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Ergonomic risk factors associated with workers involved in shaping and crushing activity in stone masonry work

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Abstract

Construction is one of the important industries which employ a large number of people in its workforce. Job opportunities in the hilly regions are very less due to low education level, therefore, the majority of the people are involved in stone masonry work to sustain their lives and it become a second important source of income in hilly areas after agriculture. The present study was purposively conducted in the Kumaon region of Uttarakhand, India, with the objective–of assessing the ergonomic risk factors associated with this work. Methodology–A Modified Nordic Musculoskeletal based questionnaire was used for assessing pain or discomfort and a Rapid Entire Body Assessment sheet was used for assessing postural load among workers. It is basically a labour intensive job, where most of the activities are performed manually. Occupational health and safety hazards are more pronounced in manual crushing and shaping of stones operations. Results revealed that an old traditional tool (hammer) without any palm support was used in crushing and shaping activities therefore workers were in direct contact with hard surfaces and complained about pain in the palm portion. While performing these activities workers were adopting awkward postures for long periods of time and were at risk of injuries and musculoskeletal disorders. REBA scores indicated that in both activities the higher MSD risk was noticed in the lower back, wrist/hands and knees. It was also found that workers were not using and personal protective equipment while working and at risk of injuries. A significant association was found between musculoskeletal disorder and body regions especially, in the lower back, wrist and knees in both activities.

Keywords: Crushing, shaping, stone masonry, musculoskeletal disorders, injuries, posture

1. Introduction

Construction industry is one of the most booming industries in the whole world. The construction industry of India is an important indicator of development as it creates investment opportunities across various related sectors. GDP from construction in India averaged 2203.46 INR billion from 2011 until 2019. Construction is one of the important industries which employ a large number of people in its workforce. Owing to the advent of industrialization and recent developments, this industry is playing a pivotal role in construction of buildings, roads, bridges, and so on. (Gopireddy *et al*; 2016)^[2].

The present study was purposively conducted in the Kumaon region of Uttarakhand, in India. In hilly regions of Uttarakhand stones are widely used for the construction purposes, such as construction of commercial and residential buildings, floors, roofs, roads, walls, etc. because of their suitability and easy availability by local people. Along with that job opportunities in the hilly regions are very less due to low education level, therefore, the majority of the people are involved in stone masonry work to sustain their lives and it become a second important source of income in hilly areas after agriculture.

Stone masonry is a type of building masonry construction that uses stones and mortar. It is basically a labour intensive job, where most of the activities are performed manually. Six major activities extraction, breaking, loading and unloading, crushing, shaping, and layering of stones come under this work. In the present paper workers who were involved in shaping and crushing activities are taken into account. Stone masonry work is one of the most dangerous informal sectors to work in because of the enormous health hazards associated with this work. Occupational health and safety hazards are more pronounced in manual stone operations.

The workers have to perform all the activities manually, using traditional tools like hammers for breaking large size stones into small pieces during the crushing activity and in the shaping activity large sized stones are shaped at the edges by using traditional hammers to make them even and then further used in construction.

While performing these activities workers were at risk of injuries and musculoskeletal disorders. The injuries resulting from accidental hazards includes being hit by stones or tools, injury of hands, fingers, toes, eye injury resulting from penetration of small dust particles into the eyes while shaping and crushing the stones.

Globally, musculoskeletal disorder is the single largest cause of work related illness; accounting for over 33% of all newly reported occupational illness in the general population and 77% in the construction workers. Musculoskeletal disorders not only hinder productivity at work, they are also leading cause of sickness, absenteeism and end with disability if ignored (Gopireddy, *et.al*; 2016) [2]. Musculoskeletal discomfort consists of functional impairments and physical disabilities that affect the muscles, bones, nerves and joints. Symptoms include tenderness, aches and pains, tingling, stiffness and swelling.

In shaping and crushing activities workers used to sit in awkward static positions for long periods of time without considering their postures and suffering from pain in various body parts specially in hands, wrist, lower back and knees. Awkward postures, repetitive and forceful motions are involved in stone masonry work that leads to burden on muscles and joints that increase their efforts in response to fatigue which leads to musculoskeletal discomfort (Okello *et al.*, 2020) [4].

It has been also found in research studies that while performing those activities, a respirable crystalline silica dust is generated, this dust is inhaled by workers during work and accumulated in lungs that cause respiratory disease, called silicosis, which leads to lung cancer and tuberculosis and may be related to the development of chronic renal disease and autoimmune disease such as rheumatoid arthritis among workers. (Occupational Safety and Health Administration).

The workers who are involved in this sector, hardly provided or using personal protective equipments and ergonomically designed tools while performing activities. There is an emerging need for protecting workers and reducing ill effects to some extent with the following objectives

1. To study personal profile of the workers.
2. To study the work profile of workers.
3. To assess common injuries sustained by workers.
4. To assess pain and discomfort felt by workers
5. To assess work posture, associated musculoskeletal disorders among workers.
6. Rapid Entire Body Assessment (REBA) for postural analysis of workers.

2. Methodology

Selection of subjects

The present study was purposively conducted in the Kumaon Region of Uttarakhand in the in India. Descriptive research was planned among 32 male workers who were involved in shaping and crushing activities in stone masonry work.

Questionnaire

The interview schedule was planned for collecting data regarding the demographic profile of workers. A modified Nordic Musculoskeletal based questionnaire was administered to the subjects for assessing the pain or discomfort felt by

workers while doing the activity. The questionnaire consisted of a series of objective questions with multiple-choice responses.

Analysis of working postures

The different working postures during crushing and shaping activities were analyzed by using the Rapid Entire Body Assessment (REBA) sheet. Digital photography and videos were recorded for further analysis. The most frequent postures adopted by the workers were considered.

Statistical analysis

For statistical analysis χ^2 test of independence was used to determine a significant association between musculoskeletal disorders in different body parts with respect to shaping and crushing activity performed by workers. The computed χ^2 values were then compared with critical χ^2 values for the chosen level of significance ($p < .05$). All the responses received on the data sheet were categorized and analyzed using (frequency, percentage, and standard deviation).

3. Results

Demographic profile of load lifting workers

The mean age of workers involved in crushing and shaping activities were 42 ± 7.48 , 53.52 ± 7.6 years, respectively. In crushing activity, more than half 60 percent of the workers were found in the age group of 35-45 years followed by 13.33 percent of the workers were under the age group of 25-35 years. Remaining 20 percent and about 6.66 percent workers were laid under the age group of 45-55 and above 55 years of age respectively. In shaping activity, more than half 52.94 percent of the workers were under the age group of 55 and above. Rest 29.41 percent and 17.64 percent workers were under the age group of 45-55 and 35-45 years respectively. It was found that majority, 76.47 percent of the workers engaged in shaping activity were illiterate, while 73.33 percent of the workers were not educated in crushing activity. It was investigated that the mean income of workers involved in crushing and shaping activities were, 3300 ± 1877 , and 7058 ± 1908 Rs/month respectively. Majority 86.66 percent of the workers in crushing, and 76.47 percent of the workers in shaping activity were working for 8-9 hours per day. About 46.66 and 23.52 percent of the workers involved in crushing and shaping activity had the same work exposure of more than 13 years respectively.

Method of work

As far as the method of work was concerned, it was found that all of the workers involved in various activities were performing activities manually. None of them were using any machine for accomplishing the activity.

Table 1 investigated the work pattern of workers and it was found that all of the workers involved in crushing and shaping activities were carried out the same work almost the whole day. Both activities were repetitive in nature and required movement of arm, wrist and hands many times per day. About 41 percent of the workers involved in shaping activity said that sometimes they had to work very fast to accomplish the task on time.

Table 1: Work pattern of workers while performing activities, n=32

Work pattern	Crushing (n4=15)		Shaping (n5=17)	
	Yes	No	Yes	No
Carry out the same work almost the whole day	15 (100)	-	17 (100)	-
Work rotate between you and your colleagues	4 (26.66)	11 (73)	4 (23.52)	13 (76.47)
Repetitive tasks many times in a day	15 (100)	-	17 (100)	-
Breaks between the tasks	15 (100)	-	12 (70.58)	6 (35.29)
Breaks sufficient for a day	9 (60)	6 (40)	12 (70.58)	5 (29.41)
Breaks were decided by your choice	6 (40)	9 (60)	12 (70.58)	5 (29.41)
Pressure to work for long hours	4 (26.66)	11 (73)	7 (41.17)	10 (58.82)
Pressure to work very fast	4 (26.66)	11 (73)	7 (41.17)	10 (58.82)
Holiday when you wish	7 (46.66)	8 (53)	7 (41.17)	10 (58.82)
The movements with your arm, wrist and hands many times per day	15 (100)	-	17 (100)	-

Note: Values in parenthesis indicates percentage

Table 2: Working postures adopted by workers while performing activities, n =32

Activity/Posture	Crushing (n4= 15)	Shaping (n5= 17)
Standing	-	-
Squatting	11 (73.33)	11 (64.70)
Forward Back bending	11 (73.33)	11 (64.70)
Forward neck bending	11 (73.33)	11 (64.70)
Sitting	4 (26.66)	6 (35.29)
Knee bend	11 (73.33)	11 (64.70)

Note: Values in parenthesis indicates percentage

Table 2 visualizes data regarding the posture adopted by workers while performing various activities. On the basis of the findings, it was revealed that in the case of crushing activity 73.33 percent of the workers were working in squatting positions with forwarded back, neck and knee bending. While 26.66 percent of the workers were working in a sitting posture with forwarded back bending. In the case of shaping activity majority 64.70 percent of the workers were working in the squatting positions with forwarded back, neck and knee bending. Whereas 35.29 percent of the workers were performing activities in sitting positions. Due to the repetitive nature of work and carrying out the work in the same position for a long period of time, the majority of the workers reported symptoms of pain in the lower back, wrist and in knees. The results are in line with the study conducted on brick kiln workers and reported that most 67 percent of the workers were adopted squatting position during work and complained about pain in low back and in knees.

Tools used by workers while performing activities

All the workers engaged in the crushing and shaping activities were using old traditional tools like hammers. None of the workers were using chisels or machines as a tool while performing activities.

Experience in manual handling of tools

Data regarding experience in manual handling of tools while performing activities in stone masonry work by workers. About 66.66 percent of the workers involved in crushing activity said that the traditional tool (hammer) they were using was not comfortable and did not have proper palm support to carry work easily. It was observed that while crushing and shaping the stones their hands were in direct contact with the hard surface of the tool. That causes pain or

stiff feelings in the wrist and palm portion of workers.

Similarly, a large proportion i.e 64.70 percent of the workers involved in shaping activity reported that the tool (hammer) they were using was not comfortable. It was observed that the tools they were using did not have any palm support and they were continuously in contact with the hard surface of those tools for 8-9 hours while performing the activities. Therefore they were suffering from musculoskeletal discomfort or pain especially in the hands/wrist and palm portion of the hands.

In totality it was found that the tools used in these activities were not accepted by workers and they were not comfortable with these traditional tools and asked for improved and comfortable ergonomically designed tools. Similar study was conducted by Anandraj *et al.*, (2017) [1] among hammering tool workers and it was revealed that the hammering workers were exposed to musculoskeletal discomfort mostly on the neck, wrist/hand and shoulder, when they work for 8-10 hours regularly with poorly designed tools.

Table 3 visualizes that on the bases of activities, it was found that none of the workers involved in crushing, and shaping activities, were using gloves, facemask, helmet, tools with hand support and eye goggle. This may increase the risk of injuries and accidental hazards. It was also observed that the workers had poor knowledge regarding using of protective clothing, especially masks, gloves, head support, helmet and eye goggles during work. Therefore all of the workers were at high risk of musculoskeletal discomfort, respiratory hazards, eye injuries, cuts and wounds. Similar study was conducted by Prasad *et al.*, (2014) [5], who revealed that the workers involved in stone crushing industry were not using any protective equipment during task and suffering with musculoskeletal problems, eye problems and respiratory problems.

Table 3: Safety practices adopted by workers while performing activities, n=32

Activity Safety/Practices	Crushing (n4= 15)	Shaping (n5= 17)
Gloves	-	-
Face mask	-	-
Helmet	-	-
Tool with hand support	-	-
Handkerchief	3 (20)	2 (11.76)
Sleeper	4 (26.66)	5 (29.41)
Shoes	11 (73.33)	12 (70.58)
Eye goggles	-	-

Note: Values in parenthesis indicates percentage

Table 4: Pain and discomfort in various body parts felt by stone masonry workers, n=32

Pain in various body parts	Crushing (n4=15)		Shaping (n5=17)	
	Yes	No	Yes	No
Do you know about musculoskeletal discomfort /pain	-	15 (100)	-	17 (100)
Pain start during your current job?	12 (80)	3 (20)	13 (76.4)	4 (23.5)
Do you stay away from normal activity because of pain / discomfort	-	15 (100)	-	17 (100)
Activities cause pain / discomfort	12 (80)	3 (20)	13 (76.4)	4 (23.4)
Is pain getting worse?	4 (26.6)	11 (73)	6 (35.2)	11 (64)
Is the severity of pain strongly varying?	8 (53.3)	7 (46.6)	8 (47)	9 (52.9)
Pain start suddenly?	7 (46.6)	8 (53.3)	8 (47)	9 (52.9)
Pain hinder your sleep?	4 (26.6)	11 (73)	5 (29.4)	12 (70)
Getting up in the morning with a stiff feeling	5 (33.3)	10 (66.6)	6 (35.2)	11 (64)
Numbness or twinkling feeling in your arms or hands?	4 (26.6)	7 (46.66)	6 (35.29)	11 (64.70)
Did you ever had				
A frozen shoulder	4 (26.6)	11 (73.3)	2 (11.7)	14 (82.3)
A herniated cervical disc	-	15 (100)	-	17 (100)
medical treatment due to your pain	-	15 (100)	3 (17.6)	14 (82)
A hospitalization due to your pain?	-	15 (100)	-	17 (100)

Note: Values in parenthesis indicates percentage

Table 4 stated that workers had no idea about the term musculoskeletal discomfort earlier. After asking about their pain or discomfort majority 80 percent of the workers involved in crushing activity reported pain due to their current job, while 76 percent of the workers from shaping activity had pain because of their current job. About 46 percent and 47 percent of the workers from crushing and shaping activity

reported that the pain started suddenly and sometimes hindered their sleep. Any type of health facility was not provided to workers in any activity.

Risk of musculoskeletal disorders among workers involved in crushing and shaping activities

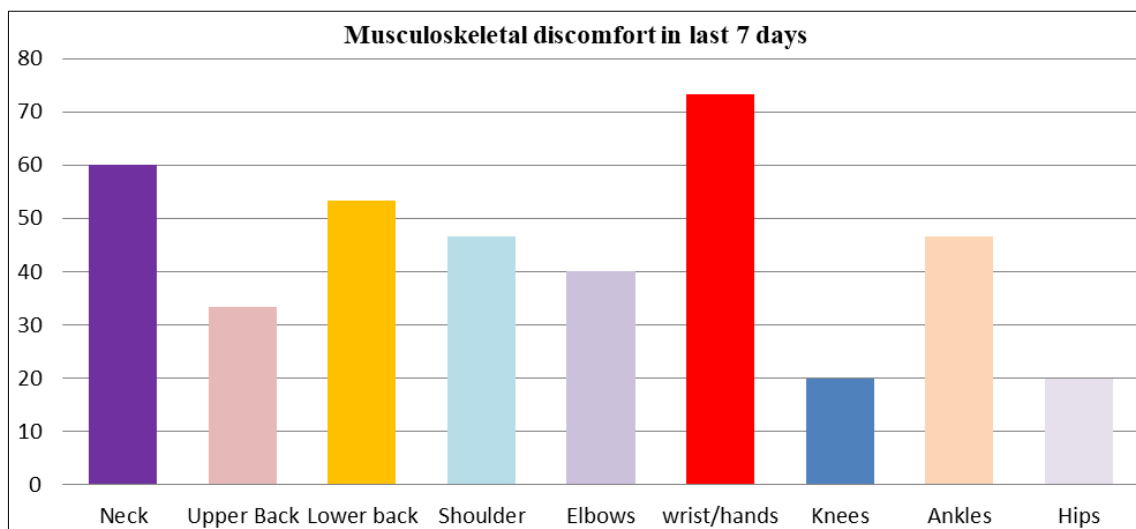


Fig 1: Prevalence of musculoskeletal pain/discomfort among workers involved in crushing activity in last 7 days

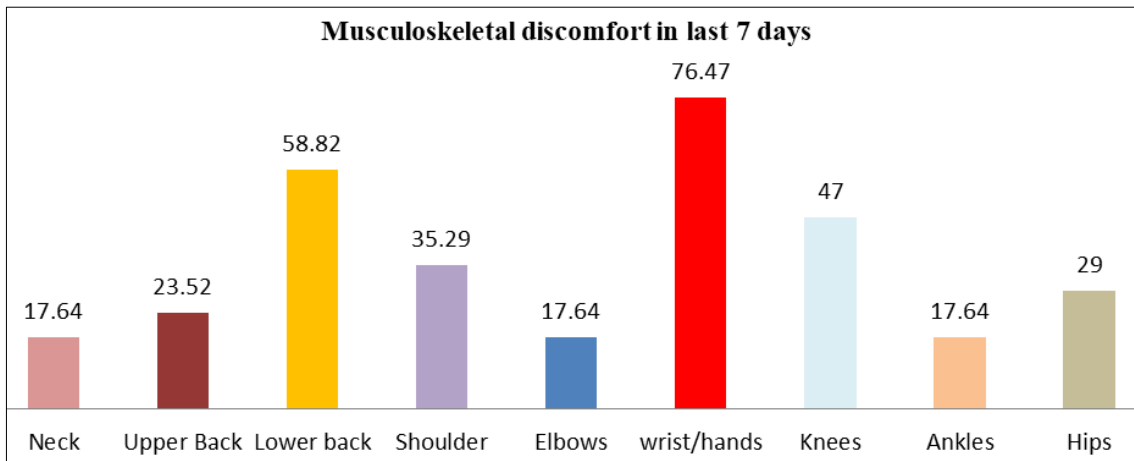


Fig 2: Prevalence of musculoskeletal pain/discomfort among workers involved in shaping activity in last 7 days

It was observed from the fig.1 that large proportion, i.e 73.33 percent of workers complained about pain in wrist or hands in last 7 days in crushing activity. More than half 53.33 percent of the workers were suffering from lower back pain in last 7 days. Whereas 46.66 percent and 40 percent workers were having pain in shoulders and elbows respectively.

It was observed from the fig. 2 that large proportion, i.e 76.47 percent of workers complained about pain in wrist or hands in last 7 days in shaping activity. More than half 58.82 percent of the workers were suffering from lower back pain in last 7 days. Whereas 47 percent and 35.29 percent workers were having pain in knees and shoulders respectively

Table 5: REBA analysis for postural assessment of workers, n=32

Activity/REBA Action category	Crushing n4=15	Shaping n5 =17	Body parts with discomfort	Risk level REBA
AL ₁	-	-	-	-
AL ₂	-	4 (23.52)	Wrist	Low
AL ₃	9 (60)	7 (41.17)	Hands, wrist, lower back, knee	Medium
AL ₄	6 (40)	6 (35.29)	Wrist, hands, knee, lower back, shoulder	High
AL ₅	-	-	-	Very high

Note: Values in parenthesis indicates percentage

Postural stress may lead to musculoskeletal disorders while performing the task and cause pain and injuries to vertebral column in the long run. In Table 5 the total postural analysis for the activities in masonry work is represented. In case of crushing activity 60 percent workers were comes under AL₃ (medium risk, change soon) category and remaining 40 percent were found in the zone of AL₄ indicating (high risk level and immediate change) in postures. Whereas in shaping activity 41.17 percent workers were in AL₃ (medium risk, change soon) and 35.29 percent workers were found in AL₄ (high risk, immediate change) in postures. A small proportion 23.52 percent of the workers were found in AL₂ (Low risk of MSD).

Awareness about effect of silicosis on human health among workers

Although the acute problem of silicosis is not a major issue in mountain regions of India. But it is better to educate or create awareness among stone masonry workers, to use small covers on face/mouth / nose etc. so they can protect themselves from silicosis in the future. Data regarding awareness level of workers in terms of silicosis. The results revealed that on the whole out of total workers, no one had awareness regarding silicosis. They never heard the term silicosis before, its types, signs, symptoms and associated information about silicosis. The reason was high illiteracy level and no source of information among workers. Along with that there was not any such type of study was conducted in this area, focusing to stone masonry workers, silica dust in stones, its release and effects and related occupational health. The results are in line with the study conducted by Sivanmani and Rajathinakar

(2013) [6] on stone crushing workers to assess the level of awareness among workers about silicosis and level of preventive measures associated with it. On the bases of results it was found that majority of the workers had lack awareness about the disease and there was low implementation of preventive control measures.

Table 6: Association between musculoskeletal discomforts with respect to different Body regions

Activities	Body regions	χ^2	Significance
Crushing	Wrist	12.26	($p < 0.05$)
	Lower back	16.20	($p < 0.05$)
	Knee	6.51	($p < 0.05$)
Shaping	Wrist	14.35	($p < 0.05$)
	Knee	12.39	($p < 0.05$)
	Lower back	6.51	($p < 0.05$)

4. Conclusion

On the basis of findings, the following conclusion was drawn: The workers, who were involved in crushing and shaping activity in stone masonry work, were highly at risk of musculoskeletal discomfort and postural stress. The workers were unaware about the risk associated with these activities; they were vulnerable to being affected by a wide range of injuries and accidents. This work requires high physical exertion, force and repetitive motions of hands, arms and wrist therefore proper breaks between the tasks is required for rest. But they were forced to work for several hours, which may cause fatigue and tiredness among workers. They used to adopt awkward postures while working and are highly at risk of problems in disks, vertebral and spinal Column in the near

future. Due to the unavailability of ergonomically designed tools and equipment, they were forced to work with old traditional tools and faced problems related to pain or discomfort in the palm portion. Therefore the urgent need for precautions/safety measures should be taken into account. The findings of this study suggest the need for educating the workers about musculoskeletal disorders, postural stress and utilization of safety measures. Working posture should be appropriate for minimizing the risk of lower back pain. Ergonomically designed hammer with palm support should be provided to the workers. Medical and other facilities should be offered along with wages to reduce the economic constraints and enhance quality of life of the workers. Traditional tools must be replaced with advanced handy tools. It should be equipped with hand support to minimize the discomfort or pain in palm portion. Personal protective equipment especially gloves, helmets, eye goggles, face masks must be provided to the workers during activities, which may reduce the risk of hazards, dust and eye injuries at work.

5. References

1. Anandaraj T, Nishant S, Sakthivelu S, Snthilraj K. Work related musculoskeletal disorders among hammering workers. *Journal of Chemical and Pharmaceuticals Sciences*. 2017;3:14-17.
2. Gopireddy MMR, Nisha B, Thangaraj GP, Vishwambhar V. Musculoskeletal morbidity among construction workers: A cross sectional community based study. *Indian Journal of Occupational Environmental Medicine*. 2016;20(3):144-149.
3. Lalzirliani R. Socio economic and health condition of the stone quarry workers in Aizawl. Published Ph.D. Thesis in Social Work, Mizoram University, Aizawl; c2014.
4. Okello A, Wafula S, Sekimpi KD, Mugamble R. Prevalence and predictors of work related musculoskeletal disorders among workers of a gold mine in South Kivu. Democratic Republic of Congo. *BMC Musculoskeletal Disorders*. 2020;21(1):1-10
5. Prasad MA, Bhagat V, Wagh V, Mudey A, Nayak S, Gaiki V. Assessment of health status of stone quarry workers in Yelakeli, Wardha district in Central India. *Innovative Journal of medical and health science*. 2014;4(6):180-181.
6. Sivanmani K, Rajathinakar V. Silicosis in Coimbatore district of Tamil Nadu: A passive surveillance study. *Indian Journal of Occupational and Environmental Medicine*. 2013;7(1):25-28.
7. Sulainman S, Kamalnathan P, Ibrahim A, Nuhu J. Musculoskeletal disorders and associated disabilities among bank workers. *International Journal of Research in Medical Science*. 2015;3(5):1153-1158.
8. Subhasis B, Giyasuddin S, Arindam R. Economic importance of stone quarrying in rural livelihood and its impact on environment: a case study of Saltora Block, Bankura, West Bengal. *International Journal of Scientific Research and Reviews*. 2018;7(3):1045-1062.
9. Trading Economics. India GDP from construction. Retrieved on 22 March 2022.