

Epidemiology of Work-Related Musculoskeletal Symptoms and Illnesses among Brick Kiln Workers in Kathmandu Valley, Nepal

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ABSTRACT

Background

Workers in the brick manufacturing industries require to carry heavy loads, do repetitive work and remain in awkward postures for extended periods of time. These activities may cause them to develop work-related musculoskeletal symptoms and disorders.

Objective

To investigate the epidemiology of musculoskeletal symptoms and disorders among brick manufacturing workers as well as similar exposure groups among brick kiln workers.

Method

An analytical cross-sectional study was conducted during February - March 2015 in the Kathmandu Valley. From 16 brick kilns, 400 interviewees involving green brick molding, green brick stacking/carrying, red brick loading/carrying, coal crushing/carrying and firing were recruited. An unmatched equal size of reference group of grocery workers was maintained for comparison. Prevalence of all musculoskeletal symptoms and disorders were computed and compared among brick workers and grocery workers as well as similar exposure groups among brick kiln workers.

Result

The musculoskeletal symptoms and disorders were prevalent in 90.5% of the exposed and 82.2% of the reference group. Brick kiln workers were about two times more likely to experience musculoskeletal symptoms and disorders compared to the reference group. When the associations among similar exposure groups were evaluated, there were significantly high prevalence of musculoskeletal symptoms and disorders among green brick molders, red brick loaders/carriers and coal crushers/carriers in comparison to firemen.

Conclusion

This study showed a high prevalence of musculoskeletal symptoms and disorders among brick kilns workers. Among all similar exposure groups, coal crushing/carrying task significantly elevated with all types of musculoskeletal symptoms and disorders.

KEY WORDS

Brick kiln workers, Ergonomics, Musculoskeletal symptoms and disorders, Similar exposure groups

INTRODUCTION

Brick manufacturing, a labor intensive informal sector industry, requires workers to carry heavy loads, perform repetitive works and remain in awkward postures for extended periods of time.¹⁻⁵ Work-related musculoskeletal symptoms and disorders (MSDs) describe a wide range of inflammatory and degenerative conditions.⁵⁻⁹ These conditions result in pain and functional impairment affecting the neck, shoulders, elbows, forearms, wrists and hands.^{2,6} Daily work activities and work conditions significantly contribute to their development or exacerbation.^{2,5,6}

The symptoms were experienced by 58.0-73.0% and 75.0% of brick kiln workers based on previous studies.^{2,7} Posture and force analyses found poor standing posture, undesirable wrist positions, repetitive work, forced loadings and piecework system as the causes of MSDs.^{3,10} Awkward postures such as squatting postures while forming bricks and carrying heavy loads resulted in a large number of workers complaining of pain in different body parts. Among brick kiln workers, 50.0% had low back pain, 38.0% had neck pain and 29.0% had shoulder pain in a previous study.¹¹

The objective of this study was to find out the prevalence of MSDs among brick manufacturing workers and grocery workers as well as workers from different work zones among the brick manufacturing workers.

METHODS

An analytical cross-sectional study was carried out in the Kathmandu Valley During February- March 2015. There were 106 operating brick kilns in Kathmandu Valley at the time of the study. Among those, 62 brick kilns were in Bhaktapur, 26 in Lalitpur and 18 in the Kathmandu district. At first, all the brick kilns were visited, and a list was generated to construct the sampling frame. A probability proportionate to size (PPS) sampling was applied to select the brick kilns and the brick kiln workers.¹² In total, 9 kilns from Bhaktapur, 4 kilns from Lalitpur and 3 kilns from Kathmandu district were selected.

A total of 800 (exposed: 400 and reference: 400) were selected for interview. Brick kiln workers who had been working for ≥ 2 year were assessed. Grouping of the workers was done based on the similar work type, called similar exposure groups (SEG).¹³ Within the brick kilns, the groups of workers working in the green brick molding zone (GBMZ) (n=80), green brick stacking/carrying zone (GBS/CZ) (n=80), red brick loading/carrying zone (RBL/CZ) (n=84), coal crushing/carrying zone (CC/CZ) (n=75) and firing zone (FZ) (n=81) were maintained. Reference groups were recruited applying an unmatched equal size sampling technique including grocery workers. The use of unmatched reference group, obtained through random sampling, allows greater flexibility in studying various interactions and information

on potential confounding factors, so that these can be adjusted in the analysis.¹⁴ The workers involved in brick manufacturing have to carry heavy loads, perform tasks repeatedly, have to stay in awkward postures for long periods of time and work for long periods of time. Grocery workers, on the other hand, do not carry that heavy load and need not stay in awkward postures. Both groups are of informal nature and do work for long periods of time; that is why grocery workers were chosen as the reference group. Among the SEGs in the brick kiln, the FZ workers were taken as the reference workers in the bivariate and multivariate logistic regression analysis because their task was a bit different than that of brick kiln for example they carry a smaller amount of loads with their hand and use less force during work, but they remain bent most of the time to feed the fuel in the kilns furnace. A considerably large number of groups were interviewed through careful sampling which minimized participation bias. As a result, the response rate was 98%.

Socio-demographic measures, work period, and the 'Standardized Nordic Questionnaire for the analysis of musculoskeletal symptoms were applied for the interview.^{2,15} With cycles of translations into Nepali version and back translations into English version, the questionnaire was finalized through reviews and revisions getting feedbacks from experts. The finalized Nepali version questionnaire was validated through pre-test in the unselected brick kilns.

The interviews were completed using structured questionnaire administered by trained health personnel. The questionnaire included socio-demographic measures (age, gender and marital status), level of education and duration of work as well as the 'Standardized Nordic Questionnaire for the analysis of musculoskeletal symptoms'. This article mainly focuses on the following 'yes', 'no' dichotomous questions and their response options: "Have you at any time during last 12 months had trouble (ache pain, discomfort) in: neck; right shoulder, left shoulder and both shoulders; right elbow, left elbow and both elbows; right wrist/hand, left wrist/hand and both wrist/hand; upper back; lower back; hips/thighs; knees; ankles/feet?" Groups who responded 'yes' for the questions were again asked two more questions: "Have you at any time during the last 12 months been prevented from doing your normal work (at home or in the brick kilns) because of the pain?" and "Have you had trouble at any time during the last 7 days?"

Those workers who were willing to involve in the interview process and working for ≥ 2 years in brick kilns and working for at least eight hours in a day for at least six days in a week were interviewed as the study group. The grocery workers who worked for ≥ 2 years and were working for at least eight hours in a day for at least six days in a week in the small and medium-sized grocery stores were interviewed as the reference group. Workers

working in the big shopping malls and road side huts were excluded in the study.

The response ‘yes’ was entered as ‘1’ and ‘no’ was entered as ‘0’. The proportion of ‘yes’ out of total number for last one year was considered as prevalence of the musculoskeletal symptoms. The prevalence with 95% confidence intervals (CIs) for all musculoskeletal symptoms for a year was estimated. Mean, median, minimum, maximum and proportions were calculated as socio-demographics (age, gender, marital status, schooling and duration of work). Bivariate and multivariate logistic regression analyses (odds ratios [ORs] and adjusted ORs [AORs] with 95 % CIs) were applied to the prevalence of musculoskeletal symptoms and groups (exposed and reference), and SEGs within brick kiln workers. Age of groups, years of schooling of groups, and duration of work in the company were taken as covariates in the multivariate logistic regression analysis. Prevalence for all musculoskeletal symptoms were computed and compared among brick workers and grocery workers as well as SEG among brick kiln workers at 0.5 and 0.01 level of significance. Statistical analyses were performed using the IBM SPSS statistics 21. To calculate 95% CI for the prevalence, stat calculator online software was used.¹⁶

Ethical approval for study was obtained from the institutional review committee of the Kathmandu University School of Medical Sciences, Dhulikhel hospital, Dhulikhel, Kavre. Participation in the study was voluntary and informed written consent (thumb print in case of illiterate interviewees) for the assessment and publication was obtained from each interviewee before the interview. The consent form at the top of every questionnaire was read out by the interviewer at the beginning of the interview.

RESULTS

The mean age for the exposed group was 31.74±12.97 years and for referent was 33.33±9.03 years. Females represented 25.5% and 32.5% in exposed and referent groups, respectively. (table 1) The prevalence of ache/pain/discomfort symptoms with 95% CIs of all nine musculoskeletal joints included in the “Standardized Nordic Ergonomic Questionnaire”, namely neck, shoulders, elbows, wrists/hands, upper back, lower back, hips/thighs, knees and ankles/feet were estimated among brick industry and grocery workers. In total, 90.5% of exposed and 82.3% of reference experienced some type of musculoskeletal symptoms during a year (Table 2).

Figure 1 presented the prevalence of MSDs within SEGs among the brick kiln workers. Figure 2 presented the MSDs, which at any time during the year had prevented the workers from doing normal work because of the pain. Refer to figure 3 for MSDs at any time during a week which prevented the workers from doing normal work.

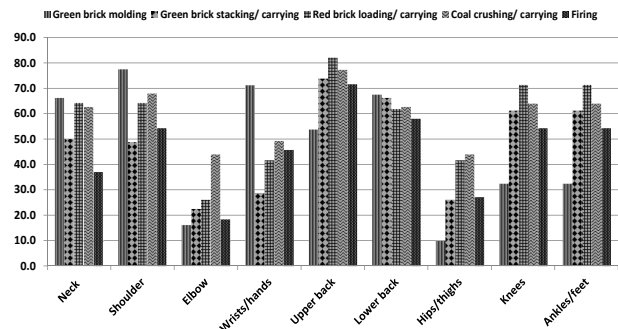


Figure 1. Prevalence of musculoskeletal symptoms/illnesses among SEGs (%)

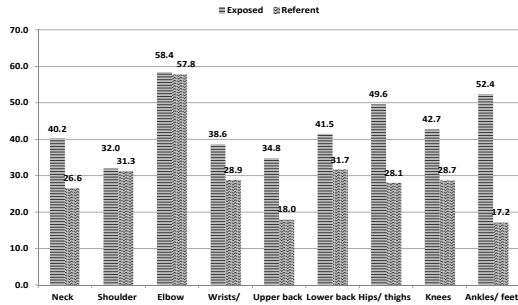


Figure 2. MSK symptoms at any time during the last year prevented from doing normal work (%)

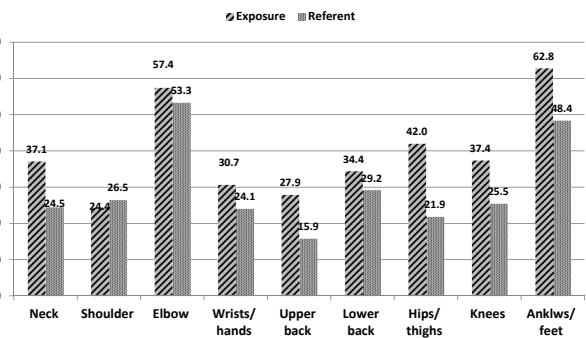


Figure 3. MSK symptoms at any time during the last week prevented from doing normal work (%)

The prevalence of MSDs among the exposed were compared with the reference group. Brick kiln workers were almost two times more likely to have MSDs in any body part compared to the reference group (Table 3).

When the association was evaluated among the brick kiln SEGs, GBMZ, RBL/CZ, and CC/CZ workers had higher neck MSDs; GBM workers had higher shoulder and wrists/hands MSDs; CC/CZ workers had higher elbow MSDs; FZ workers had higher wrists/hands and upper back MSDs; GBMZ and CC/CZ workers had higher hips/thighs MSDs; GBM and RBL/CZ workers had higher knees MSD; and FZ and CC/CZ workers had more ankles/feet MSDs (Table 4).

DISCUSSION

A construction industry like the brick industry necessitates heavy physical work, often requiring poor and awkward working postures for prolonged periods, which significantly

Table 1. Socio-demographic findings of exposed and reference workers

Socio-economic variables	Response groups			
	Exposed		Reference	
	N	%	N	%
Age group of the respondents				
≤19 years	81	20.2	12	3.0
20 - 29 years	119	29.8	129	32.2
30 - 39 years	84	21.0	166	41.5
40 - 49 years	68	17.0	72	18.0
50 - 59 years	33	8.2	16	4.0
60 - 69 years	11	2.8	5	1.2
≥70 years	4	1.0	0	0
Total	400	100.0	400	100.0
Attainment of formal education				
No	238	59.5	30	7.5
Yes	162	40.5	370	92.5
Total	400	100.0	400	100.0
Levels of education				
Primary	145	89.5	92	24.9
Secondary	14	8.6	203	54.9
University	3	1.9	75	20.3
Total	162	100.0	370	100.0
Duration of work in years				
≤5 years	265	66.2	237	59.2
6-10 years	63	15.8	113	28.2
11-15 years	30	7.5	28	7.0
16-20 years	23	5.8	19	4.8
≥21 years	19	4.8	3	0.8
Total	400	100.0	400	100.0

increases the morbidity and considerably decreases the work ability of the workers.^{3,17-20} Furthermore, physical work exposures, such as repetitive and forceful movements, are an important source of risk and in particular account for a large proportion of excess MSDs among manual workers.²¹

In this current study, 90.5% exposed and 82.2% reference groups had some type of MSDs during the previous year. In a previous study in Nepal, 58-73% of brick kiln workers experienced discomfort which was eight times more likely to experience discomfort compared to non-brick workers.² In similar studies conducted in India, the prevalence of MSDs among brick kiln workers ranged from 72.0%-87.0%.^{18,22}

In the current study, the prevalence of neck MSDs among brick kiln workers was 56% and among grocery workers was 23.5%. In a similar type of study in Nepal, the prevalence of neck discomfort was 52.1% for kiln workers and only 4.7% for the reference groups.²³ Findings of this study for brick kiln workers were relatively consistent to the previous

Table 2. Prevalence of MSDs/illnesses within a year for exposed and reference groups

Prevalence	Response groups			
	Exposed		Reference	
	N	% (95% CI)	N	% (95% CI)
Any of the body parts				
No	38	9.5	71	17.8
Yes	362	90.5 (87.63 to 93.37)	329	82.3(79.64 to 86.96)
Total	400	100.0	400	100.0
Neck				
No	176	44.0	306	76.5
Yes	224	56.0 (51.14 to 60.86)	94	23.5(19.34 to 27.66)
Total	400	100.0	400	100.0
Shoulder				
No	150	37.5	317	79.3
Yes	250	62.5 (57.76 to 67.24)	83	20.8(16.82 to 24.78)
Total	400	100.0	400	100.0
Elbow				
No	299	74.8	355	88.8
Yes	101	25.3 (21.04 to 29.56)	45	11.3(8.2 to 14.4)
Total	400	100.0	400	100.0
Wrists/hands				
No	211	52.8	317	79.3
Yes	189	47.3 (42.41 to 52.19)	83	20.8(16.82 to 24.78)
Total	400	100.0	400	100.0
Upper back				
No	113	28.3	155	38.8
Yes	287	71.8 (67.39 to 76.21)	245	61.3(56.53 to 66.07)
Total	400	100.0	400	100.0
Lower back				
No	111	27.8	229	57.3
Yes	289	72.3 (67.91 to 76.69)	171	42.8(37.95 to 47.65)
Total	400	100.0	400	100.0
Hips/ thighs				
No	246	61.5	368	92.0
Yes	154	38.5 (33.73 to 43.27)	32	8.0 (5.34 to 10.66)
Total	400	100.0	400	100.0
Knees				
No	136	34.0	243	60.8
Yes	264	66.0 (61.36 to 70.64)	157	39.3(34.51 to 44.09)
Total	400	100.0	400	100.0
Ankles/ feet				
No	236	59.0	336	84.0
Yes	164	41.0 (36.18 to 45.82)	64	16.0(12.41 to 19.59)
Total	400	100.0	400	100.0

Table 3. Logic regression analysis between musculoskeletal symptoms/illnesses and participants groups adjusted with age, duration of work and educational attainment

Musculoskeletal disorders	OR (95% C.I.)	AOR (95% C.I.)
Any body part		
Exposed	2.06(1.35-3.13)**	1.77(0.79-3.96)
Reference	1	1
Neck		
Exposed	4.14(3.06-5.62)**	3.53(2.02-6.19)**
Reference	1	1
Shoulder		
Exposed	6.37(4.64-8.72)**	5.67(3.16-10.16)**
Reference	1	1
Elbow		
Exposed	2.67(1.82-3.91)**	1.29(0.62-2.67)
Reference	1	1
Wrists/hands		
Exposed	3.42(2.51-4.67)**	2.07(1.17-3.68)*
Reference	1	1
Upper back		
Exposed	1.61(1.20-2.16)**	1.24(0.72-2.15)
Reference	1	1
Lower back		
Exposed	3.91(2.90-5.25)**	3.48(2.01-6.03)**
Reference	1	1
Hips/thighs		
Exposed	8.01(5.22-12.29)**	3.92(1.92-7.99)**
Reference	Reference	Reference
Knees		
Exposed	3.00(2.25-4.01)**	2.50(1.45-4.32)**
Reference	1	1
Ankles/ feet		
Exposed	3.65(2.61-5.10)**	2.54(1.35-4.80)**
Reference	1	1

*significant at 0.05 level
 **significant at 0.01 level

studies in different countries.^{7,22,19,24} The prevalence of shoulders MSDs within a year among the exposed was 62.5% and among the reference was 20.8%. In a similar type of study in Nepal, the prevalence of shoulder MSDs among the exposed was 42.5% and just 1.6% for the reference group.²³ In previous brick kiln worker studies, the prevalence was comparable with this study.^{7,19,24} In the current study, elbow discomfort was experienced by 25.3% of the exposed and 11.3% of the reference groups within a year. In a similar type of study in Nepal, the prevalence of elbow discomfort among brick kiln workers was 34.2% and among reference groups was only 3.1%.²³ In the previous brick workers' studies, the prevalence was higher.^{7,24,19} In our study, the prevalence of wrists/hands MSDs was 47.2% for the exposed and 20.8% for the reference groups.

Table 4. Logic regression analysis between MSDs/illnesses and SEGs among brick Kiln workers adjusted with age, duration of work and educational attainment

Musculoskeletal disorders	OR (95% C.I.)	AOR (95% C.I.)
Neck		
Green brick molding	3.34 (1.75-6.37)**	7.74 (2.19-27.32)**
Green brick staking/carrying	1.70 (0.90-3.19)	4.37-1.15-16.59)*
Red brick loading/ carrying	3.06 (1.62-5.77)**	10.16 (2.31-44.74)**
Coal crushing/ carrying	2.85 (1.49-5.47)**	9.43 (2.09-42.67)**
Firing	1	1
Shoulder		
Green brick molding	2.90 (1.46-5.74)**	4.04 (1.25-13.02)*
Green brick staking/carrying	0.80 (0.43-1.49)	1.25 (0.39-4.01)
Red brick loading/ carrying	1.51 (0.81-2.83)	1.14 (0.31-4.17)
Coal crushing/carrying	1.79 (0.93-3.43)	1.92 (0.51-7.29)
Firing	1	1
Elbow		
Green brick molding	0.85 (0.38-1.93)	2.09 (0.47-9.35)
Green brick staking/carrying	1.28 (0.59-2.75)	1.36 (0.26-7.01)
Red brick loading/carrying	1.56 (0.74-3.28)	2.23 (0.39-12.70)
Coal crushing/carrying	3.46 (1.69-7.12)**	4.33 (0.84-22.43)
Firing	1	1
Wrist hands		
Green brick molding	2.95 (1.54-5.66)**	6.58 (1.97-21.99)**
Green brick stacking/carrying	0.48 (0.25-0.92)*	1.26 (0.36-4.43)
Red brick loading/carrying	0.85 (0.46-1.57)	1.66 (0.41-6.70)
Coal crushing/ carrying	1.16 (0.62-2.17)	1.34 (0.33-5.38)
Firing	1	1
Upper back		
Green brick molding	0.46 (0.24-0.89)*	0.81 (0.27-2.46)
Green brick staking/carrying	1.11 (0.56-2.23)	2.34 (0.69-7.93)
Red brick loading/carrying	1.82 (0.87-3.82)	7.63 (1.63-35.78)*
Coal crushing/ carrying	1.35 (0.66-2.79)	8.26 (1.39-49.28)*
Firing	1	1
Lower back		
Green brick molding	2.00 (0.97-4.10)	1.89 (0.58-6.24)
Green brick staking/carrying	1.61 (0.80-3.21)	1.37 (0.40-4.73)
Red brick loading/carrying	1.00 (0.52-1.91)	1.47 (0.36-6.00)
Coal crushing/carrying	1.29 (0.65-2.55)	0.91 (0.24-3.53)
Firing	1	1
Hips/thighs		
Green brick molding	2.52 (1.31-4.84)**	3.64 (1.05-12.60)*
Green brick staking/carrying	0.96 (0.48-1.90)	1.25 (0.32-4.95)

Red brick loading/carrying	1.89 (0.99-3.62)	2.36 (0.55-10.18)
Coal crushing/carrying	1.98 (1.02-3.85)*	2.97 (0.69-12.69)
Firing	1	1
Knees		
Green brick molding	3.12 (1.56-6.22)**	4.67 (1.40-15.57)*
Green brick staking/carrying	1.33 (0.71-2.49)	1.92 (0.576-6.42)
Red brick loading/carrying	2.10 (1.10-4.00)*	6.7 (1.61-27.81)**
Coal crushing/carrying	1.50 (0.79-2.84)	2.44 (0.62-9.56)
Firing	1	1
Ankles/ feet		
Green brick molding	0.49 (0.25-0.95)*	0.75 (0.21-2.67)
Green brick staking/carrying	0.66 (0.35-1.26)	1.87 (0.49-7.07)
Red brick loading/carrying	1.46 (0.78-2.69)	5.63 (1.30-24.33)*
Coal crushing/carrying	2.07 (1.09-3.91)*	2.41 (0.58-10.08)
Firing	1	1

*significant at 0.05 level

**significant at 0.01 level

In a previous study in Nepal, the prevalence of wrists/hands MSDs for exposed was 38.4% and for reference group was 3.1%.²³ The previous studies showed that the prevalence of brick kiln workers wrists/hands MSDs were comparable.^{7,22,19,24}

In this study, the prevalence of upper back MSDs within a year for the exposed was 71.8% and for the reference groups was 61.3%. In Nepal, the prevalence of upper back MSDs for the exposed was 54.8% and for the reference population was 75.0%.²³ The previous brick kiln workers studies were comparable with the current study.^{7,19,24} The prevalence of lower back MSDs was 72.3% for the exposed and 42.8% for the reference groups in our current study. In a previous study in Nepal, the prevalence of lower back MSDs for the exposed was 54.8% and for the reference was nil.²³ In other previous studies, the prevalence were brick kiln workers were a bit higher than the findings of this study.^{7,18,19,22} The hips/thighs MSDs were prevalent among 38.5% the exposed and 8.0% the reference groups. In a previous study in Nepal, the prevalence of hips/thighs MSDs for the brick kiln workers was 50.7% and for the reference group was 41.7%.²³ In other previous studies on brick kiln workers, the prevalence was comparable with this study.^{7,19,24} The prevalence of knees MSDs was 66.0% for the exposed and 39.3% for the reference group. In the previous study in Nepal, the prevalence of knees MSDs for the exposed was 68.2% and for the reference was 69.2%.²³ The prevalence of knees MSDs were slightly lower in the previous studies.^{7,18,19} Also, in our current study the ankles/feet MSDs were prevalent for 41.0% exposed and 16.0% reference groups. In a previous study in Nepal, the prevalence of ankles/feet MSDs for the exposed was 60.3% and for the reference group was nil.²³ In previous brick kiln workers studies, the results were comparable.^{7,19,24}

In the present study, RBL/CZ workers followed by CC/CZ workers had the highest prevalence of upper and lower back MSDs. Backache had high prevalence for all the other SEGs workers. Because all the SEGs workers either carry a heavy load or remain in awkward posture for long duration and repeat the same task again and again, as a result they had high prevalence of backache.²⁵⁻²⁷ In a previous study conducted in India, it was found that among the body parts of exposed workers, lower back was the most affected among all groups of brick kiln workers.²⁸

The prevalence of neck MSDs in present study among SEGs was 66.2%, 50.0%, 64.3%, 62.7% and 37.0 % respectively for GBMZ, GBS/CZ, RBL/CZ, CC/CZ and FZ workers. In a previous study in India, the prevalence of neck MSDs were 94%, 92%, 76% and 88% for RBL/CZ, GBMZ, FZ and GBS/CZ workers respectively.²⁸ Likewise, in this study, wrists/hands MSDs were 71.2%, 28.8%, 41.7%, 49.3% and 45.7% for GBMZ, GBS/CZ, RBS/CZ, CC/CZ and FZ workers respectively. In the previous study in India, the prevalence of hands MSDs were 62%, 71%, 38% and 52% for RBL/CZ, GBMZ, FZ and GBS/CZ workers respectively.²⁸

In this current study, lower back MSDs were 67.5%, 66.2%, 61.9%, 62.7% and 58.0% respectively for GBMZ, GBS/CZ, RBL/CZ, CC/CZ and FZ workers respectively. In the previous study in India, low back MSDs were 90%, 92%, 75% and 88% for RBL/CZ, GBMZ, FZ and GBS/CZ workers respectively.²⁸ Alike, in this study, knees MSDs were 32.5%, 61.2%, 71.4%, 64.0% and 54.3% respectively for GBMZ, GS/CZ, RBL/CZ, CC/CZ and FZ workers respectively. A study conducted in India revealed that knee MSDs among GBMZ workers was 85%.²⁸ The chance of MSDs was about nine times more for brick kiln workers, which was in the same notion but more than four times higher than that of current study.² Ergonomic symptoms happened because of the presence of various ergonomic hazards like improper designing of tools, workplace, manual material handling, lifting and lowering the load.²⁷

The workers involved in brick industry were almost four times more likely to have neck MSDs in comparison to the reference group. In contrast, in the previous study conducted in Nepal, there was no association for neck MSDs between brick kiln and reference workers.²³ Likewise, the workers involved in brick kiln were about six times more likely to have MSDs with shoulder MSDs when compared with grocery workers. The result of the current study was consistent with the previous study conducted in Nepal.²³ Similarly, the workers involved in the brick industry were about three times more likely to endure elbow MSDs compared to grocery workers. The finding of the previous study were consistent with this study.²³ Brick kiln workers were about three times more likely to have wrists/hands MSDs, but the finding was inconsistent with the previous study.²³ Brick kiln workers were about two times more likely to suffer upper back MSDs during a year. In contrast to findings of this study, the previous study in Nepal revealed

that being exposed deserved 15% less chance of getting upper back MSDs.²³ In this study, the brick kiln workers were about three times more likely to suffer lower back MSDs during a year but, there was no such association in the previous study.²³ The brick industry workers were nearly five times more likely to endure hips/thigh MSDs during a year nevertheless; the association was not significant in the previous study.²³ Likewise, the brick industry workers were two times more likely to suffer knees MSDs during the previous year but, the association was not significant in a previous study carried out in Nepal.²³ And also, the brick kiln workers were approximately four times more likely to have ankles/feet MSDs during a year, but the association was not significant in previous study.²³

This study evaluated the prevalence of all the other SEGs workers' MSDs against FZ workers. The brick kiln workers' types of work 29 and repetitiveness of work was found to be significantly associated with the incidence of reported MSDs in the wrist, hand, or fingers.^{21,30} The workers' posture and workstation are contributing risk factors for MSDs.³¹ When the evaluation was done among SEGs, GBMZ workers were about three times more likely to have neck MSDs. This result was consistent in a study conducted in Japan with the assembling workers.³² The RBL/CZ workers were almost three times more likely to have neck MSDs. The CC/CZ workers were nearly three times more likely to have neck MSDs. The GBMZ workers were nearly three times more likely to have shoulder MSDs. Among similar exposure groups, only the workers involved in CC/CZ were above three times more likely to have elbow MSDs. GBMZ workers were just about three times more likely to experience wrist MSDs compared with FZ workers, which was consistent with the findings from the previous studies.^{26,33,34} RBL/CZ and CC/CZ workers were approximately eight times more likely to have upper back MSDs when adjusted. There was no association between SEGs with low back MSDs in this study, but in contrast in a previous study low back MSDs was the most prevalent among GBMZ workers.²⁶ The GBMZ workers were almost three times more likely to suffer hips/thighs MSDs. Similar to the result of this study, hips/thighs MSDs was highly prevalent in the GBMZ workers in the previous studies.^{33,34} The CC/CZ workers were almost two times more likely to have hips/thighs MSDs. The GBMZ workers were almost three times more likely to have knees MSDs, In multivariate analysis this was five times higher and was consistent with the previous studies.^{33,34}

Implications for Nepal and the countries using similar brick manufacturing technologies

Brick manufacturing is a labor-intensive industry, which requires huge numbers of unskilled laborers. This industry remains informal because most of the workers are not registered and worked on a contract basis through contact persons.⁴ The evidences from this study will inform health policy makers, and provide a basis for health-care needs assessment especially for the brick kiln workers because ergonomic problem is one of the major problems among brick kiln workers.^{7,22,24} This study will facilitate to initiate the improvement of occupational environment by integration of technology, quality of life of the workers and people living in the neighborhoods of the factory.^{4,18,35} This study will be useful for task redesign to eliminate high-risk elements; modification to the payment system; and workplace changes.³ In order to help reduce or prevent MSDs, it is proposed that ergonomics education and redesign of work places should be routinely implemented.³¹ Immediate ergonomic interventions are needed to prevent the MSDs by correcting the harmful working postures and to reduce their work stress.²⁶ As claimed by Sadeghian et al., this study will be a important tool for effective urgent ergonomic interventions among kiln workers.³⁶

CONCLUSION

This study found out some burning issues related to the ergonomic status of the extremely complex occupational environment seen in the brick industry and can exist as the landmark for ergonomic problems of the brick kiln workers in Nepal and those countries using similar brick manufacturing technology. Most of the musculoskeletal joints included in the Nordic Ergonomic Questionnaire had a very high prevalence of ergonomic MSDs among brick kiln workers. The proportion of MSDs preventing the workers from doing normal work was also very high among brick industry workers compared with grocery workers. Among SEGs, the upper extremities, hips/thighs, knees and ankles/feet joints MSDs were high among GBMZ workers. Back and lower extremities MSDs were more prevalent among workers involved in the GBS/CZ and CC/CZ. The prevalence of MSDs were higher for the FZ in comparison to the GBMZ, GBS/CZ, RBL/CZ and CC/CZ. Moreover, among all the work zones, the CC/CZ was significant with all the MSDs and should be a top priority in work at the brick kiln that should be improved ergonomically.

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