arms (2.18), mid back (2.07), neck (1.54), lower arms and thighs (1.52 each). Very mild discomfort was felt in the knee (1.43), buttocks (1.39), lower back, head (1.30 each), chest (1.08) and wrists (1.01).

However, while carrying the heavy load with the help of head load manager, very heavy discomfort was felt in the shoulders (4.67) and moderate discomfort was felt in upper back (3.64) and lower back (3.59). Discomfort in feet (2.76), legs (2.70), thighs (2.68), wrists (2.37), mid back (2.35), knee (2.33), upper arms (2.25), neck (2.24), lower arms (2.22), head (2.20), buttocks (2.15), and chest (2.03) was sensed mild. While carrying the heavy load with the assistance of head load harness, moderate discomfort was felt in the upper back (3.50) while mild discomfort was felt in the wrists (2.60), legs (2.52), knee, shoulders (2.50 each), mid back (2.36), thighs (2.29), lower back (2.25), buttocks, chest (2.23 each), upper arms (2.20), lower arms (1.99), neck (1.64), feet (1.50) and head (1.30). The reason behind this might have been that the load manager was not comfortable to carry the load as no load was supported by the head and handle length of the product was too short. Hence the respondents had to raise their lower arms above elbow level to hold it leading to pain in shoulders. Suthar *et al.* (2011) [10] also reported that 77 per cent of tribal women, aged between 20-50years, had pain in their neck due to head load carrying activity. Likewise, Llyod *et al*. (2010a) also concluded that head loading is characterized by significant neck pain and though it may have an advantage in terms of balance and stability. Its long-term use does not protect from health problems. Chattopadhyay *et al.* (2009) [12] also found that low back problem was more common in both male and female labourer (BPD- 8.6 in males and 9.1 in females). Qutubuddin *et al.* (2013) [13] reported that the workers involved in loading, unloading and carrying experienced pain in the shoulder, neck, hand/wrist and elbows. Bagchi *et al.* (2014) [14] reported that the female brick carriers who carried a heavy load to and from the field and the brick kiln, suffered from more discomfort and pain in the head, neck, shoulder and trunk regions. Sahu *et al.* (2010) [15] reported that female brick carriers felt more pain on upper parts of their body such as head, neck, shoulders etc. This is so because female workers had to carry heavy load (50.31 ± 1.01kg) on their head and covered the shortest distance (0.6 ± 0.13 km) from the field to the kiln top.

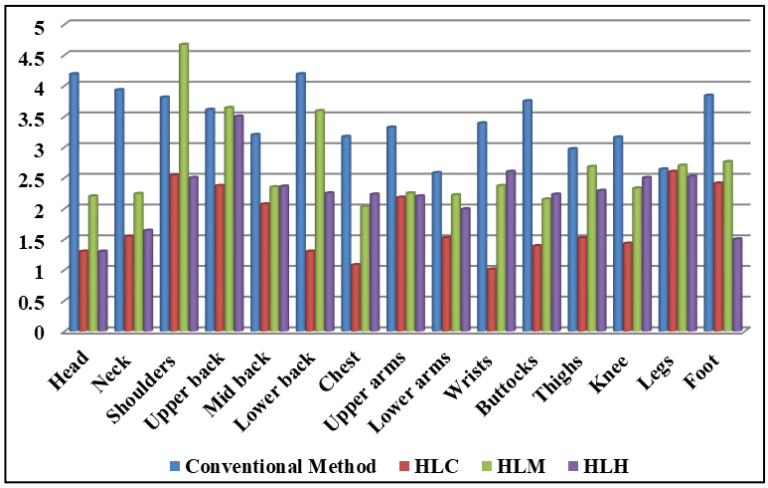

Fig 2: Body Part Discomfort

Environmental Parameters

Workplace environment refers to condition at the place where workers devote most of their working time. Therefore, comfortable work environment is the key for workers to perform their task in an efficient way. They have to work in all types of seasons having extreme temperatures. The experiment was conducted in the month of September and the average temperature was observed to be 34.26 ^{0}C during carrying the head load which was much higher than the recommended value i.e. 20-25 ^{0}C whereas the average level of humidity was 48.16% which was within the recommended value but on the lower side i.e. 40-60%. The noise level at the construction site was 90.43 dB which was more than the recommended value i.e. 60-80 dB. Light was found to be 386.60 lux which was within the recommended limits i.e. 250-500 lux. Hence, it describes that the environment in which the respondents had to work was hot and somewhat dry carrying thermal discomfort to the workers while carrying load during this season. Oberoi (2008) [16] reported that the environmental parameters like temperature, ventilation, humidity, air quality, lighting, noise etc. in which the workers perform their tasks may have an effect on health of the workers.

Table 1: Environmental conditions while carrying the head load n=30

Parameters	(Mean ± SD)	Recommended value*
Temperature (^{0}C)	34.26±2.60	20-24
Humidity (%)	48.16±11.89	40-60
Noise (dB)	90.43±6.61	60-80dB
Light (lux)	386.60±327.61	250-500lux

*Grandjean (1978)

Conclusions and Suggestions

Workers felt severe discomfort in the head, lower back (4.19 each), neck (3.93), feet (3.84), shoulders (3.81), buttocks (3.75) and upper back (3.61) while preforming activity with conventional method. However, while carrying the heavy load with the help of head load manager, very heavy discomfort was felt in the shoulders (4.67) and moderate discomfort was felt in upper back (3.64) and lower back (3.59). Carrying the heavy load with the assistance of head load harness, moderate discomfort was felt in the upper back (3.50) while mild discomfort was felt in the wrists (2.60), legs (2.52), knee, shoulders (2.50 each), mid back (2.36). Relating to this condition several suggestions for modification in the ergo tools, improving the body posture while performing the activity and making some guidelines for load limits. Use of personal protective devices like gloves, helmet, ear plugs etc. should be provided by the contractor to workers at construction site to protect them from injuries like neck, shoulder, back and head injury, hearing loss etc.

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