Airborne Particulate Matter and Health Condition in Brick Kiln Workers in Kathmandu Valley, Nepal

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ABSTRACT

Background

Air quality monitoring in brick kilns indicates very high concentrations of airborne particulate matter. Air pollution from brick kilns poses an enhanced threat to the environment and to human health.

Objective

To evaluate airborne particulate matter concentration and health status of brick kiln workers.

Method

A cross-sectional comparative study was conducted in the Kathmandu valley targeting all brick industries and their workers during January - March 2015 and March - April 2016. A total of 16 brick kilns and 800 participants (400 brick workers as exposed and 400 grocery workers as referent) were selected for study. A direct-reading, Dusttrak model 8533 was used for air sampling. Nepali version questionnaire was applied to obtain epidemiological data. SPSS version 16 was used to perform statistical analysis. Median, mean, range and proportion were calculated and Mann-Whitney U test, Kruskal-Wallis test and chi square (χ^2) test were applied to test significance.

Result

Mean values of particulate matter concentrations for brickfields were as follows: Total Suspended Particulate Matter (TSPM): 5.179 mg/m^3, PM$_{10}$: 4.958 mg/m^3, respirable suspended particulate matter (RSPM): 4.140 mg/m^3, PM$_{2.5}$: 3.965 mg/m^3, and PM$_1$: 3.954 mg/m^3. The mean concentrations for grocery workers were; TSPM: 0.089 mg/m^3, PM$_{10}$: 0.089 mg/m^3, RSPM: 0.085 mg/m^3, PM$_{2.5}$: 0.082 mg/m^3 and PM$_1$: 0.082 mg/m^3. Among brickfield workers, red and green brick loading zones had results that exceeded the ACGIH Threshold Limit Values for TSPM and RSPM. Workers complaints of injury were 52% and 44.2%, and illnesses were 88.5% and 82.2%, respectively among exposed and referent. The occurrence of injuries/illnesses during work showed significant association between exposed and the referent groups at 0.05 level.

Conclusion

The high level of airborne particulate matter in the brick fields requires action for the protection of workers. The availability of health services within brick industries needs to be enhanced.

KEY WORDS

Brickworks, environment, health conditions, Nepal, particulate matter concentration

INTRODUCTION

Brick production in Nepal, especially in Kathmandu valley, is an old industry where bricks are seen as part of Nepalese art and architecture from very beginning.[1,2] According to the Federation of Nepal Brick Industry (FNBI), 110 brick kilns are in operation in the Kathmandu Valley.[3] Air quality monitoring in Kathmandu indicates a very high concentration of particulate matter (PM) especially particulate matter less than 10 microns in aerodynamic diameter (PM_{10}) Particulate matter concentrations have tripled over the past 10 years for which brick industry has contributed significantly.[4]

PM with aerodynamic size less than 2.5 microns ($PM_{2.5}$) to PM_{10} ratio is above 0.6 and this indicates that most of the pollution is from combustion sources such as brick kilns and vehicles.[5] Moreover, the average values of PM_{10} and total suspend particle (TSP) increased significantly during kiln operation.[6]

In developing countries, brick kilns pose an increased threat to the environment and health of workers and people in surrounding areas.[7,8] Health problems related to musculoskeletal, respiratory and digestive systems, nutritional and skin diseases are the major morbidity among brick industry workers.[9] Occupational exposures to dust continue to cause respiratory diseases.[9-11] Moreover, next to smoking, occupational risk factors are the major cause of chronic respiratory symptoms and illnesses which account for 13% of chronic obstructive pulmonary disease (COPD) and 11% of asthma.[12] Among the brick field workers, chronic cough, phlegm expectoration, wheeze on exposure to smoke, shortness of breath, dyspnea and chronic bronchitis are common illnesses.[13-17] This study was carried out to evaluate the intensity of airborne PM concentration and the health of brickfield workers.

METHODS

A descriptive and analytical cross-sectional study was conducted. The study was carried out in the Kathmandu valley that includes three densely populated districts (Kathmandu, Lalitpur and Bhaktapur) targeting all the bricks kilns and their workers. According to the Federation of Nepal Brick Industry (FNBI), currently in valley, 110 brick kilns are in operation.[3] Nevertheless, there were 106 operating brick kilns in Kathmandu Valley at the time of sampling. Among them, 62 brick kilns were in Bhaktpur, 26 brick kilns in Lalitpur and 18 brick kilns in Kathmandu district. First, all the brick kilns were visited and made the district-wide list as the sampling frame. Multistage probability proportionate-to-size (PPS) sampling was applied to select brick kilns. In total, nine kilns from Bhaktapur, four kilns from Lalitpur and three kilns from Kathmandu district were selected. A total of 800 participants were selected (400 exposed and 400 referent) for interview to obtain socio-demographic, work history and health information. An unmatched equal size referent group applying the same procedure among grocery workers was recruited. The first round of air sampling and interviews with workers was carried out from January to March 2015. The second round of air sampling was completed from March to April 2016.

A direct-reading instrument, TSI Inc. model 8533 Dusttrak aerosol monitor, a light scattering laser photometer with a laser diode directed at a continuous aerosol stream, was used for air sampling. The real-time particle mass concentration is determined by the intensity of the light scattered by the particles in the aerosol stream. The particle size range of the Dusttrak is from 0.1 to 10 µm, with a detection range from 0.001 to 100 mg/m^3. The Dusttrak was factory-calibrated. Total suspended particulate matters (TSPM), PM with aerodynamic size of less than 10 micron (PM_{10}), PM with aerodynamic size of less than 5 micron (respirable), PM with aerodynamic size of less than 2.5 micron ($PM_{2.5}$) and PM with aerodynamic size of less than 1 micron (PM_1) were measured in this study. The Dustrak is capable of measuring concentrations of each of these size fractions simultaneously.

Exposure information on all exposed workers was desirable, but not practically possible. Therefore, a strategy has been developed based on grouping workers who were believed to have similar exposures, called similar exposure groups (SEG). At each brick kiln, SEGs including the following work stations: green brick molding, green brick stacking, red brick loading, coal crushing/carrying and firing. These SEGs were maintained for both air sampling and interviews. Source air sampling was carried out on the five work stations. The samples were taken by placing the Dusttrak near to the work stations at the height of the workers' breathing zone for two hours. Zero calibration of Dusttrak was done before each use. It was obvious from previous studies that data generated by the Dusttrak slightly overestimates results, which is a good indicator for sensitivity test.[18-20]

The Dusttrak was checked on a regular basis during sampling to ensure that it was properly functioning and remained in the correct position. An eight-hour time-weighted average data displayed in the Dusttrak monitor was taken for the statistical analysis.

Socio-demographic characteristics, work history and health history were obtained applying a pre-tested structured and semi-structured questionnaire. The Nepali version of the questionnaire was finalized after necessary modifications as per feedback from the experts. The questionnaire was field pre-tested prior to field survey. Monitoring and supervision of interviewers was done by the principal investigator frequently during interview time in the field. Each worker and each site was identified with an identification code to maintain confidentiality. MS excel computer software program was used to enter data. The data in the computer were kept safe with password protection. Ethical approval for study was obtained from the institutional review committee of Kathmandu University School of Medical

Sciences (IRC-KUSMS). Written consent was obtained from the brick kiln owners before obtaining any data. Written consent (thumb print in case of illiterate interviews) was obtained from each interviewee before verbal consent.

Data analysis was done applying SPSS software version 16 after transferring the data into SPSS from MS excel. Mean, median, range and proportions were calculated. Mann-Whitney U test was performed to compare TSPM, PM_{10}, respirable, $PM_{2.5}$ and PM_1 between brick industry and grocery workers. Kruskal-Wallis test was used to compare TSPM, PM_{10}, respirable, $PM_{2.5}$, PM_1 among SEGs in brick industry. Chi square (χ^2) test was applied to test association between exposed and referent groups against injuries and diseases outcome.

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. Among brick workers, 40.5% of workers attained formal education and among grocery workers 92.5% attained formal school. The majority of brick industry workers attained primary (63.0%) and lower secondary (26.5%) levels of education, whereas, majority of grocery workers achieved secondary (54.9%) and university (20.3%) education. Among brick industry workers, 66.2% of respondents worked for ≤5 years, 15.8% worked for 6-10 years, 7.5% worked for 11-15 years, 5.8% worked for 16-20 years and 4.8% worked for ≥21 years. On the other hand, 59.2% of grocery workers worked for ≤5 years, 28.2% worked for 6-10 years, 7.0% worked for 11-15 years, 4.8% worked for 16-20 years and only 0.8% of them worked for ≥21 years (table 1).

Mean and median values of PM concentrations for brickfields were as follows; TSPM: 5.179 mg/m^3 and 1.400 mg/m^3; PM_{10}: 4.958 and mg/m^3 1.400 mg/m^3; respirable: 4.140 mg/m^3 and 1.100 mg/m^3; $PM_{2.5}$: 3.965 mg/m^3 and 1.040 mg/m^3; and PM_1: 3.954 mg/m^3 and 1.030 mg/m^3, respectively. Likewise, mean and median values of PM concentrations for groceries were as follows; TSPM: 0.089 mg/m^3 and 0.089 mg/m^3; PM_{10}: 0.089 mg/m^3 and 0.089 mg/m^3; respirable: 0.085 mg/m^3 and 0.084 mg/m^3; $PM_{2.5}$: 0.082 mg/m^3 and 082 mg/m^3; and PM_1: 0.082 mg/m^3 and 0.082 mg/m^3, respectively.(table 2).

Mann-Whitney U test was applied to compare the extent of airborne particulate concentrations between brick industries and groceries. The results of tests revealed significance differences for each in terms of the size of dust particles between the two groups. For TSPM, the chi square value was 14.511 (p <0.001), for PM_{10} chi square was 14.279 (p <0.001), for respirable chi square was 14.636 (p <0.001), for $PM_{2.5}$ chi square value was 14.401 (p <0.001), and for PM_1 chi square value was 10.547 (p <0.001). All the dust concentrations were significantly different for

Table 1. **Socio-demographics of respondents**

Socio-economic variables	Response groups		Response groups	
	Exposed		Referent	
	Frequency	Percent	Frequency	Percent
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
Gender				
Female	102	25.5	130	32.5
Male	298	74.5	270	67.5
Total	400	100.0	400	100.0
Caste				
Brahmin/Chhitri	27	6.8	135	33.8
Madhesi other caste	95	23.8	13	3.2
Dalit	138	34.5	12	3.0
Newar	20	5.0	195	48.8
Janajati	110	27.5	43	10.8
Muslim	10	2.5	2	0.5
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	102	63.0	16	4.3
Lower secondary	43	26.5	76	20.5
Secondary and higher secondary	14	8.6	203	54.9
University	3	1.9	75	20.3
Total	162	100.0	370	100.0
Marital status				
Married	303	75.8	319	79.8
Unmarried	94	23.5	78	19.5
Divorced/separated	3	0.8	3	0.8
Total	400	100.0	400	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

Table 2. Particulate matter (PM) concentration in brickfields and groceries

Types of particulate maters	Mean (mg/m3)	Median (mg/m3)	Minimum (mg/m3)	Maximum (mg/m3)
PM concentrations in brick industries				
Total suspended particulate matters (TSP)	5.179	1.400	0.107	43.400
Particulate matter size of 10 micron (PM_{10})	4.958	1.400	0.107	43.400
Particulate matter size of 4 micron (respirable)	4.146	1.100	0.103	37.600
Particulate matter size of 2.5 micron ($PM_{2.5}$)	3.965	1.040	0.102	36.000
Particulate matter size of 1 micron (PM_1)	3.954	1.030	0.101	35.500
PM concentrations in groceries				
Total suspended particulate matter (TSP)	0.089	0.089	0.079	0.098
Particulate matter size of 10 micron (PM_{10})	0.089	0.089	0.078	0.098
Particulate matter size of 4 micron (respirable)	0.085	0.084	0.074	0.096
Particulate matter size of 2.5 micron ($PM_{2.5}$)	0.082	0.082	0.072	0.092
Particulate matter size of 1 micron (PM_1)	0.082	0.082	0.070	0.093

these two sites at 0.001 level. Likewise, Kruskal Wallis test showed that there were significant differences at 95% level of confidence for all types of PM concentrations in the different work types, namely green brick molding, green brick stacking, red brick loading, coal crushing and firing. The results, for TSPM, z = -3.847 (p: 0.006), for PM_{10}, z = -3.847(p: 0.003), for respirable, z = -3.861(p:= 0.006), for $PM_{2.5}$, z = -3.861(p: 0.006), and for PM_1, z = -3.861(p: 0.032) were significantly different at 0.01 level (table 3).

The occurrence of injuries during work or other activities was 52.0% for exposed and 44.2% for referent groups. This showed significant association (p: 0.028) between exposed and the referent groups. Similarly, there were significantly higher (p <001) occurrences of cuts, bruises or open wounds among brick industry workers than grocery workers. Likewise, there was higher rate (p <0.001) of incident of leg or foot injuries among brick field workers. In the same way, back injury was significantly higher (p: 0.005) among brick industry workers than grocery workers. The association was significantly different (p: 0.026) for occurrence of shoulder injury between brick field and

Table 3. Comparison of PM concentrations between brickfields and groceries

Mann-Whitney U test between exposedand Referent groups	Mann-Whitney U	Z	P value
Total suspended particulate matter (TSP)	4.500	-3.847	<0.001**
Particulate matter size of 10 micron (PM_{10})	4.000	-3.847	<0.001**
Particulate matter size of 4 micron (respirable)	4.000	-3.861	<0.001**
Particulate matter size of 2.5 micron ($PM_{2.5}$)	4.000	-3.861	<0.001**
Particulate matter size of 1 micron (PM_1)	4.000	-3.861	<0.001**
Kruskal-Wallis Test among SEGs	**Chi-square**	**Df**	**P value**
Total suspended particulate matter (TSP)	14.511	1	0.006**
Particulate matter size of 10 micron (PM_{10})	14.279	1	0.003**
Particulate matter size of 4 micron (respirable)	14.636	1	0.006**
Particulate matter size of 2.5 micron ($PM_{2.5}$)	14.401	1	0.006**
Particulate matter size of 1 micron (PM_1)	10.547	1	0.032*

*significant at 0.05 level
**significant at 0.01 level

grocery workers. All the above associations were significant at 95% level of confidence. In contrast, the injuries to arms or hands and head were not significantly different. There were no significant different occasion of eyes or ears injuries, abdominal injuries or hip injuries between exposed and the referent groups. The aforementioned results were not significant at 95% level of confidence (table 4).

Concerning the remedy to cure injuries, doing nothing was 38.6% for exposed and 31.1% for grocery workers, first aid from family member or self was 4.3% for exposed and 10.2% for control, local healer was 11.6% for exposed and 13.0% for control, clinic or hospital was 18.4% for exposed and 45.0% for control, company-provided first aid was 26.6% for exposed and 0.0% for control, and traditional healer was 0.05% for exposed and 0.0% for the referent group (figure 1). The treatment expenses for the health problems were self-paid by 39.7% of workers in brick kilns and 77.1% in groceries followed by parents' expenses was 6.1% in brick kilns and 21.2% in groceries, owners/ contactors expense was 54.2% in brick kilns and 0.0% in the groceries and free of cost was 0.0% in brick kilns and 1.7% in the groceries (figure 2).

Regarding the occurrence of health illnesses, 88.5% of exposed and 82.2% of referent group complained of any type of health problem during work or other activities, which was statistically significant (p: 0.012) at 95% level of confidence. Breathlessness was experienced by 31.5% of the exposed and 8.2% of the referent group, which

Table 4. **Occurrence of injuries between exposed and referent**

Injuries during work or other activities in previous 12 months			
Response groups	**Yes**	**No**	**P value**
Exposed	208(52.0%)	192 (48.0%)	0.028*
Referent	177(44.2%)	223 (55.8%)	
Cuts, bruises or open wounds			
Exposed	119(29.8%)	281 (70.2%)	<0.001**
Referent	65(16.2%)	335 (83.8%)	
Broken bones			
Exposed	12(3.0%)	388 (97.0%)	0.832
Referent	11(2.8%)	389 (97.2%)	
Sprains, strains or dislocations			
Exposed	119(29.8%)	281 (70.2%)	0.938
Referent	118 (29.5%	282 (70.5%)	
Burns, scalds, frostbite			
Exposed	18(4.5%)	382 (95.5%)	0.470
Referent	14(3.5%)	386 (96.5%)	
Leg or foot			
Exposed	139(34.8%)	261 (65.2%)	<0.001**
Referent	64 (16.0%)	336 (84.0%)	
Arm or hand			
Exposed	93(23.2%)	307 (76.8%)	0.933
Referent	92 (23.0%)	308 (77.0%)	
Head			
Exposed	31 (7.8%)	369 (92.2%)	0.153
Referent	21 (5.2%)	379 (94.8%)	
Neck			
Exposed	10(2.5%)	390(97.5%)	0.089
Referent	19 (4.8%)	381 (95.2%)	
Back			
Exposed	48(12.0%)	352 (88.0%)	0.005**
Referent	77 (19.2%)	323 (80.8%)	
Eyes or ears			
Exposed	2(0.5%)	398 (99.5%)	0.412
Referent	4 (1.0%)	396 (99.0%)	
Abdomen			
Exposed	8 (2.0%)	392 (98.0%)	0.056
Referent	2(0.5%)	398 (99.5%)	
Shoulder			
Exposed	28 (7.0%)	372 (93.0%)	0.026*
Referent	14 (3.5%)	386 (96.5%)	
Hip			
Exposed	2 (0.5%)	398 (99.5%)	0.412
Referent	4 (1.0%)	396 (99.0%)	

was statistically significant (p <0.001) at 95% level of confidence, persistent cough was 27.2% for exposed and 13.0% for referent and eye problems was 14.8% for exposed and 22.5% for referent group (p <0.001), which were significantly different between brick field workers and

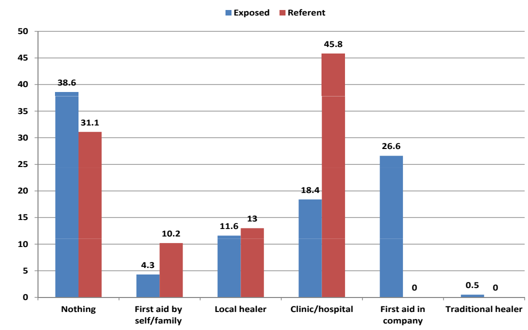

Figure 1. **Health intervention for the injury (%)**

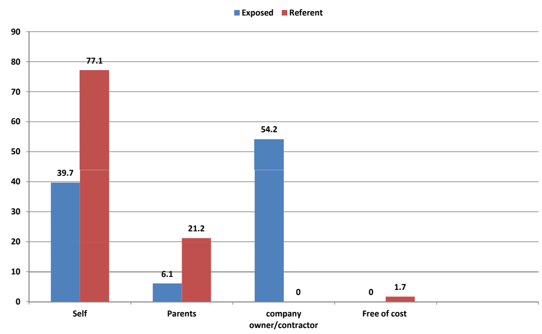

Figure 2. **Paying expenses for the injuries (%)**

grocery workers. In contrast, skin problems were 14.8% for exposed and 16.8% for control, stomach problems/diarrhea was 21.5% for exposed and 20.8% for control, fever was 37.0% for exposed and 35.0% for referent and headache was 58.2% for both exposed and referent group. All the aforementioned health problems were not significantly different between brick kiln and grocery workers at 95% of confidence level. The experience of extreme fatigue was 64.5% for brick kiln workers and 41.2% in grocery workers (p <0.001), feeling weak was 68.2% for brick kiln workers and 28.8% for grocery workers (p <0.001), and feeling bad all over was 19.8% for brick kiln workers and 8.8% for grocery workers (p <0.001). All these health problems mentioned above were significantly higher in the brick kiln workers in 0.01 level of confidence (table 5).

As the means of treatments, nothing was done for treatment by 65.6% brick kiln workers and 36.8% grocery workers followed by 1.2% self/ family care for brick industry workers and 3.0% for grocery workers, local healer 8.3% each for brick fields and grocery workers, clinic or hospital 13.2% for brick industry workers and 51.4% for grocery workers, first aid in the factory 11.0% for brick field workers and 0.3% for grocery workers, and use of ocular appliances was 0.0% for brick industry and 0.03% for the grocery workers (figure 3). The treatment expenses for the health problems were self-paid by 48.2% for brick industry workers and 77.8% for the grocery workers followed by parents 7.9% for brick field workers and 22.2% for grocery workers and owner/factory 33.9% for brick industry workers and nil for the grocery workers (figure 4).

Table 5. Occurrence of health problems between brick industry and grocery workers

Response groups	Yes	No	P value
Health problems			
Exposed	354(88.5%)	46(11.5%)	0.012*
Referent	329(82.2%)	71(17.8%)	
Breathlessness			
Exposed	126(31.5%)	274(68.5%)	<0.001**
Referent	33 (8.2%)	367(91.8%)	
Persistent cough			
Exposed	109(27.2%)	291(72.8%)	<0.001**
Referent	52(13.0%)	348(87.0%)	
Eye problems			
Exposed	59(14.8%)	341(85.2%)	0.005**
Referent	90(22.5%)	310(77.5%)	
Skin problems			
Exposed	59(14.8%)	341(85.2%)	0.437
Referent	67(16.8%)	333(83.2%)	
Stomach problems/diarrhea			
Exposed	86(21.5%)	314(78.5%)	0.795
Referent	83(20.8%)	317(79.2%)	
Fever			
Exposed	148(37.0%)	252(63.0%)	0.556
Referent	140(35.0%)	260(65.0%)	
Headache			
Exposed	233(58.2%)	167(41.8%)	1.000
Referent	233(58.2%)	167(41.8%)	
Extreme fatigue			
Exposed	258(64.5%)	142(35.5%)	<0.001**
Referent	165(41.2%)	235(58.8%)	
Feeling weak			
Exposed	273(68.2%)	127(31.8%)	<0.001**
Referent	115(28.8%)	285(71.2%)	
Feeling bad all over			
Exposed	79(19.8%)	321(80.2%)	<0.001**
Referent	35(8.8%)	365(91.2%)	

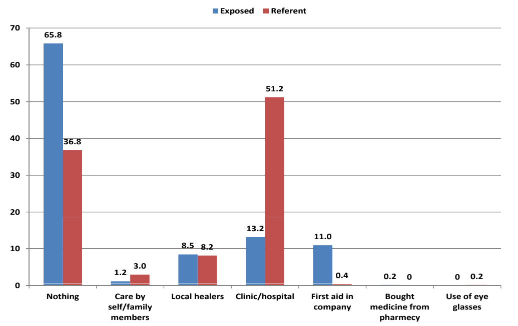

Figure 3. Health intervention for the illnesses (%)

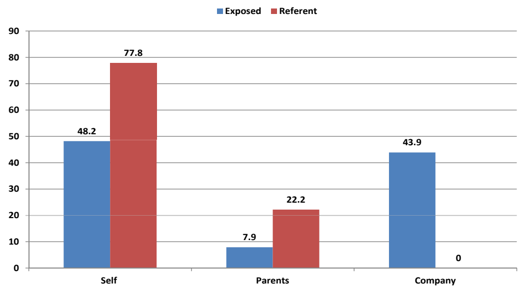

Figure 4. Treatment expenses paid for illnesses or pain by (%)

DISCUSSION

In this study, PM concentrations were measured and found significantly higher in brick fields compared to groceries. Results of this study were consistent with the study conducted by Murthy et al. in 2006, which revealed there was a high level of source sample TSPM (4.88 to 11.55 mg/m^3) and PM_{10} (2.03 to 21.59 mg/m^3) in brick industries and in selected SEGs especially red brick loading and green brick staking zone of Kathmandu valley.[21] Based on protecting workers from pulmonary diseases, the threshold limit value (TLV) for respirable dust is 3 mg/m^3 and for TSP is 10 mg/m^3.[22] The findings of this study were considerably higher than the study done by Joshi and Dudani which showed the average value of PM_{10} and TSPM were increased during the brick industry operation.[6] PM pollution is the most significant problem in Kathmandu valley and also the main source of PM pollution the brick industry (28% PM_{10} and 31% TSP), domestic fuel combustion (25% PM_{10}, 14% TSP), Himal Cement Factory (17 % PM_{10}, 36 % TSP) and re-suspension of road dust (9% PM_{10} and 9% TSP).[4,23] However, the contribution of emission of brick industry was found to be higher than the other sources (28%) for PM_{10} concentration, which causes more apprehension as these particles can enter the respiratory system.[4] In this current study, there was significantly higher intensity of PM concentrations in brick industry than the grocery at <0.05 level. Likewise, there were significantly different results for all types of PM concentrations in different work stations specifying higher concentrations in red and green brick loading areas at <0.05 level.

The current study showed that occurrence of injuries during work or other activities was 52.0% among brick workers and 44.2% among grocery workers. Similar to this study, a cross sectional study of children aged 17 years and below in the districts of Bhaktapur and Sarlahai, Nepal identified that the musculoskeletal disorder (MSD) pain and discomfort was experienced by 73% of working children in Bhaktapur and 58% in Sarlahi.[24] In this current study, the occurrence of injuries showed significant difference between the exposed and the referent groups. The prior studies indicated that the workers are constantly adapting awkward postures as a result they experienced MSDs for example severe back pain, aches in the upper extremities and in lower extremities of their body.[8,25-27] In another study, it was observed a large number (81%) of workers complained of pain in different body parts with the main complaints of low back (50%), neck (38%) and shoulder pain (29%).[28] These are due to carrying heavy loads, well above recommended limits, remaining in squatted postures for long periods and doing highly repetitive tasks which cause MSDs for workers in brick industries.[27,29]

In the present study, occurrence of illnesses was significantly higher for brick field workers at <0.05 level of confidence demonstrating high magnitude of breathlessness and persistent cough. Previous studies validated that pulmonary disease such as pneumoconiosis was more common in the brick industry workers.[8,30,31] A study conducted among school children in nearby brick kilns illustrated the worst health conditions and they suffered from higher prevalence of upper respiratory tract infections like pharyngitis and tonsillitis.[6,32] Eye problems were 14.8% for exposed and 22.5% for referent participants, which was statistically significant at <0.05 level of confidence. In contrast, the events of skin problems were 14.8% for exposed and 16.8% for controls. Previous studies indicated that among the various categories of workers in the brick fields, the fire masters and brick un-loaders were inhaling the pollutants which caused irritation of skin and eyes.[30] Moreover, the processes in brick fields involve the interaction of various personal factors including fatigue, fitness, age, and experience of the workers as well as circumstantial factors like work schedule, work load and psychological factors.[33]

CONCLUSION

There was a much higher concentration of airborne particulates in the brick industry in comparison to groceries as confirmed by statistical tests. These findings looked for the control of pollutions and protection of workers applying engineering control and personal protective equipment (PPE). Brick industry workers work for longer duration during the day than grocery workers which results in prolonged exposure to dust pollution. This ultimately contributes to the significantly high proportion of respiratory symptoms and illnesses among brick industry workers. For the treatment of injuries and illnesses, the brick industry workers could not provide the first aid necessary for treatment due to the low pay they receive and their dependence on the brick industry work. Time off for injuries and illnesses would mean not being able to provide for themselves and their families. The brick industries should have enhanced treatment facilities to provide for the treatment of injuries and illnesses and not solely rely on the limited medication distributed by untrained persons.

There is a resounding need for improved evaluation of the hazards within the kilns in the Valley and the risks posed to the workers and the community. Control areas of focus in the brick kilns include: poor quality fuel used in the kilns; outdated kiln technology leading to toxic emission levels; illegal kilns in the Valley; long hours on the job leading to greater risk of overexposure to toxicants in the workplace; and minimal personal protective equipment (PPE). No governmental standards on emission have been promulgated yet. A reactive legislation approach to control is falling behind, with occupational safety and health standards unenforced throughout the Valley; nevertheless, priorities geared towards the health of the community and the workers in the brick kilns are increasingly pertinent with the rise in industry.

Voluntary organizational efforts to promote and educate the workers in the kilns, their employers, and the general public on the necessity of industrial hygiene practice should be considered. These measures to investigate further into the industrial hazards of the brick kilns in Kathmandu Valley, Nepal and mitigation strategies will help promulgate the need for greater intervention. All workers deserve a workplace environment free from extreme health hazards and unsafe conditions.

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