Sys Rev Pharm 2020; 11(6): 864 – 870
A multifaceted review journal in the field of pharmacy
E-ISSN 0976-2779 P-ISSN 0975-8453

Knowledge and Practice of Cement Factory Workers in Relation to Respiratory Symptoms: A Cross-Sectional Study

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Article History: *Submitted: 22.04.2020* *Revised: 20.05.2020* *Accepted: 28.06.2020*

ABSTRACT

Background: Workers in cement industry are at high risk due to the dust that is emitted at various steps of cement production. This study aims to assess the respiratory symptoms, knowledge of the workers about cement hazards and the appropriate protective behaviors to minimize or prevent these health hazards.

Methods: A cross-sectional study design was applied in 4 cement factories in Nineveh province / Iraq, between December 2019 and March 2020. Only non-smoker workers were included and a total of 105 male workers were initially interviewed. A structured questionnaire was used to collect information about workers' knowledge and practices in relation to cement hazards, in addition to the data regarding different respiratory symptoms of the workers.

Results: The final sample consisted from 97 workers with a mean age of 39.46 ± 9.51 and the average employment duration was 15.4 ± 7.38. Cronbach's alpha value for knowledge scale and practice were 0.714 and 0.776 respectively. The means knowledge and practice scores were 10.77 ± 2.07 and 3.94 ± 1.34 respectively with a significant correlation between the two scores (r=0.488, p <0.001). The prevalence of chronic cough, chronic sputum production and work-related shortness of breath were 39.2%, 28.8% and 60.8% respectively. The means of total knowledge and total practice scores were generally higher in workers without symptoms compared to workers suffering from these respiratory symptoms.

Conclusion: This study revealed an acceptable level of knowledge and positive practices among the study sample from four cement factories who are participated in the survey. Higher knowledge score was directly correlate with better practice of the workers during the working hours and improving workers' knowledge might enhance the protective behavior of the factory workers.

Keywords: Cement dust, knowledge, practice respiratory symptoms

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DOI: 10.31838/srp.2020.6.124

INTRODUCTION

Occupational toxicology is the "application of the principles and methodology of toxicology toward understanding and managing chemical and biological hazards encountered at work"(1). Exposure to various toxicants at workplace occurs through different routes, mainly by inhalation and to a lesser extent by dermal contact or ingestion (2). Inhalation exposure is common with gases, fumes, dust or their combinations that may be presented at the occupational sites. In a recent Indonesian study, the mortality rate as a result of occupation was 34% from cancer, 21% due to respiratory diseases and 15% of occupational mortalities were attributed to cardiovascular diseases (3). Today, with the industrial revolution throughout the world, occupational exposure to risks is increased and has led to the emergence of new provokers of health problems like smoke, dust, toxic gases and fumes (4, 5).

Dust is considered the most important element in impairing the respiratory system as it can be encountered in various industries around the world, such as the production of cement, textiles, cotton, wood products and coal (6). Workers in cement industry are at high risk due to the dust that is emitted at various steps of cement production, from the raw materials mining to the product packaging.

Job hazards can be avoided or reduced by following the safety measures strictly, which can only be guaranteed by the workers' knowledge about work-related threats and their awareness of the importance of correct behaviors that have to be adopted, alongside with the appropriate usage of personal protective equipment (PPE) (7, 8). Moreover, knowledge and understanding of occupational health help in preserving a healthy workplace environment, permitting early diagnosis of work-related health problems, facilitating possible protection, enhancing workers performance to minimize disabilities and rehabilitation of the workers (9). The cement hazards can be very dangerous and may lead to severe chronic outcomes. These consequences may require life-long treatment that could be associated with poor adherence and high costs. The prevention of such occupational hazards would be much easier than treating the consequences in the future.

Exposure to cement dust has been associated with very different outcomes, the most important of which is its effect on pulmonary function, which may range from transient change in respiratory tract to reduced activity and emergency admissions and eventually may lead to death (10). The degree of impairment depends mainly on the length and level of exposure to cement dust, it also varies according to the sensitivity of the workers (11). The accumulation of the cement dust particles along the tracheobronchial zone leads to the interaction of these particles with mast cells or basophils causing degranulation of the cells and releasing their contents of chemical mediators such as histamine and serotonin, these mediators will act on various tissues like bronchial smooth muscles producing the respiratory symptoms (12). Questionnaires were used to assess the respiratory symptoms in cement factory workers in the majority of studies conducted around the world. Such questionnaires would gather information about the severity and frequency of the symptoms that the workers are suffering from, including questions about cough, sputum production, dyspnea and wheezing (11, 13).

Determining the workers' knowledge about job hazards will contribute to the assessment of the workers' ability to protect

themselves against these hazards. Workers' behavior also plays a critical role in minimizing the toxicity by reducing the exposure to the dust and by using appropriate protective measures. The workers' knowledge about the protective behaviors, such as the types of PPE to be used, their correct usage and what to do when dust contaminations happen would be very important to keep them safe (7, 14, 15). A significant reduction in respiratory symptoms was observed among cement workers in Tanzania after the implementation of an educational campaign, this reduction can be explained by the improvement of workers' knowledge and an increase in their acceptance to use PPE. This has resulted in the workers becoming more confident in the importance of personal protection against cement dust (16).

According to the website of the Iraqi Cement State Company (https://icsc.gov.iq), cement industry in Iraq is one of the most important national industries that fertilizes the infrastructure of the country through its financial revenue. In Nineveh Governorate alone, there are five cement factories, three of them are located in Badosh and two in Hammam Al-Alil. This study aims to assess the respiratory symptoms, knowledge of the workers about cement hazards and the appropriate protective behaviors to minimize or prevent these health hazards. The study findings may provide the factory managements as well as the healthcare system with a better understanding of the effect of knowledge improvement on reducing health hazards.

SUBJECTS AND METHODS

Study design and setting

A cross-sectional study design was applied in this work which was carried out in cement factories in Nineveh province. A total of five cement factories are present; three in Badosh and two in Hammam Al-Alil regions. Both Badosh and Hammam AL-Alil, are within the boundaries of Nineveh Governorate. One cement factory was excluded from this study because it depends on the wet method while the remaining four factories depend on the dry method for cement production.

The study was conducted between December 2019 and March 2020. A structured questionnaire was used for data collection. All eligible workers in the milling and packaging sections were invited to participate in the study. Written and signed consent was collected from all participants who agreed to be included in the study and exactly matched the study criteria.

Ethical approval

An approval from the Scientific Committee of the Department of Clinical Pharmacy in the College of Pharmacy, University of Mosul was obtained before conducting the study. In parallel, it was approved by the Central Ethical Committee at Mosul Directorate of Health. Moreover, the aims of the study were explained to the Directorate of the Northern Cement Cooperation and a written approval was obtained from them to facilitate admission to the factories to collect data. The participation in this study was completely voluntary, both verbal and written consents were obtained from the workers and they were assured that their data would only be used for scientific research.

Participants

All the non-smoker workers in the two targeted departments (milling and packaging) of the four factories were invited to participate in the study. A total of 105 male workers were initially interviewed and 97 (92.4%) workers constituted the final sample size and were included in the study analysis. The 8 workers were excluded because their answers were incomplete. Of the final sample, fifty-six workers (57.7%) were from Badosh factories and forty-one workers (42.3%) were from Hammam AL-Alil cement factories.

Inclusion criteria: All workers in the milling and packaging sections who were non-smoker, aged more than 18 years and had service duration of more than one year were included.

Exclusion criteria: Workers suffering from respiratory diseases (acute or chronic), being smokers or alcohol drinkers were excluded.

Questionnaire

A structured questionnaire was used to collect information about workers' knowledge and practices in relation to cement hazards, in addition to the data regarding different respiratory symptoms of the workers. The intended questionnaire was designed from previous studies with appropriate adaptations and translation (8, 11, 15), and permissions were obtained from the corresponding authors. The questionnaire was conducted in Arabic language to be easily understood by cement factory workers as it was a self-administered questionnaire.

Knowledge

The knowledge part consisted of 18 items to evaluate the workers' knowledge about health hazards and diseases caused by cement dust, the types of PPE and the benefits behind wearing them. In addition, there were questions to assess workers' awareness about the appropriate action when cement dust comes in contact with the eyes or skin, and the best way to wear gloves. Of these 18 questions, 2 visual questions were used to determine the ability of workers to recognize the correct protective equipment. The scoring of knowledge was measured depending on the number of correct answers, each correct answer was given 1 and the wrong answer was given zero, so the score would range between zero and 18.

Practice

Seven questions were contained in this part to assess workers' practice at the factory and when they were home after work; they were asked about the type of PPE used daily, the frequency of wearing mask at work and the reasons behind that, washing and bathing habits. The practice scoring depended on the number of appropriate practice behaviors; one was given for each appropriate behavior while zero was given for the inappropriate one. The median split was used to classify the workers according to their knowledge and practice scores into adequate versus inadequate for knowledge and appropriate versus inappropriate practice (17).

Respiratory symptoms

The respiratory symptoms in the workers were assessed by using the British Medical Research Council (BMRC) respiratory questionnaire (18-20) after adaptation. The symptoms were classified into three categories, namely chronic cough (five questions), chronic sputum production (five questions) and dyspnea and wheeze (three questions). All the 13 items included in this part were with binary Yes or No answers.

A participant was considered to have cough and/or sputum if he answered "Yes" to any of the first four questions in the corresponding category which asked whether the symptoms occurred immediately after waking up, during the day, in the past seven days and for three or more consecutive months during a year. Answering by "Yes" for the incidence of either symptom on the most days during the last year (the fifth question in each category) was used as indicator for the presence of chronic respiratory symptoms. Dyspnea was considered a symptom when the participant answered by "Yes" to the question concerning shortness of breath, while the presence of wheeze was regarded as a symptom when the participant responded by "Yes" to hearing a sound in his chest at any time in the day, moreover, work-related shortness of breath (work-related SOB) was recorded as a symptom if the worker answered by "Yes" that the symptoms of breathing difficulties which occurred at work would improve after work or in the off days.

Validity and reliability

The Arabic version of the questionnaire was distributed among 30 cement factory workers to test validity and reliability; those workers were not included in the final analysis. Face and content validity were used to study questionnaire's validation; face validation depends on the responders' judgement on the questionnaire's items while content validation relies on the judgement of expert individuals (21). Internal consistency is used to assess reliability; Cronbach's alpha is considered the most commonly used measure for internal consistency (22). Though reliability is essential for the study, it is not enough without validity. Reliability varies from one population to another, therefore, reliability should be measured every time the questionnaire is used (22). Cronbach's alpha was the test used to estimate the reliability of the questionnaire.

Statistical analysis

All the data were processed and analyzed using IBM SPSS (Statistical Package for Social Science) Statistics for Windows, version 25 (IBM Crop., Armonk, NY, USA). A *P*-value of less than 0.05 was considered to be statistically significant, while Cronbach's alpha value of more than 0.7 was used to determine reliability of the questionnaire. Mean ± SD were used to describe all the continuous variables, while frequencies and percentages were used for categorical variables. Independent samples t-test and one-way ANOVA test were used to measure differences in continuous variables between different groups. Pearson's correlation coefficient was used to identify the relationships among total knowledge scores and total practice scores.

RESULTS

Socio-demographic characteristics

The mean age of the participants was 39.46 ± 9.51 and the average BMI of the study sample was 28.07 ± 4.85. Regarding employment duration of the workers, it extended from 1 to 37 years with a mean of 15.4 ± 7.38. On the other hand, the average working hours per day was 7.57 ± 2.43, with two-thirds of the workers spending 6 hours at work while the reminder had either 8- or 12-hour shifts. Table 1 presents the statistical description of the socio-demographic variables.

Table 1: Socio-demographic characteristics of the study participants (N=97)

Variables	Description
Age*	39.46 ± 9.51
BMI*	28.07 ± 4.85
Employment duration*	15.4 ± 7.38
Daily working hours*	7.57 ± 2.43
Educational level**	
Primary	54 (55.7%)
Secondary	28 (28.9%)
University	15 (15.4%)
Employment type **	
Engineer	9 (9.3%)
Technician	41 (42.3%)
Hand worker	47 (48.4%)
Department **	
Milling	52 (53.6%)
Packaging	45 (46.4%)

*mean ± SD, **n (%)

Knowledge and practice

Validity and reliability

Face validity of the knowledge and practice parts was assessed by a group of laymen who assured the clarity of questions and that they measured what they were intended to measure. In addition, face validity showed that the questionnaire's questions were easily comprehended and quickly completed (less than 10 minute). Moreover, content validity was judged by experts who ascertained that the questions were representative of all aspects in the areas supposed to be covered. Cronbach's alpha values of the internal consistency for the two parts were more than 0.7 indicating adequate internal consistency. For the eighteen questions in the knowledge part, Cronbach's alpha value was 0.714, while the Cronbach's alpha value was 0.776 for the seven questions involved in the practice part.

Factory workers' knowledge and practice

The means of the total knowledge and practice scores were 10.77 ± 2.07 and 3.94 ± 1.34 respectively. The median knowledge score was 11 and the median practice score was 4. Categorization of the workers into two groups of knowledge and practice was made depending on their scores. Workers were considered to have adequate knowledge and appropriate practice when their scores were more than the median, while those with scores equal to or less than the median were categorized as workers with inadequate knowledge or inappropriate practice. The majority of the workers had inadequate knowledge (60.8%) with a same frequency for inappropriate practice. Table 2Table summarizes the statistical description of the workers' knowledge and practice.

Table 2: Descriptive statistics of the workers' knowledge and practice

Variable	Frequency n (%)	Mean ± SD
Total knowledge	97 (100)	10.77 ± 2.07
Adequate knowledge	38 (39.2)	12.82 ± 0.98
Inadequate knowledge	59 (60.8)	9.46 ± 1.41
Total practice	97 (100)	3.94 ± 1.34
Appropriate practice	38 (39.2)	5.32 ± 0.52
Inappropriate practice	59 (60.8)	3.05 ± 0.87

There were no significant association, differences and correlations between total knowledge score or total practice score with any socio-demographic variables. The percentage of the correct answers for each question involved in the knowledge part was computed. The highest percentages of the correct answers (> 90%) were observed in three questions (Q1, Q7 and Q9), whereas the lowest percentages (< 20%) were noticed in two questions (Q14 and Q17). The frequency of correct answer to each knowledge question are presented in table 3. The correct answers to practice questions varied considerably among workers (table 4). The highest practice score was seen in the first question (90.7%), while lowest score was observed in the fourth question (9.3%) where only nine workers answered it correctly.

Table 3: Frequencies and percentages of knowledge correct answers

No.	Knowledge	Correct answer	
		Frequency (n)	Percentage (%)
Q1	Cement dust	93	95.9
Q2	Cement dust and diseases	65	67
Q3	Cement dust and diseases	41	42.3
Q4	Cement dust and diseases	36	37.1
Q5	Cement dust and diseases	44	45.4
Q6	Knowledge about job hazards	87	89.7
Q7	Knowledge about PPE	89	91.8
Q8	Types of PPE	28	28.9
Q9	Benefit of PPE	90	92.8
Q10	Decontamination of eyes	74	76.3
Q11	Liquid used for eyes decontamination	23	23.7
Q12	Decontamination of skin	70	72.2
Q13	Eat and drink at work	84	86.6
Q14	Method of wearing gloves	14	14.4
Q15	Wearing rings and watches at work	48	49.5
Q16	Cement and radiation	70	72.2
Q17	Types of mask (visual question)	15	15.5
Q18	Types of eye protection (visual question)	74	76.3

Table 4Error! No text of specified style in document.: Frequencies and percentages of practice correct answers

No.	Practice	Correct answer	
		Frequency (n)	Percentage (%)
Q1	Appropriate PPE usage	88	90.7
Q2	The PPE used by workers	13	13.4
Q3	Mask usage at work	74	76.3
Q4	Frequency of wearing mask	9	9.3
Q5	The reason why workers wear mask	60	61.9
Q6	Hand washing and cement dust	66	68
Q7	Bathing and cement dust	72	74.2

Difference in total knowledge scores between the two groups of practice was evaluated and a significant statistical difference was found as presented in Table 5. Pearson's correlation coefficient was calculated. A positive significant correlation was found ($r=0.488$, $p<0.001$), as the knowledge scores increased with increasing practice scores.

Table 5: Difference in knowledge scores between practice groups

Variable	Mean Knowledge	t-test*	*P*-value
Appropriate practice (n=38)	11.71 ± 1.72	3.81	<0.001§
Inappropriate practice (n=59)	10.17 ± 2.06		

*Independent samples t-test, §*P*-value < 0.05 indicates significant result

Relationships of knowledge and practice with respiratory symptoms

Cough was the most common respiratory symptom among participants (61.8%). The prevalence of chronic cough, chronic sputum production and work-related shortness of breath were 39.2%, 28.8% and 60.8% respectively. Independent samples t-test was used to determine the differences in total knowledge scores as well as practice scores between workers who were suffering from respiratory symptoms and those who were not. Significant statistical differences were only found in knowledge scores among workers with two of the respiratory symptoms (dyspnea and wheezing) and in practice scores among workers with chronic cough as shown in table 6. However, the means of total knowledge and total practice scores were generally higher in workers without symptoms compared to workers suffering from these respiratory symptoms.

Table 6: Differences in knowledge and practice scores with respiratory symptoms

Respiratory symptom	Frequencies n (%)	Knowledge		Practice	
		Mean ± SD	*P*-value	Mean ± SD	*P*-value
Cough	Yes 60 (61.8%) No 37 (38.2%)	10.58 ± 2.00 11.08 ± 2.17	0.253	3.82 ± 1.34 4.14 ± 1.33	0.259
Chronic cough	Yes 38 (39.2%) No 59 (60.8%	10.45 ± 2.03 10.98 ± 2.08	0.216	3.63 ± 1.28 4.14 ± 1.35	0.012§
Sputum	Yes 55 (56.7%) No 42 (43.3%)	10.76 ± 1.73 10.79 ± 2.47	0.959	4.00 ± 1.31 3.86 ± 1.38	0.607
Chronic sputum	Yes 28 (28.8%) No 69 (71.2%)	10.71 ± 1.76 10.80 ± 2.20	0.860	3.96 ± 1.45 3.93 ± 1.31	0.904
Dyspnea	Yes 50 (51.5%) No 47 (48.5%)	10.20 ± 1.80 11.38 ± 2.18	0.004§	3.72 ± 1.38 4.17 ± 1.27	0.1
Wheeze	Yes 35 (36 %) No 62 (64%)	10.06 ± 1.89 11.18 ± 2.07	0.01§	3.66 ± 1.41 4.10 ± 1.28	0.123
Work-related SOB	Yes 59 (60.8%) No 38 (39.2%)	10.93 ± 1.96 10.53 ± 2.23	0.349	4.00 ± 1.31 3.84 ± 1.40	0.581

*Independent samples t-test, §*P*-value < 0.05 indicates significant result

DISCUSSION

Different questionnaires and scales were used worldwide for the evaluation of knowledge and practice in cement factory workers, therefore; no comparison for total scores could be made. The workers in the current study were categorized into two groups based on their knowledge and practice total

scores by using median split method; adequate versus inadequate knowledge and appropriate versus inappropriate practice. The workers who were classified as having adequate knowledge were also exhibiting appropriate practice which reflects that having good knowledge is essential factor for promoting improvement in subjects' practice. This was proven by the presence of significant positive correlation between the total scores of knowledge and practice. Further, the mean of knowledge score was significantly higher among workers with appropriate practice than those with inappropriate practice.

Even though 60.8% of the workers were considered to have inadequate knowledge and inappropriate practice, the majority of them (95.9%) answered correctly that cement dust can cause diseases which was higher than the results observed in the Nepalese and Emirati workers (8, 15). Sixty-seven percent of the participants knew that respiratory problems would be an outcome of cement dust exposure, whereas 94.7% of the cement factory workers in Ras Al-Khaimah, UAE mentioned that (15).

A high percentage of the workers who participated in this study assured that they knew PPE (91.8%) and knew the benefits behind using them (92.8%), but only 28.9% of the workers were aware about all types of PPE that should be used by cement factory workers. Moreover, the workers were unable to identify the correct face mask for dust protection as 84.5% of the factories' workers chose surgical face masks instead of N95 face masks, N95 mask is among the recommended PPE for respiratory protection (Occupational Safety and Health Administration, 2004). On the other hand, 76.3% of the workers had sufficient knowledge about the eye protection means; the goggles. These finding could be explained by the limited information of the workers about the exact equipment used for protection; they should be provided with adequate education and instruction about the appropriate means used for protection.

Washing eyes was the action of 76.3% of the workers in this study when dust would go into their eyes and it was parallel to the result observed in Nepal (Sah *et al.*, 2015) where 82% of the workers there do the same, while other workers were used to either consulting a doctor or just rubbing the eyes with their fingers. When the workers were asked about the appropriate liquid that should be used for eyes washing; less than one-quarter of them answered they should use cold water, whereas others mentioned that any available liquid or a special eye drop would be appropriate. Occupational Safety and Health Administration (23) suggests that eyes should be rinsed with water when cement dust comes in contact with them. Again, these results prove the lack of specific information about safety measures among the workers and a need to include such detailed information in training programs.

The lowest percentage of correct answers was observed in the question about the best approach for wearing protective gloves to prevent the access of cement dust into the gloves and its subsequent contact with the skin. As only 14.4% of the workers were aware that they should pull the sleeves over the protective gloves, this approach is considered an important protective behavior to avoid the adverse effects of cement dust on the skin.

In this study, 90.7% of the workers utilized PPE and 13.4% of them used all the required protective equipment, while in Nepal (8), the usage of PPE among cement factory workers was very high as 96% of them were using PPE at work, but only 3% of the workers were using all the proper protective devices.

About three-fourths of the workers in the current study were used to wearing face masks at work, which is higher than workers in Iran (24) and Ethiopia (25) where only 40% and 15% of the workers there wore masks respectively. Even with such high usage of face masks compared to other studies, it was found that only nine workers (9.3%) were using masks the entire time they are in the factory. Workers at cement factories are highly exposed to dust at different steps of cement production, from extracting the raw materials to packaging the final product (13) and wearing a face mask is considered one of the approaches used for reducing the adverse effects of cement dust on the respiratory system (24). Approximately sixty-two percent of the workers mentioned that they used face masks to protect themselves from the cement dust. However, it is important to encourage the workers to use masks daily and all the working time. This percentage is less than that observed in the UAE where 92.2% of the workers claimed that their face mask usage was for dust protection (15). This result may be attributed to the implementation of educational and training programs among Emirati workers which led to establishing basic concepts about workers' safety.

The results in the current study showed that majority of the workers (74.2%) habitually bathed after returning from the factory. However, the remaining one-fourth (25.8%) of workers did not wash their bodies when they were at home after finishing their shift and as a result of this bad habit, workers' families may be prone to health hazards associated with cement dust. The same proportions were observed in the Nepalese study (8).

Again, workers' awareness was found to play a vital role in their wellbeing at work environment, the workers who did not complain of respiratory symptoms had better knowledge scores than those who reported the presence of the symptoms. On the other hand, the higher practice scores were distributed between workers with and without symptoms. This possibly occurred because respiratory symptoms could be reduced or prevented by using good quality face masks all the time the workers were in the factory, but in the current study only nine workers (9.3%) were using face masks all the time and this may lead to the high prevalence of symptoms among workers.

LIMITATIONS

Inclusion of only non-smokers could be considered as a limitation to the current study, however, non-smokers were only included in order to exclude the effect of smoking on the results of respiratory symptoms. Inclusion of all workers could explored a clearer picture regarding knowledge and practice in the factories. Because the study was carried out in four factories, and only from two departments (packing and milling) the sample was relatively inadequate to evaluate the knowledge and practices of all PPE.

CONCLUSION

This study revealed an acceptable level of knowledge and positive practices among the study sample from four cement factories who are participated in the survey. Higher knowledge score was directly correlate with better practice of the workers during the working hours and improving workers' knowledge might enhance the protective behavior of the factory workers. Awareness toward the effect of dust, types of PPE and it benefit was not satisfactory and educational programs or training course are needed.

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