INTRODUCTION

In India, construction works is running parallely in two sectors – organized and unorganized. The majority of the construction labourers are working in unorganized sectors. The working methods are much primitive and traditional in unorganized sectors than in organized sectors. In unorganized sectors, the labourers are generally recruited by the labour contractors on daily wage basis. The labourers neither get any training before recruitment nor have any awareness about ergonomic risks related to the work (Basu et al., 2005; Basu et al., 2008). The building construction labourers are one of the most numerous and vulnerable segments of the unorganized labour in India. There are always high job demands on these workforces in 8- hours activities of an average working day. Sometimes urgent or emergency situations compel them to do overtime work even after 8 hours of exhaustive work. Most of the contractors deny any liabilities for the injury and other occupational health hazards of the labourers and do not give any compensation for these health complaints.

In India, the cost of manpower is low and therefore manual materials handling is the cheapest

THE ERGONOMIC EVALUATION OF WORK-RELATED MUSCULOSKELETAL DISORDERS AMONG CONSTRUCTION LABOURERS WORKING IN UNORGANIZED SECTORS IN WEST BENGAL, INDIA

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The present study aimed at ergonomic evaluation of the prevalence of work-related musculoskeletal disorders among construction labourers working in unorganized sectors in West Bengal, India. A modified Nordic questionnaire was applied to one hundred forty male and ninety female construction labourers to acquire information about musculoskeletal symptoms like pain in different body parts. Work-rest schedules of the labourers in different work activities were studied. Working postures were analyzed by means of the Rapid Entire Body Assessment (REBA) tool. Body part discomfort (BPD) scale was used to assess the intensity of feeling of discomforts in the different body parts. It was revealed that the labourers performed repetitive, stressful work for a long period of time in a single work-rest cycle and the load lifted and carried by them were more than the NIOSH recommended weight limit. The analyses of working postures revealed that most of their working postures were unsafe and ranked under REBA action level 3 and 4. The results obtained by applying the Nordic questionnaire and BPD scale revealed that the prevalence of pain in various regions of the body, especially low-back pain, was alarmingly high in both male and female labourers. Training for safe lifting of materials, proper work-rest schedule, modifications of some working procedures and the use of ergonomically designed equipment may certainly reduce the work-related musculoskeletal disorders and improve the health status of construction labourers working in unorganized sectors.

Key words: ergonomics; construction labourers; manual materials handling; work-related musculoskeletal disorders; body past discomfort

INTRODUCTION

In India, construction works is running parallely in two sectors – organized and unorganized. The majority of the construction labourers are working in unorganized sectors. The working methods are much primitive and traditional in unorganized sectors than in organized sectors. In unorganized sectors, the labourers are generally recruited by the labour contractors on daily wage basis. The labourers neither get any training before recruitment nor have any awareness about ergonomic risks related to the work (Basu et al., 2005; Basu et al., 2008). The building construction labourers are one of the most numerous and vulnerable segments of the unorganized labour in India. There are always high job demands on these workforces in 8- hours activities of an average working day. Sometimes urgent or emergency situations compel them to do overtime work even after 8 hours of exhaustive work. Most of the contractors deny any liabilities for the injury and other occupational health hazards of the labourers and do not give any compensation for these health complaints.

In India, the cost of manpower is low and therefore manual materials handling is the cheapest
and easiest solution (Maiti, 2008). In unorganized sectors, the construction labourers have to manually handle a variety of materials such as bricks, soil, sand, stone chips, cement bags, mixers, wooden planks or concrete slabs that differ in size, shape and weight. The frequencies of handling of these materials also differ throughout the day, from day to day and from site to site. These manual materials handling tasks require lifting, loading, carrying, pushing, pulling, unloading and delivering activities (Sahu et al., 2008). In addition, the labourers have to manually and frequently handle different tools like spades and shovels during digging, mixing and filling different materials into containers. These manual materials handling and different equipment operating tasks make the construction work not only physically demanding but also ergonomically hazardous (Schneider and Susi, 1994; Snook and Ciriello, 1991). In fact, construction labourers are regularly exposed to various ergonomic risk factors that include lifting of heavy loads, repetitive joint motions, forceful exertions and awkward postures. Therefore, the construction labourers have to face various ergonomic health problems and injuries (Ayoub, 1992, Schneider 2001, Silverstein et al., 2002). The most common types of work-related ergonomic health problems among construction labourers include strains and sprains in different body parts that sometimes restrain them from work. However, persistence of feeling of pain for a prolonged period of time might be a sign of WMSDs (Schneider and Susi, 1994; Schneider 2001, Silverstein et al., 2002). Construction workers show elevated risks of developing WMSDs of the back, and the upper and lower extremities (Burkhart et al., 1993; Damlund et al., 1982; Holmstrom et al., 1992a, b; Latza et al., 2000; Riihimaki et al., 1990; Stenlund et al., 1993; van der Molen et al., 2004) and construction labourers within this group in particular are at risk (Hess et al., 2004). Construction work is the highest risk occupation for work-related back pain (Ringen and Seegal, 1995; Guo et al., 1995; Damlund et al., 1982; Damlund et al., 1986; Holmstrom et al., 1993; Latza et al., 2002; Nurminen, 1997). WMSD is one of the most significant work-related health problem and the most important factor leading to decreased work capacity of the construction labourers.

The Factores Act (1948) does not mention the acceptable load limit for the Indian population and only stated that no person should lift, carry or move any load so heavy as to be likely to cause him injury. In 1981, the National Institute for Occupational Safety and Health (NIOSH) first developed a lifting equation that combines the biomechanical, physiological and psychophysical approaches into a single exposure score to assist safety and health practitioners in evaluating lifting demands in the sagittal plane (NIOSH, 1981), and this equation was later revised to include asymmetric lifting as well as other factors to accommodate a larger percentage of lifting tasks (Waters et al., 1993). Recently Maiti and Ray (2004) have estimated the Recommended Weight Limit (RWL) for Indian women workers should be 15kg. In practice, the construction labourers in unorganized sectors have to lift and carry loads which are sometimes much more than NIOSH RWL and Lifting Index (LI) in all such lifting activities are greater than 1. From the NIOSH perspective, there is always an elevated risk of lifting related low-back disorders (LBDs) where the LI is greater than 1 (Waters et al., 1993). According to Riihimaki (1991), a major risk factor for LBDs is manual handling of heavy objects. The risk increases if such work has to be performed with twisting of the trunk (Hakkanen et al., 1997).

Many researchers have pointed out the close relationship between working postures and incidences of musculoskeletal symptoms (Armstrong, 1986; Armstrong et al., 1993; Corlett and Bishop, 1976; Sahu et al., 2010). Construction work by its very nature requires the labourers to adopt various awkward, extreme and repetitive postures such as bending, twisting and sometimes even extension of the back, flexion or extension of the neck, shoulders, elbows and knees, elevation of the arms at or above the shoulder or head and squatting. Performance of these postural by stressful work for a prolonged period of time can lead to MSDs in the low back, neck, shoulders, elbows, knees and wrists (Buchholz et al., 1996; Burkhart et al., 1993; Damlund et al., 1982; Damlund et al., 1986; Riihimaki et al., 1990; Riihimaki, 1991).

The aims of the present study are:

A. Ergonomic evaluation of the risk factors for the prevalence of MSDs among construction
MUSCULOSKELETAL DISORDERS IN CONSTRUCTION LABOURERS

labourers.

B. Formulating some ergonomic recommendations to minimize the prevalence of the MSDs and thereby improving the health status of the labourers.

METHODS

Subject

One hundred forty male and ninety female labourers having at least one year working experience in the construction industry were taken randomly as subjects in this study.

Questionnaire study

A modified Nordic questionnaire (Kuorinka et al., 1987) was applied to both the male and female construction labourers. The questionnaire consists of demographic questions and questions about their feeling of discomfort or pain in the different regions of the body. The demographic questions include age, years of experience in building construction and years working in the current occupation. The feeling of pain and discomfort was ascertained in categorical “yes”/“no” responses for two time periods: in the last 7 days; and in the last one year. For pain experienced in the past 7 days, respondents referred to a body map (Corlett and Bishop, 1976) to indicate the part of the body with pain.

Analysis of daily work schedules

The study of daily work schedules of the labourers was carried out by continuous observation through visual inspection and time measurement was done by using a stopwatch. Video recording was also done. Later, video records were analyzed and compared with data collected during direct observation at the work site for detailed and accurate work-rest analysis.

Postural analysis

The working postures were analyzed by the Rapid Entire Body Assessment (REBA) (Hignett and McAtamney, 2000) tool. Four steps were conducted for analysis of working postures:

Step 1: The working postures were recorded with the help of a digital video camera (Sony handycam DCR-HC 62E and DSC HX1). The camera was positioned at an angle to the subject so that three dimensional working postures can be identified during the playback. Several work cycles were recorded because postures can vary in different work cycles of the same job depending on the nature and demands of the job (Keyserling, 1986).

Step 2: The most frequently repeated postures or the postures that were held for the longest amount of time of the work cycles were chosen for assessment.

Step 3: In the chosen posture, by analyzing all joint angles and joint motions, scoring was made.

Step 4: Finally the grand score was compared with the action level list for assessing the risk level for a particular posture.

Body Parts Discomfort (BPD) scale

10 points BPD scale (Jacquelin et al., 1994) was used for measurement of discomfort feeling in the different body parts in both male and female labourers.

Statistical analysis

The data were expressed as the mean ± standard error. Comparisons of the means of different parameters of the male and female labourers were made by student’s t-test, P<0.05 as a limit of significance. A two-tail chi square test (in the contingency table) was applied to evaluate whether pain in any body part had significant association with gender (P<0.05 as a limit of significance) (Daniel, 2009; Das and Das, 2008).
RESULTS

The construction industry is such an industry where work load and working environment vary in different work sites and even in the same work site, the labourers have to perform different tasks in different time. Therefore, to evaluate work stress of labourers, working activities were minutely monitored for several days in a single work site and this method was followed in other sites also.

The physical characteristics, age and the experience of the labourers are given in Table 1. From the table, it is noticed that, though the mean height and the mean weight of the male labourers were more than female labourers, but their Body Mass Index (BMI) was much less than that of female labourers (P<0.0001).

The amount of load handled by the labourers is given in Table 2. From the table, it is found that the males carried a little more (P < 0.05) weight than the female labourers.

The description of joint motions and stressful working postures and the duration of single work-rest cycle during performance of different kinds of construction work are given in Table 3. From the table, it is found that the forward bending of the back (0 – 60º flexion of the back and sometimes even more) was the most frequently repeated awkward posture of the labourers during performance of most kinds of the construction work. Other stressful working postures were – flexion or extension of the neck, shoulder flexion or extension, the hands at or above the head at the time of carrying materials on the head, elbow flexion, radial or ulnar deviation of the wrist and bending of the knees.

The analyses of working postures during different construction jobs performed by male and female labourers are given in Table 4. From the analysis of working postures by the REBA method, it is revealed that most of the working postures adopted by the labourers were unsafe and ranked under action level 3 in REBA. This category of postures requires corrective action through redesigning of working methods. The risk level was very high (most unsafe working postures) at the time of

### Table 1. Physical characteristics, age and experience of male and female labourers (mean ± SD).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Male Labourers (n=140)</th>
<th>Female Labourers (n=90)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height (cm)</td>
<td>165 ± 5.15</td>
<td>149 ± 4.76</td>
</tr>
<tr>
<td>Weight (Kg)</td>
<td>52.68 ± 3.67</td>
<td>50.05 ± 3.54</td>
</tr>
<tr>
<td>Body Mass Index (Kg/m²)</td>
<td>19.34 ± 2.09</td>
<td>22.54 ± 1.89</td>
</tr>
<tr>
<td>Age (years)</td>
<td>28.48 ± 5.40</td>
<td>36.27 ± 7.85</td>
</tr>
<tr>
<td>Experience (years)</td>
<td>6.76 ± 3.81</td>
<td>12.73 ± 5.08</td>
</tr>
</tbody>
</table>

### Table 2. Amount of load handled by the male and female construction labourers at the time lifting of these materials (mean ± SD).

<table>
<thead>
<tr>
<th>Materials handled</th>
<th>Male labourers (n=140)</th>
<th>Female labourers (n=90)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Load handled (Kg)</td>
<td>Load handled (Kg)</td>
</tr>
<tr>
<td>Soil</td>
<td>38.6 ± 1.74</td>
<td>36.5 ± 1.78</td>
</tr>
<tr>
<td>Bricks</td>
<td>44.8 ± 2.56</td>
<td>42.2 ± 2.48</td>
</tr>
<tr>
<td>Sand</td>
<td>28.8 ± 1.33</td>
<td>27.2 ± 1.28</td>
</tr>
<tr>
<td>Stone chips</td>
<td>35.5 ± 1.23</td>
<td>33.8 ± 1.24</td>
</tr>
<tr>
<td>Motor mixture</td>
<td>36.2 ± 1.36</td>
<td>34 ± 1.39</td>
</tr>
<tr>
<td>Cement</td>
<td>50.2 ± 0.19</td>
<td>25.6 ± 1.18</td>
</tr>
</tbody>
</table>
carrying of cement bags and wooden planks having action level 4 in REBA. So these postural activities require immediate ergonomic intervention and corrective action.

The feelings of discomfort in the different parts of the body in both male and female labourers are given in Fig. 1. From the figure, it is found that in all the body parts feelings of discomforts were higher in females (P<0.05) than in males. The body part with the worst discomfort in both male and female labourers was the low back (BPD – 8.6 in males and 9.1 in females).

Prevalence of pain among male and female construction labourers for two time periods (past 7 days and past one year) is given in Table 5. Association of the feeling of pain or the absence of feeling of pain between male and female construction labourers on the basis of their pain prevalence for the past one year is given in Table 6. From the statistical analyses by means of the chi square test, it is clear that no body part pain has a significant association with gender.

From Table 7 (a) and 7 (b), it is revealed that prevalence of low back pain was significantly higher in males as well as females working for more than 5 years than the other group of workers with 5 years or less of experience respectively.

**DISCUSSION**

It was noticed that the male labourers working in the construction industry are much younger than the female labourers as the young males joined the industry as labourers but after gaining experience and adopting working skills, many male labourers become masons. On the other hand, the females, although they learn many facts about construction, are not encouraged or allowed to do the masonry work. So, this work culture lead compel female labourers to work as labourers throughout their working life in the construction industry. The labourers in the industry regularly lift and carry
loads much more than NIOSH RWL which is identified as one of the most significant ergonomic stressors for the prevalence of pain in the low back. As females have only about two-thirds of the muscle strength of males, their manual materials handling capacity is also less (Redgrove, 1979) and lifting of heavy loads produced more stress on females than in males (Sahu et al., 2008).

Different awkward working postures are known to be associated with specific musculoskeletal disorders (Gangopadhyay et al., 2004; Gangopadhyay et al., 2008; Kivi and Mattila, 1991). Prolonged elevation of the arms above the shoulders can lead to shoulder injuries (Hagberg, 1982). Westgaard and Aaras (1984) also reported a high rate of musculoskeletal injuries in the shoulders and the neck among workers who have to adopt postures with considerable static load on the shoulder and neck muscles. Knee injuries are generally caused by repeated or prolonged knee flexion (Bejjani et al., 1984), while bending or twisting the trunk is a major source of low back injuries (Kjeserling et al., 1988). In the construction industry, forward bending and twisting of the back, flexion of the neck, shoulders and knees and elevation of the arm at or above the shoulders were common type of awkward postures adopted by the labourers for carrying out most of the construction works; therefore, the low back, knee, neck and shoulders were affected more than other parts of the body.

<table>
<thead>
<tr>
<th>Type of work</th>
<th>Stick diagram</th>
<th>score</th>
<th>REBA action levels (AL)</th>
<th>Risk level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brick loading</td>
<td></td>
<td>9</td>
<td>3</td>
<td>High</td>
</tr>
<tr>
<td>Digging soil by a spade</td>
<td></td>
<td>10</td>
<td>3</td>
<td>High</td>
</tr>
<tr>
<td>Mixture making</td>
<td></td>
<td>9</td>
<td>3</td>
<td>High</td>
</tr>
<tr>
<td>Lifting materials from the ground</td>
<td></td>
<td>10</td>
<td>3</td>
<td>High</td>
</tr>
<tr>
<td>Wooden plank carrying</td>
<td></td>
<td>11</td>
<td>4</td>
<td>Very high</td>
</tr>
<tr>
<td>Cement bag carrying</td>
<td></td>
<td>11</td>
<td>4</td>
<td>Very high</td>
</tr>
<tr>
<td>Sand loading into a bucket by a spade</td>
<td></td>
<td>10</td>
<td>3</td>
<td>High</td>
</tr>
<tr>
<td>Filling motor mixture into a container by a shovel</td>
<td></td>
<td>10</td>
<td>3</td>
<td>High</td>
</tr>
</tbody>
</table>
Fig. 1. Feeling of discomfort in the different parts of the body in both male and female labourers in Body Parts Discomfort scale.

<table>
<thead>
<tr>
<th>Just noticeable discomfort</th>
<th>Worst discomfort ever</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td>1 2 3 4 5 6 7 8 9 10</td>
</tr>
</tbody>
</table>

Male labourers

- Neck: 5.4
- Shoulder: 5.1
- Elbow: 2.5
- Lower Back: 8.6
- Wrist: 2.4
- Thigh: 2.3
- Knee: 5.6
- Ankle: 2.2

Female labourers

- Neck: 6.1
- Shoulder: 5.9
- Elbow: 2.7
- Lower Back: 9.1
- Wrist: 2.6
- Thigh: 2.5
- Knee: 6.8
- Ankle: 2.5

Table 5. Prevalence of pain among male and female construction labourers for two time periods (past 7 days and past one year).

<table>
<thead>
<tr>
<th>Body parts</th>
<th>Pain experienced in past 7 days</th>
<th>Pain experienced in past one year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male (n=140)</td>
<td>Female (n=90)</td>
</tr>
<tr>
<td>Neck</td>
<td>37 (26.4%)</td>
<td>26 (28.8%)</td>
</tr>
<tr>
<td>Shoulder</td>
<td>33 (23.5%)</td>
<td>23 (25.5%)</td>
</tr>
<tr>
<td>Elbow</td>
<td>9 (6.4%)</td>
<td>5 (5.5%)</td>
</tr>
<tr>
<td>Wrist</td>
<td>8 (5.7%)</td>
<td>4 (4.4%)</td>
</tr>
<tr>
<td>Lower back</td>
<td>69 (49.2%)</td>
<td>46 (51.1%)</td>
</tr>
<tr>
<td>Knee</td>
<td>38 (27.1%)</td>
<td>26 (28.8%)</td>
</tr>
</tbody>
</table>
addition, as forward bending of the back was the most frequently repeated awkward posture; postural stress was the maximum in the low back than in any other joints of the body. From the analysis of the work rest cycle, it was also revealed that the labourers used to perform repetitive stretch work for about 30 minutes in the working time of a single work-rest cycle and then they usually took a rest break for 10 to 15 minutes. On the average, there were six to eight work-rest cycles in 8 hours of a single working day.

From the study of pain for two time periods, it was noticed that pain was most frequently reported in the low back region (49.2% male and 51.1% female labourers reported low back pain for the past 7 days and the low back pain in the last one year was experienced by 73.5% male and 78.8% female labourers). Low back pain was followed by pain in the knees, neck and shoulders, elbows and wrists in both male and female construction labourers. Therefore, the body part where the most pain was felt in both male and female construction labourers was the low back which might be a sign of MSD of the low back. As the age progresses, the problem of low back pain also increases.

The female labourers have in an extra burden of doing all the household jobs including cooking, washing, managing children and family both before joining the work and also after returning from work in the evening whereas the male labourers almost remain in a relaxed position or mood both before and after work hours. This is the cultural background of these people in a developing country.

<table>
<thead>
<tr>
<th>Body parts</th>
<th>Sex</th>
<th>Labourers felt pain</th>
<th>Labourers without Feeling of pain</th>
<th>Chi square value</th>
<th>P value</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neck</td>
<td>Male</td>
<td>59</td>
<td>81</td>
<td>0.29</td>
<td>0.59</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>42</td>
<td>48</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shoulder</td>
<td>Male</td>
<td>57</td>
<td>83</td>
<td>0.06</td>
<td>0.79</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>39</td>
<td>51</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elbow</td>
<td>Male</td>
<td>25</td>
<td>115</td>
<td>0.003</td>
<td>0.95</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>15</td>
<td>75</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wrist</td>
<td>Male</td>
<td>20</td>
<td>120</td>
<td>0.06</td>
<td>0.80</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>11</td>
<td>79</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower back</td>
<td>Male</td>
<td>103</td>
<td>37</td>
<td>0.57</td>
<td>0.44</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>71</td>
<td>19</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knee</td>
<td>Male</td>
<td>60</td>
<td>80</td>
<td>0.85</td>
<td>0.35</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>45</td>
<td>45</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 6. Association of the feeling of pain or without feeling of pain between male and female construction labourers on the basis of their pain prevalence for the past one year.

<table>
<thead>
<tr>
<th>Body parts</th>
<th>Sex</th>
<th>Groups feeling pain</th>
<th>Without pain</th>
<th>Chi square value</th>
<th>P value</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neck</td>
<td></td>
<td>&lt;5</td>
<td>20</td>
<td>40</td>
<td>1.489</td>
<td>0.2224 NS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;5</td>
<td>36</td>
<td>44</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shoulder</td>
<td></td>
<td>&lt;5</td>
<td>19</td>
<td>41</td>
<td>1.634</td>
<td>0.2012 NS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;5</td>
<td>35</td>
<td>45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower back</td>
<td></td>
<td>&lt;5</td>
<td>31</td>
<td>29</td>
<td>7.212</td>
<td>0.0072 S</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;5</td>
<td>60</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elbow</td>
<td></td>
<td>&lt;5</td>
<td>10</td>
<td>50</td>
<td>0.410</td>
<td>0.5219 NS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;5</td>
<td>18</td>
<td>62</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knee</td>
<td></td>
<td>&lt;5</td>
<td>20</td>
<td>40</td>
<td>0.154</td>
<td>0.2828 NS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;5</td>
<td>35</td>
<td>45</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 7 (a). Prevalence of MSDs in two groups of male labourers categorized on the basis of their working experience.

S: significant; NS: not significant.
So they feel more discomfort in different body parts than their male counterparts.

The construction labourers especially those who are working in the unorganized sectors shift very frequently from one worksite to another. Moreover, their tasks change according to the need or demand of the work. For example, if they carry bricks for two hours on a particular day, as the demand for bricks stops, they switch over to the other job as the situation demands (such as carrying cement mixtures for another two hours, etc.). Thus the causative factors of musculoskeletal disorders among these labourers are difficult to identify.

CONCLUSION

From the study using the Nordic questionnaire, work schedules and analysis of working postures, it was revealed that several factors were responsible for the prevalence of MSDs among construction labourers. These factors are:

1. High job demand.
2. Handling of heavy loads much more than the NIOSH recommended weight limit.
3. Performance of repetitive awkward postures during at a stretch work in a single work-rest cycle.
4. Inadequate rest-breaks opportunities.
5. Poor working environment such as, uneven or slippery working surfaces, lack or inadequate space during lifting of load.

Therefore, overexertion and feeling of pain and discomfort in different body parts, especially low back pain, were very common among construction labourers that sometimes restrain from work resulting in loss of their working day. The following ergonomic interventions and recommendations can certainly reduce the prevalence of MSDs of construction labourers.

The recommendations are:

1. Proper work-rest schedule of labourers: Decrease of number of repetitive work cycles during at a stretch work in a single work rest cycle in any kind of MMH and equipments handling activity by taking of 4 – 5 micro breaks.
2. Implementation of well designed job rotation with incorporation of task variability.
3. Safe work practice during MMH activity; (a) Decrease of lifting and carrying frequencies per minute; (b) The materials lifted from the ground should not be too close or far away from the body. Labourers should avoid lifting uneven or unbalanced loads; (c) There must be sufficient space during lifting or lowering of materials; (d) Weight of the materials handled should be within NIOSH recommended weight limit; e) Training for safe lifting of materials.
4. Use of some ergonomically designed equipments: (a) tools like a spade and a shovel with an extension handle to minimize bending activity while doing a ground or floor level task; (b) Equipments should be lighter and balanced to reduce extra muscular effort to hold it in position during its handling; (c) Proper gripping of tools or equipments.
5. The improvement of postures through redesign of workplaces or work methods reduces work-related musculoskeletal disorders and increases work productivity.
6. Proper rehabilitation of labourers who complain about pain and discomfort of their body parts may minimize disability, improve the health status of the labourers and therefore decrease the lost work time by work-related injury.

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