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RISK ASSESSMENT OF WORKERS INVOLVED IN STONE MASONRY WORK OF HIGH HILLS OF UTTARAKHAND

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ABSTRACT

After agriculture, stone masonry work is the second most commonly known practice followed by local people at high hills for their livelihood. In hills of Uttarakhand stones are widely used material for constructions of houses, walls, floors, buildings and roads because of its suitability and easy availability due to absenteeism of bricks at hills and high transportation cost that local people can't afford. Therefore Manual Stone Masonry work is flourishing rapidly in high hills of Uttarakhand. The main objectives of this study are to assess work- related Musculoskeletal Disorders among workers while performing various activities in stone masonry work and to assess the causes of discomfort related to various postures adopted by the workers by using RULA and REBA. Methodology- A total of 120 workers were randomly selected for assessing musculoskeletal pain/discomfort among workers while performing various activities with the help of Modified Nordic Questionnaire and 75 workers were selected for postural analysis by using RULA and REBA. Results- On the bases of results it was found that majority 84.16 percent of the workers said that they were suffering from pain and discomfort in different body parts because of the activities. It was found that 47 percent and 46 percent complained about pain in neck and lower back, 44 and 55 percent had pain in shoulders and hands respectively. It was also observed that the workers were working in awkward postures and felt pain or discomfort in different parts of the body specially in lower back, neck, shoulder, hands, wrist and knees. Postural analysis using RULA and REBA gave high scores in activities that indicated that workers were working in awkward postures and were vulnerable to injuries, musculoskeletal discomfort and required immediate change in postures and intervention in this area.

INTRODUCTION

During the time of Globalization and high industrialization, there has been an increase in the demand for building materials at hilly areas. Therefore many natural material or substances like rocks, stones, clay, wood, stone chips are widely used material at hills because of the absenteeism of bricks and high transportation cost, that force the local people to use locally available material. Hills are prone to natural hazards like cloudburst, earthquake, land sliding. After considering all these risk there is demand for strong materials for construction and stones are strong durable and hard material suitable for construction. Stone is most suitable and locally available material at hills and widely used for construction. Therefore stone masonry work is flourishing rapidly at hilly areas. According to **Giyasuddin and Arindam (2018)** acute and prolonged jobless conditions at hilly areas, local people are easily attracted by the employment opportunities offered by the stone construction sector and become an alternative source of employment and earning for hilly people. At hills stones are used for residential as well as for commercial purposes for construction of buildings, houses, cottages, roads, walls, floors and so on.

It is a fact that workers who are involved in stone masonry work are involved in various activities and suffering from several occupational health hazards like ergonomic hazards includes, awkward postures, musculoskeletal disorders, poorly designed tools and repetition, in physical hazards vibration, noise, lifting, slip and fall are common. In psychosocial hazards include work stress, long working hours, fatigue, pressure and over time. Respiratory hazards were also associated with stone masonry work specially chest pain, shortness of breath due to exposure of dust at work that leads to silicosis. The workers are unaware about the ill effects of this work on their health. They are suffering from injuries resulting from accidental hazards like being hit by stones or tools, injury of hands, fingers, toes, cuts, and eye injury resulting from penetration of small dust particles and small size stones into the eyes while crushing and shaping of stones.

Stone masonry is one of the hazardous work that required physical strength, high muscle exertion and force that leads to burden on muscles, ligaments and joints, which leads to Musculoskeletal discomfort (MSDs). It is a major problem in stone masonry work and become most hazardous occupation. According to **Okello *et al.*, 2020** work related muscul oskeletal discomforts are main constraints to workers performance and health. It can affects musculoskeletal system of the body and cause pain in upper and lower extremities specially in neck, shoulders, back, wrists, hands, back, knee, legs and feet which is depends upon nature of work. That may be caused by repetitive movements of muscles/ joints or working in awkward postures for long period of time. Tenderness, aches, pains, tingling, stiffness and swelling are the main symptoms of musculoskeletal disorders. Improper material handling also affects the cervical spine, neck muscles and end with severe pain. **(Sulainman *et al.*, 2015)**. The common activities in stone masonry work, comprises of extraction of stones, breaking of stones, loading and de loading of stones, crushing, shaping and layering of stones to construct walls, floors and houses, roads and so on. The prolonged stresses and strains caused during the various activities with different load conditions is a cause for Work Related MSD's

Scope of the study

This study helps to know the existing occupational health hazards, musculoskeletal disorders, working posture, injuries and accidents in stone masonry work at high hills. Awkward postures, repetitive motions and long working hours may leads to musculoskeletal disorders among workers and end with severe pain and injury. Therefore there is an emerging need for eliminating the risk of musculoskeletal disorders and postural stress among workers, to enhance their work efficiency and minimize the risk of occupational hazards. This study also try to bring out some suggestions to optimize comfort level for workers that will improve their health as well as their performance. Hence considering the above issues and problems of the stone masonry workers residing in hill regions, the present study was planned with the following objectives:

1. To assess Musculoskeletal Disorders among workers while performing various activities in stone masonry work
2. To assess the causes of discomfort related to various postures adopted by the workers with the help of RULA and REBA.

MATERIALS AND METHODS

The present study was purposively conducted in Kumaon region of Uttarakhand in Nainital district under Dhari block and five villages were selected from it by random sampling. A total of 120 workers were selected for collecting information regarding musculoskeletal discomfort with the help of Modified Nordic Questionnaire and 75 workers for experimental data for postural analysis with the help of RULA and REBA. The workers carried out the following activities: (i) Extraction of stones (ii) Breaking of stones (iii) loading and de loading of stones (iv) Crushing (v) Shaping (vi) Layering of stones. To carry out such activities, workers most often have to adopt awkward postures for a longer period of time, that result in musculoskeletal pain/discomfort in different body parts of the workers.

(a) Modified Nordic Questionnaire

A Modified Nordic Questionnaire was given to the workers for assessing Musculoskeletal Disorder. The questionnaire consisted of a series of objective questions with yes or no response. Detailed questions on work-related pain in different body parts were asked by workers in last 12 months. The participants were interviewed about any kind of discomfort in different body parts during every activity by showing a body map to them and asked them to point in which body part they felt pain or discomfort.

(b) Postural analysis

Working postures were assessed directly by visual observation and indirectly by using photography and video of the different activities performed by the workers in stone masonry work. The photographs and video were later used to identify the different categories of work postures prone to injury such as bending, twisting, tilting while performing various activities. These photographs and videos were later used by researcher to evaluate the risk level by the techniques RULA and REBA.

(b) Upper Limb Assessment worksheet (RULA)

RULA is a quick survey method for evaluating the exposure of ergonomic risk factors associated with upper extremity musculoskeletal discomfort reported by **(McAtamney, L. and Corlett 1993).** This tool assessed the posture, force and movement associated with tasks related to upper extremity. This tool requires no special equipment, just providing a quick assessment of postures of the upper arm, lower arm, wrist, neck, trunk and the external loads experienced by the body. A scoring system is used to generate an action list which indicates the level of intervention required to reduce the risks of injury by make changes in the postures.

(c) REBA (Rapid Entire Body Assessment) worksheet developed by **Hignett and Atamney, (2000)** for postural analysis of workers for assessing the risk of musculoskeletal discomfort while performing various activities. It is a pen and paper based tool used in the field by direct observations. Different body postures (neck, trunk, back, wrist, upper arm, lower arm and leg) force and coupling were evaluated. A final REBA score was generated giving an indication about the level of risk and urgency with which action should be taken on a five-point action level scale of AL_1 to Al_5.

RESULTS AND DISCUSSION

(a) Activities associated in stone masonry work

There were six activities were observed in stone masonry work. In the first activity, large size stones were extracted from the barren land or non agricultural land. This activity required more physical strength and force to extract the stones. This activity was very hazardous in nature. The stones were extracted by workers with the help of traditional tool like Crowbar/Sabbal, no machines were utilized for extraction at hills. In second activity large sized stones were break into smaller sizes with the help of sledgehammer. In third activity loading and de loading of stones was carried by workers manually by putting load on their head, neck and shoulder. In fourth activity stones were crushed into very smaller sizes with the help of traditional tool i.e hammer. In fifth activity stones were shaped from edges with the help of hammer to make them even for further use. The last activity was layering in which stones were used for construction purpose for making walls, roofs, floors roads and so on.

The workers involved in different activities shows in figure 1 that 14.16 percent workers were found in extraction activity, 13.33 percent of workers found in breaking, whereas 40.83 percent workers were involved in loading and de loading activity, 12.5 percent were engaged in crushing, while 14.16 percent were found in shaping and 5 percent workers were engaged in layering activity.

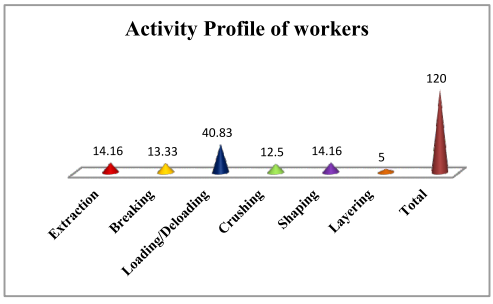

Fig. 1 Percentage distribution of workers with respect to activities

(b) Physical characteristics of stone masonry workers

The physical characteristics of the workers shows that the mean age of stone masonry workers was 56.39 ±14, mean income of the workers was 7424 ± 2531 Rs /month. Nearly 50.83 percent of the workers were illiterate. A large proportion of the workers i.e 73.33 percent were earning 3000-6000/- per month. Majority 88.33 percent of the workers reported that they work for 8-9 hours per day. More than half 51.66 percent of the workers had 7-12 years of work experience.

C) Discomfort and Pain (Modified Nordic Questionnaire)

The work related musculoskeletal disorders and the body pain perceived by the stone masonry workers was determined by administering the standard Nordic musculoskeletal disorder questionnaire. The responses given by the workers were analyzed. It was found that 84. 16 percent of the total workers complained about the activities causing pain and discomfort. More than half 63.33 percent of the total workers said that severity of pain strongly varying, 33 percent of the workers reported that pain hinder their sleep while 41.66 percent of the workers said that they get up in the morning with a stiff feeling in shoulders. On the bases of results it was found that out of total workers, 10.83 percent of the workers sometimes felt pain in head, while 14.16 percent of the workers regularly complained pain in head by putting heavy load on their head in last 12 months.

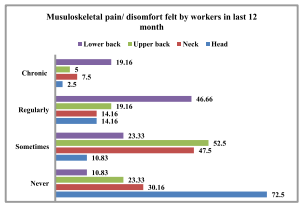

Fig.2 Percentage distribution of workers with respect to musculoskeletal discomfort

Nearly 47.5 percent of the workers sometimes experienced pain in neck in last 12 months while performing activities. Awkward postures for long period of time may increase the risk of musculoskeletal discomfort in upper and lower extremities. Around 52.5 percent of the total workers reported that they sometimes experienced pain in upper back and 19.16 percent of the workers complained about regular pain in upper back in last 12 months. Nearly 46.66 percent of the workers were regularly experiencing pain in lower back region in last 12 months. The reason for back pain was continuous working in back bending position while performing various activities such as extraction, breaking, crushing and shaping by workers that may increase pressure on muscles that leads to pain or discomfort. The results are in line with the study conducted by **Goldshyder, D (2002)** to determine the musculoskeletal disorders among mason tenders and assess work-related activities perceived by them as contributing to their disorders. The results revealed that 82% of the mason tenders experienced musculoskeletal symptom in the last year and low back pain was the most frequently reported symptom by 65% of the workers. Similarly **Das, (2015)** also gave same findings for brick klin workers, in which 70 % of the workers reported low back pain due to working in awkward posture for long period of time.

Around 44.16 and 42.5 percent of the stone masonry workers sometimes felt pain in right and left shoulders respectively. Whereas 34.16 and 40.83 percent of the workers sometimes experienced pain in right and left wrist respectively. More than half 55 percent of the workers sometimes felt pain or discomfort in right and left hands. The reason may be awkward postures for long period of time adopted by workers, repetitive motion of hands shoulders, wrist and poorly designed traditional tools like hammer which were heavy and not having any kind of hand support, therefore workers were direct contact with the tools and complained about pain in palm, hand and wrist portion. The similar findings were given by **Anandraj *et al.*, (2017)** in his study on 321 Hammering tool workers who were suffering from Musculoskeletal discomfort mostly on the neck, wrist/hand and shoulder. It was also revealed that long working hours, high mental load at work and past injury history were major risk factors for work-related MSD.

Nearly 48 percent and 49 percent of the workers sometimes felt pain or discomfort in right and left knees in last 12 months. Similar study was conducted by **Ahmad and Alvi (2017)** among quarry workers with comparison group to assess the relationship between musculoskeletal discomfort among quarry workers. The results revealed that complains regarding prevalence of musculoskeletal discomfort during the past 12 months was higher among stone quarry workers 81.2% as compared to the control group 56%. Most affected body parts were low back 61.5%, followed by knee 39.4% and shoulder28% among quarry workers.

On the bases of activities it was found that more than half 52.94 percent of the workers involved in extraction activity were regularly experiencing pain in lower back region and 47 percent workers complained about pain in wrist portion in last 12 months. While 62.5 percent and 50 percent workers involved in breaking activity complaining about pain in lower back and shoulder respectively in last 12 month. In loading de loading activity 46.93 percent, 36.73 percent and 26.53 percent workers felt pain in lower back, shoulder and head in last 12 months respectively. In crushing 26.66 percent workers suffering from lower back pain regularly while 20 percent had chronic lower back pain in last 12 month. Forty percent workers were suffering from wrist pain in last 12 months. While 47 percent workers involved in shaping activity complained about pain in lower back and 35 percent in upper back in last 12 months. In case of layering all of the workers were reported that they sometime felt pain in lower back, hands and knees in last 12 months.

(d) Postural Analysis

The postural analysis of the workers while performing different activities in stone masonry work were observed and each posture was identified according to the risk involved. The position of the back, upper limbs, and lower limbs i.e. arms and legs as well as load or force used in carrying out the activities were considered for the analysis of posture. The postures adapted by the workers in extraction, breaking, loading/ de loading, crushing, shaping and layering were carefully analyzed. It was found that most of the postures involve bending, twisting, standing or sitting and squatting position. The postures were analyzed using the RULA and REBA techniques. In Table 1 the total postural analysis for the different activities in stone masonry work is represented.

Table 1: Different RULA and REBA scores for different postures

Posture and activity	RULA score	REBA score	Risk level REBA	Maximum discomfort in body parts
Extraction	7	10-13	High to very High	Shoulder, lower arm, wrist, hand lower back, knees
Breaking	7	10-13	High to very High	Shoulder, lower arm, wrist, hand lower back
Loading and De-loading	6-7	7-10	Medium to High	Head, shoulder, neck, lower back, knees
Crushing	6-7	7-8	Medium to High	Lower back , upper back, neck, wrist
Shaping	4-6	3-7	Low to Medium	Wrist, lower back
Layering	4-7	7	Medium	lower arm, lower back,

In Table 1 the total postural analysis for the different activities in stone masonry is represented. In three activities, extraction, breaking and loading/ de-loading, RULA posture scores was 7 indicating a postural change is needed immediately as the working postures are vulnerable to risks and required immediate ergonomic intervention. Similarly REBA posture scores indicate that the postures for extraction and breaking activities required immediate attention with a score of 10 to 13. Remaining activities loading and de-loading, crushing, shaping and layering were also at risk and changes may be needed in postures, with a score of 7-10 and require intervention soon. Similar study was conducted by **Mukhopadhyay and Srivastava (2010)** to investigate the ergonomic risk factors among 25 male workers involved in stone carving unit at Jaipur. For posture analysis tools like REBA and RULA was used. The results revealed that postural analysis by REBA showed high score (13/13) and RULA showed score (7/7) that showed vulnerability of many of the postures to musculoskeletal discomfort and injury.

CONCLUSION

Stone masonry work is one of the hazardous occupations. There are numerous risks and hazards are associated with the activities performed by workers manually by using traditional tools, working with manual load lifting and awkward postures in which the workers are engaged for long period of time. As the workers continuously work in bent or stressful postures during activities, they were suffering from discomfort and pain in different parts of the body. The feeling of pain and discomfort is troubled to them, if the stressful postures are maintained for a long period of time. Postural analysis using RULA and REBA indicated that most of the postures adopted by workers in stone masonry work while performing activities were vulnerable to work related musculoskeletal disorders and required immediate ergonomics intervention. The workers experienced injuries in different body parts specially, cuts from sharp edges of stones, hand/finger injury

from tool or stones and eye injury. They were not using personal protective equipments like gloves, helmet, face mask, eye goggle during work that may increase the risk of injuries. The accidents during loading and de loading activity included slips trip and falls. No medical facility was provided by the owners in case of an accident or injury. Most of the workers were smokers or had habits of tobacco chewing. At the end of the day most of the workers drink the locally available liquor to get relieved from the stress or body pain. Because of the economic conditions, unemployment, less job opportunity, no agricultural land and illiteracy, force these workers to work under this sector for their livelihood and they are compelled to work under poor working conditions and follow unsafe practices without knowing the ill effects of this work on their health.

Recommendations

The stone masonry work need a well designed comprehensive ergonomics plan and the necessary resources to support the same in order to improve the prevention of work related Musculoskeletal disorders, health risks and improve the working conditions and productivity of the workers. Some of the improvements may be needed in the following directions:

a) Implement a continuous training programme so that, each worker becomes aware of the relevant factors concerning postures/discomfort associated with the activities in stone masonry work.
b) Improve the workplace and equipment by making minor changes in the traditional tools by providing hand support to prevent pain in palm portion of the hands.
c) Design of trolley based on locally available material for transportation of stones and/or raw materials to avoid manual loading and de loading of stones, to protect workers from musculoskeletal disorders.
d) Illiteracy and unawareness emerged as the major constraints regarding workers involvement in different activities. Therefore various guidelines and measures, information, educational programmes, workshops should be formulated to prevent MSD's.
e) Continuous use of personal protective equipments during working hours will improve the quality of life of the workers.

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