International Journal of TROPICAL DISEASE & Health

Volume 45, Issue 8, Page 1-9, 2024; Article no.IJTDH.121249
ISSN: 2278–1005, NLM ID: 101632866

Manifestations of Respiratory Dust Related Health Effects among Quarry Stone Diggers in Small Scale Quarries in Nairobi City County, Kenya

Warutere Peterson Njogu [a*]

[a] Department of Environmental and Occupational Health, Kenyatta University, P.O. BOX- 43844-00100 Nairobi, Kenya.

Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

Article Information

DOI: https://doi.org/10.9734/ijtdh/2024/v45i81576

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/121249

Original Research Article

Received: 04/06/2024
Accepted: 07/08/2024
Published: 13/08/2024

ABSTRACT

Quarrying activities generate huge quantities of dust particles that cause a variety of respiratory illnesses among quarry workers. In Kenya, quarry industry suffers several constraints: some quarry workers get injured, others get chronic disease, while some die. Quarry dust control measures are not implemented, and quarry workers are exposed to dust that increase their risk of respiratory diseases. The study was done in 2 quarries in Kayole (Mihang'o and Matopeni ward) which are mainly involved in stone digging and crushing. The study used an analytical cross-sectional design and a sample size of 165 respondents was taken to represent the study population. An interviewer administered questionnaire was used to assess quarry workers respiratory symptoms and such

**Corresponding author: Email: warutere.peterson@ku.ac.ke;*

Cite as: *Njogu, Warutere Peterson. 2024. "Manifestations of Respiratory Dust Related Health Effects Among Quarry Stone Diggers in Small Scale Quarries in Nairobi City County, Kenya". International Journal of TROPICAL DISEASE & Health 45 (8):1-9. https://doi.org/10.9734/ijtdh/2024/v45i81576.*

symptoms were diagnosed by a qualified clinician. Spirometry tests were done by a qualified technician to assess the pulmonary function. Respirable dust levels were determined through the aid of a particle counter. Data was analyzed using Statistical Package for Social Sciences (SPSS) version 25. Chi square tests and logistic regression were done to establish relationship between different variables. T tests were done to compare means of study variables in two groups. This study found the prevalence of the respiratory symptoms among quarry workers to be 24.2% and reported symptoms were cough, throat clearing, chest pain/tightness, cold, breathlessness and wheezing. The study concludes that; the levels of respirable dust ($PM_{2.5}$ and PM_{10}) in Kayole quarries was three times higher than the daily level of 25 ug/m^3 for $PM_{2.5}$ and 50 ug/m^3 for PM_{10} recommended by WHO, chronic exposure to quarry dust increase the risk of developing respiratory symptoms and decreased pulmonary function. This study recommends that quarry owners should provide adequate water in the quarries so that wet dust suppression can be done. The study also recommended chest radiograph be done on quarry workers and the radiographic image to be compared with spirometry results to accurately determine the type of respiratory disease that quarry workers suffer from.

Keywords: Inhalable dust; pneumonoconiosis; quarry; respirable dust; dust related health effects; respiratory hazards.

ABBREVIATIONS

COPD : Chronic Obstructive Pulmonary Disease
PFT : Pulmonary Function Test
PPE : Personal Protective Equipment
WHO : World Health Organization

1. INTRODUCTION

Quarry is a place from which stones, rocks, sand, gravel and many more can be excavated for human resource [1]. Quarries are generally used for extracting building materials such as dimension stones. Quarry workers are exposed to several respiratory hazards arising from breathing quarry air borne particles and these causes a significant risk to their respiratory health especially exposure to silica dust that leads to silicosis, an irreversible respiratory disease [2] among exposed quarry workers [3].

The global prevalence of pneumoconiosis has been about 450,000 while that of other respiratory illnesses resulting from occupational exposure is about 2,631,000 cases [4]. Workers in dusty occupations in Britain have been reported to have developed related occupational diseases at an annual prevalence of 44 per 1000 [5] while in China a positive correlation between exposure to respirable silica and high mortality from silicosis lung cancer, respiratory tuberculosis and cardiovascular diseases among mine workers has been observed [6]. A study among quarrymen in Germany, particularly ore miners showed high Odds Ratio of 3.36 for adenocarcinoma [7].

In India reported case of respiratory symptoms among exposed stone carving workers and complaints of shortness of breath, cough, and chest pain were present among 26%, 19% and 2% of the workers, respectively [8]. In Bangladesh the prevalence of cough at 28.33%, breathlessness, wheezing and chest tightness were reported at 4.58%, 2.29% and 1.68% respectively [9]. In Umuoghara Nigeria subjects exposed to quarry pollutants had significantly greater ($P < 0.001$) presence of sputum production (28% versus 13.5%), runny nose (45% versus 25.5%), persistent cough (36.5% versus 19%), sneezing (56.7% versus 29%), wheezing (34.5% versus 17%), chest tightness (17% versus 6.5%) and breathlessness (29.5% versus 15.2%) compared with the unexposed control group [10].

In Zambia, the frequent of occupational exposure to cumulative respirable dust exceeding concentration of ≥ 5.89 mg-year/m^3, was significantly associated with doctor-diagnosed respiratory disease (OR 1.72; 95% CI 1.14-2.59), breathlessness (OR 3.28; 95% CI 1.53-7.00) and phlegm (OR 2.01; 95% CI 1.26-3.22) [11]. Self-reported respiratory symptoms were more prevalent in respondents from the exposed community than in the control community. Cough

was reported at 48.1%, phlegm at 55.9%, persistent cold at 46.5%, wheezing at 45% and 20% of the respondent suffered from pneumonia [12]. Quarries in Kajiado Kenya showed the prevalence of occasional cough was 45%, wheezing was 26.6% and shortness of breath was 32.1% [13]. Whereas chronic respiratory illnesses associated with occupational exposure to respirable dust have been documented by several studies, there is limited literature about the effects of such exposure and their impacts on different occupational groups in small scale stone diggers. There is also scarcity of research on the pulmonary function of stone diggers working in small scale quarries like those in study area therefore this study was necessary to in providing such information.

2. METHODOLOGY

2.1 Study Design

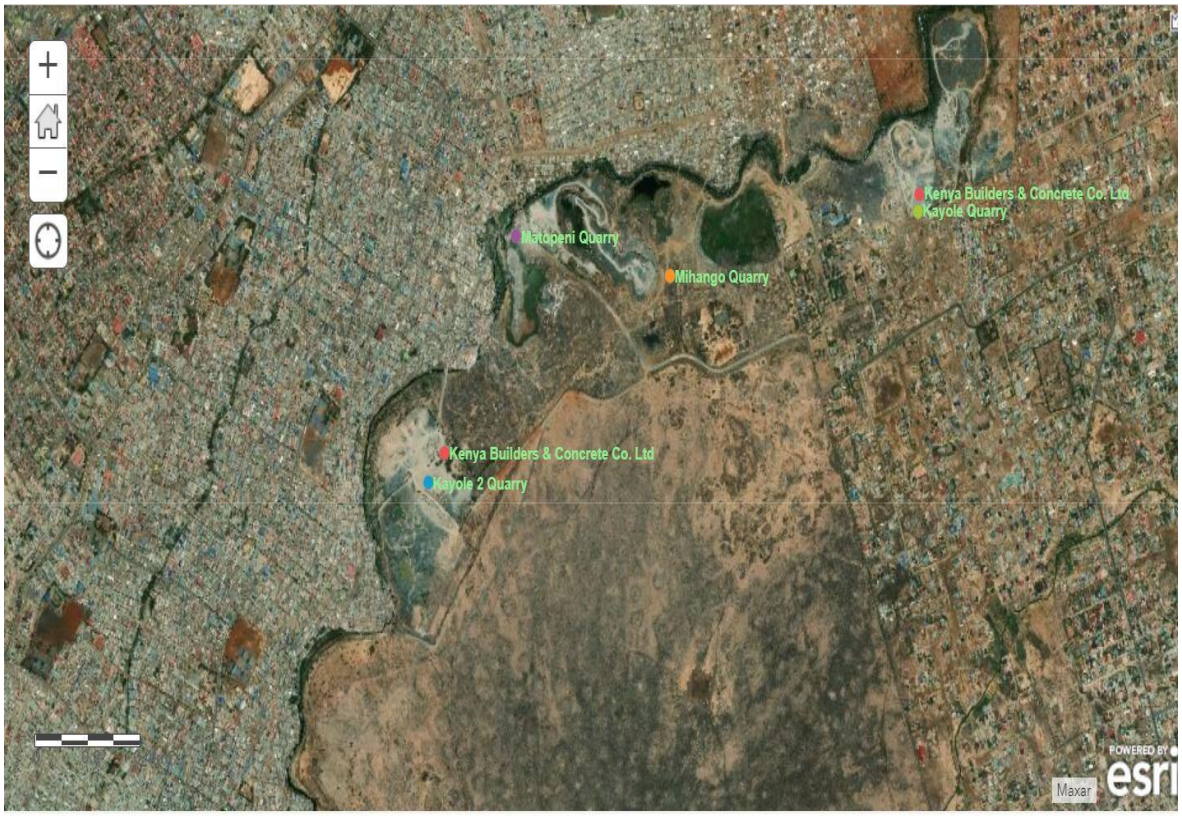
Analytical cross- sectional design was adopted where data was collected at a point in time. The data on level of respirable dust was collected using a particle counter using Contec (SP70B) while spirometer was used to assess the pulmonary functions of the stone diggers. Forced Expiratory Volume in first second (FEV_1); the forced vital capacity (FVC) and the Ratio of FEV to FVC were determined. Interviewer administered questionnaires were used to establish the perceived magnitude of respiratory symptoms associated with dust exposure.

2.2 Study Area

This study was carried out in Kayole quarries located in the Eastern part of Nairobi County at an estimated distance of 10 km east of the city center as shown in Map [14].

2.3 Sampling Technique

Two quarries Matopeni and Mihang'o quarries were purposively selected because of the heavy digging and crushing compared to the other quarries in the area. Studies have shown that crushing and digging activities have the highest concentration of dust compared to other quarrying processes [3,4]. Simple random sampling was then used to select quarry workers from the two quarries and the sample size was distributed proportionate to the population size of each quarry to ensure representativeness.



Map. 1. Study location

2.4 Sample Size Determination

The prevalence of respiratory symptoms among stone diggers in the two quarries was unknown. However, evidence from a study done in Iran among stone cutting and quarry mine workers suggest that the prevalence of respiratory symptoms such as cough and wheeze is around 11% among quarry workers [14]. Thus, in this study, the prevalence of these symptoms was assumed to be 11%. For sample size calculation Cochran (1977) formula was used. The formula is represented in the equation below.

$$n_o = Z^2 P_q / e^2$$

Where,

n_o is the sample size.

Z is confidence level at 95% and a standard value of 1.96.

P estimated proportion, its anticipated that 11% of quarry stone diggers will have perceived respiratory symptoms.

q is 1-p. which was 89% while e = margin of error, taken as 5%

$$\text{Sample size } n_o = 1.96^2 \times 0.11 \times 0.89 / 0.05^2 = 150.43$$

The sample size was then adjusted by 10% to cater for non-response.

Thus, a minimum sample of 165 participants was used in this study (Table 1).

The stone diggers were stratified into two strata, one of stone diggers in Matopeni and another of stone diggers in Mihangó and sample size was apportioned to each cluster based on its population.

Table 1. Sampling frame

Quarry Name	Population of Stone Diggers	Sample of Stone diggers
Matopeni	275	96
Mihang'o	200	69
Total	475	165

2.5 Data Collection Tools and Methods

The following data collection tools were used:

i. Questionnaire

A comprehensive structured questionnaire was designed, it contained both open and closed ended questions to obtain data on demographic characteristics, followed by a set of questions framed about the perceived magnitude of respiratory symptoms associated with dust exposure. The questionnaire collected quantitative data and was interviewer administered to each of the sampled participant at their work site.

ii. Clinical observation

A clinician examined the quarry workers for respiratory symptoms.

2.6 Data Analysis and Presentation

Statistical Packages for Social Scientists Version 25 was used for analysis. Descriptive statistics like frequency, mean, standard deviations and percentages were used in summarizing the data and results were presented in frequency tables and graphs. Chi square tests were done to determine associations between different study variables. Odds ratios were also computed at 95% confidence level using two by two contingency tables.

3. RESULTS

3.1 Clinically Diagnosed Respiratory Symptoms

Clinically diagnosed respiratory symptoms among stone diggers in the quarries in Kayole varied from 3.6% who were diagnosed with wheezing to 19.4% who were diagnosed with persistent cough (Table 2).

The prevalence of respiratory symptoms was 40 (24.2%); persistent cough was the most common symptom reported at 32 (19.4%) followed by throat clearing at 19 (11.5%), chest pain and tightness at 17 (10.3%) persistent cold at 14 (8.5%), shortness of breath at 8 (4.8%) and wheezing was the least reported symptom at 6 (3.6%). Among the respondents with the above respiratory symptoms 16 (40.0%) reported that they had gone to the hospital between 1 to 2 times and 4 (10.0%) had gone to hospital between 3 to 4 times because of severity of these symptoms.

The presence of respiratory symptoms was significantly associated with pulmonary function at (p=0.0001) and respondents with respiratory symptoms had a higher likelihood of having lower pulmonary function values and the odds ratio was 5.9.

Table 2. Clinically diagnosed respiratory symptoms among stone diggers in the quarries

Probable respiratory symptoms	Specific symptom	Frequency	Percentage
Prevalence Respiratory Symptoms	Persistent Cough	32	19.4%
	Throat Clearing	19	11.5%
	Chest Pain and Tightness	17	10.3%
	Persistent Cold	14	8.5%
	Shortness of Breath	8	4.8%
	Wheezing	6	3.6%
Times gone to Hospital in the last 12 months among those with symptoms	1 to 2 Times	16	40%
	3 to 4 Times	4	10%

Table 3. Chi-square results between factors associated respiratory symptoms

Variable	Category	Pulmonary Functions					
		Abnormal	Normal	Chi Square	Odds Ratio (OR)	Confidence Interval Lower	Upper
Presence of Respiratory symptoms	No	18	107	χ^2=21.67	OR=5.9	2.68	13.16
	yes	20	20	df=1			
	Total	38	127	p=0.0001			

Table 4. Binary logistic regression between variables and pulmonary function

Variables	Pulmonary Function			
	P Value	Ratio Adjusted Odds	Confidence Interval at 95% Lower	Upper
Presence of Respiratory symptoms	0.03	5.2	1.14	23.31
Smoking	0.001	50	10.00	250.0

Table 5. Pulmonary functions of stone diggers in quarries

Pulmonary function of the respondent		Frequency	Percentage
Forced Expiratory Volume in the first second (FEV_1) in percentage	Moderately abnormal (60%-69.9%)	9	5.5%
	Mildly abnormal (70.0% -79.9%)	35	21.2%
	Normal (80%- 120%)	121	73.3%
Forced Vital Capacity (FVC) in percentage	Moderately abnormal (60%-69.9%)	6	3.6%
	Mildly abnormal (70.0%-79.9%)	25	15.1%
	Moderately abnormal (80% -120%)	134	81.2%
Ratio of (FEV_1) to (FVC) in percentage (FEV/FVC) *100	Moderately abnormal (60%-69.9%)	5	3.0%
	Mildly abnormal (70.0%-79.9%)	20	12.1%
	Normal (if FEV is $\geq$ 80%) (80%120%)	140	84.8%

The mean value of Forced Expiratory Volume in the first second (FEV_1) was 85.97% $\pm$ 11 where the lowest FEV_1 value was 67% while the highest was 119%. The mean value of Forced Vital Capacity (FVC) was 88.29% $\pm$ 11.43 where the lowest FVC value was 64% while the highest was 120%. The mean Ratio of (FEV_1) to (FVC) was 86.54% $\pm$ 6.63. Based on these spirometry values 23.0% (38) of the respondent had abnormal pulmonary where 12.7% (21) had restrictive pulmonary disorder and 10.3% (17) had obstructive pulmonary disorder.

At multivariate analysis the presence of respiratory symptoms was significantly associated with pulmonary function at (p=0.03) and respondents with respiratory symptoms were five times more likely to have lower pulmonary function values when compared to those without the symptoms (AOR = 5.3 at 95% CI=1.14 - 23.31). Smoking was significantly associated with respiratory symptoms at (p=0.001) and respondents who were smokers were more likely to have respiratory symptoms in comparison with nonsmokers (AOR = 50 at 95% CI=10.0 - 250.0).

Table 6. A cross tabulation of duration of work experience and pulmonary functions

Variable	Category	FEV_1			FVC			Ratio of FEV_1 to FVC		
		Normal	Abnormal	FEV_1 Chi Square	Normal	Abnormal	FVC Chi-square	Normal	Abnormal	Ratio of FEV_1 to FVC Chi square
Duration of work experience in years	5 years or less	62	2	p=0.05	63	1	p=0.03	61	3	p=0.03
	More than 5 years	82	19	Odds Ratio=6.7	85	16	Odds Ratio=5.9	87	14	Odds Ratio= 4.8
Days worked per week	3 to 5 days	24	2	p=0.45	24	2	p=0.63	21	5	p=0.103
	Over 5 days	120	19	Odds Ratio=1.7	124	15	Odds Ratio=1.5	127	12	Odds Ratio=1.0
Hours worked per day	6 to 8 hours	137	18	p=0.74	139	16	p=0.97	140	15	p=0.29
	Over 8 hours	7	3	Odds Ratio=1.2	9	1	Odds Ratio=1.0	8	2	Odds Ratio=1.1
	Total	144	21		148	17				

There was a significant association between years of work experience and pulmonary function at FEV_1(p=0.05), FVC (0.03) and Ratio of FEV1 to FVC (0.03). Respondents with 5 or more years of work experience had a higher likelihood of having decreased pulmonary functions and the odds ratio were 6.7(FEV_1), 5.9(FVC) and 4.8 (Ratio of FEV1 to FVC). However, the number of days worked per week and hours worked per day were not significantly associated with pulmonary functions at (p>0.05)

3.2 Pulmonary Functions and Spirometry Results of among the Quarry Workers

The pulmonary functions assessed among the quarry stone diggers were Forced Expiratory Volume in the first second (FEV_1), Forced Vital Capacity (FVC) and Ratio of (FEV_1) to (FVC) in percentage (Table 5).

3.3 Association between Work Experience and Pulmonary Functions among Quarry Stone Diggers

Majority of the respondent 61.% (101) had worked in the quarries for more than five years. It was observed that 84% (139) were working for more than 5 days in a week with 94%(155) working for 6to 8 hours in a day (Table 6).

4. DISCUSSION

This study reported prevalence of the respiratory symptoms at 24.2%, persistent cough, throat clearing, chest pain and tightness, persistent cold, shortness of breath and wheezing were reported at 19.4%, 11.5%, 10.3%, 8.5%, 4.8% and 3.6% respectively. These findings agree with a study done by Isara et al [2] in Nigeria where Chest pain and tightness was reported at 35.5%, cough at 23.7%, sputum at 21.1%, dyspnea at 7.9% and wheezing at 10.8% among the exposed group. This finding is further affirmed by Kabir et al. [2] who reported cough at 28.3%, shortness of breath at 4.6%, wheeze at 2.3% and chest tightness at 1.68% among quarry stone crushers.

This study found that 40.0% of the respondents with respiratory symptoms had gone to hospital between one to two times because of severity of these respiratory symptoms. This finding are consistent with Enuma et al. [10] who reported that 41.7% of the quarry workers in Umuoghara sought treatment when their respiratory symptoms became worse and could not do physical quarry activities. This study also showed that prevalence of the respiratory symptoms was significantly associated with pulmonary function and respondents with respiratory symptoms had a higher odds ratio of having decreased pulmonary function when compared with those without the symptoms. This finding is harmony with a study done by Sunil et al. [11] who reported that respiratory symptoms were more prevalent in exposed quarry stone workers with lower pulmonary functions.

This finding further concurs with a study done by Gholami et al [12] where the mean years of work experience among quarry workers in Eastern Iran was 8.0 $\pm$ 3.3. This finding was further affirmed by Sahbanathul et al [13] in a study done in India where 16.6% of the quarry workers were reported to have work experience of 1 to 5years, 25% had 6 to 10 years, 35% had 11 to 15 years and 23.3% had over 15 to 20 years.

This study showed a significant association between years of work experience and pulmonary function, finding consistent with a study done in India by Nandini et al [14] where granite quarry workers who had over 10 years exposure had significant decrease in FEV1, FVC, FEV1/FVC% values when compared with those exposed for less than 10 years. In Ebonyi state Nigeria, Henry et al [15] also had similar finding where increase in years of exposure showed a significant decrease in FEV_1 among quarry workers. This study also showed a high odds ratio and a significant association between years of work experience and prevalence of respiratory symptoms This finding agrees with a study done by Gizaw et al [16] where years of service was significantly associated with chronic respiratory symptoms and workers with greater than 5 years of experience were 5.44 times more to develop the symptoms compared with those that had a work experience of less than 5 years. This finding is further affirmed by Shrivastava et al [4] who revealed that respiratory symptoms were more common in workers exposed for longer duration among workers in a marble quarry in India.

5. CONCLUSION AND RECOMMENDATION

Chronic exposure to quarry dust increases the risk of developing respiratory symptoms and the prevalence of these symptoms among stone diggers. These symptoms were persistent cough, throat clearing, chest pain and tightness, persistent cold, shortness of breath and wheezing. Respiratory symptoms were significantly associated with pulmonary function and respondents with respiratory symptoms had a higher odds ratio of having decreased pulmonary function when compared with those without the symptoms. There exists significant association between years of work experience and pulmonary function. Their respiratory symptoms and FEV1, FVC, FEV1/FVC% values should be closely monitored as they are important indicators of respiratory related

conditions. Routine medical examinations along OSH requirements [17] should be adhered to in order to mitigate severe outcomes associated with respiratory symptoms. The Directorate of Occupational safety and Health Services (DOSH) should monitor conformity in these workplaces.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

I hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

CONSENT AND ETHICAL APPROVAL

Authority to undertake the research was obtained from Kenyatta University Graduate School and Ethical clearance was obtained from Kenyatta University Ethics Review Committee. A research permit was also obtained from the National Commission for Science, Technology and Innovation. Quarry owners and managers were contacted for permission to conduct research in their setting and allow their workers to participate in this study. The study participants were notified about the purpose of this study and voluntary and informed consent of the respondents was sought before data collection. Workers were not coerced to participate in this study and were allowed to decline or withdraw at any time of their will during the study. Confidentiality was guaranteed throughout the study.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. Stefan G., Costner M, Sudharsan S. Study on the status of quarry workers in kandegai nagar, International Journal of current Advanced Research. 2019;8(8):2319-6505.
2. Isara RA, Adam VY, Aigbokhaode, A, Alenoghena IO. Respiratory symptoms and ventilatory functions among quarry workers in Edo state, Nigeria. Pan African Medical Journal. 23:212
3. Ahadzi DF, Afitiri A, Ekumah B. Self-reported disease symptoms of stone quarry workers exposed to silica dust in Ghana. Journal of Health Sci Rep. 2020;3: 189.
4. Shrivastava A, Tomar SP, Patel M. Prevalence of symptoms of occupational lung diseases in marble cutting workers. International Journal of Community Medicine and Public Health. 2018;8: 3368-3371.
5. Health and safety executive. Silicosis and coal workers coal worker's pneumoconiosis in Great Britain; 2018.
6. Wang D, Meng Y, Liu Y, Jixuan M, Tingming S, Weihong M, Chen D. Association of silica dust exposure and cigarette smoking with mortality among mine and pottery workers in China. JAMA Network Open | Occupational Health. 2020;3(4):e202787
7. Taeger D, Beate P, Kendzia B, Behrens T. Brüning T. Lung cancer among coal miners, ore miners and quarrymen: smoking-adjusted risk estimates from the synergy pooled analysis of case–control studies. Scand J Work Environ Health. 20106;41(5):467477.
8. Shrivastava A, Tomar SP, Patel M. Prevalence of symptoms of occupational lung diseases in marble cutting workers. vol 8 - Google Search. International Journal of Community Medicine and Public Health. 2018;3368-3371.
9. Kabir E, Islam A, Taufikuzzaman M. An investigation into respiratory health problems of workers at stone crushing industries in Bangladesh. Journal of Health Research. 2017;32(2):172-178. Available:https://doi.org/10.1108/JHR-01-2018-017.
10. Enuma U, Babatunde IO, Olanike RA, Ijeoma MA. Health seeking behaviour of workers in the quarry village of Umuoghara, Ebonyi state, south East Nigeria. Palgo Journal of Medicine and medical science. 2016;3(2).
11. Sunil D. Isolated FEV1 reduction among stone crusher workers- A possible indicator of obstructive pulmonary disease. Int J Biochem Physiol. 2019;4(3).
12. Gholami A, Sajedifar J, Dehaghi BF, Gavamabadi LI, Boghsani GT, Tazeroudi A, et al. Lung function and respiratory symptoms among mine workers in the Eastern part of Iran. Russ Open Med J. 2018;7(3).
13. Sahbanathul M, Subashini A. Assessing the prevalence of respiratory problem and knowledge on the health effects of people residing near quarry. International Journal of Pharmacy and Pharmaceuticals

Science. 2017;9(2).
14. Nandini C, Malleshappa K, Vastrad BC, Nafees S. Study of lung function in granite workers based on duration of exposure. Natl J Physiol Pharm Pharmacol. 2018; 8(10):1374-1376.
15. Henry EA, Getrude AO, Chibuisi FO, Shu NE. Occupational health hazards associated with continuous exposure to quarry activities among quarry workers in Ebonyi state, South East Geopolitical zone, Nigeria. Journal of Environmental Science,Toxicology and Food Technology: 2017;11(4).
16. Gizaw Z, Yifred B, Tadesse T. Chronic respiratory symptoms and associated factors among cement factory workers in Dejen town, Amhara regional state, Ethiopia. Multidiscip Respir Med. 2016;11: 13.
17. Osh Act. The laws of Kenya. The occupational safety and health act; 2007.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/121249