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Pulmonary Problems among Stone Cutting Workers in West Bank-Palestine

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Abstract

Introduction: Respiratory problem is one of the major health hazards in dust-exposed workers; it is a major cause of morbidity and mortality all over the world.

Objectives: To determine the prevalence of respiratory problems and lung function impairment (PFI) among Palestinian stone cutting workers, and to investigate its association with work conditions and other risk factors.

Method: During April-June 2012, a cross-sectional study was conducted among 259 male workers, who were available at all stone-saw workshops (n=42) located around the valley between Nablus and Tulkarm in the northern part of West Bank, Palestine. Respiratory problems and lung function were studied through interviews questionnaire, detailed history, clinical examination and spirometry.

Results: The respondents were all males, with mean age of 36.8 years and with 13.4 years mean duration of current work. Complaints of chronic cough, chest pain and wheezes were present among 28.2%, 17.8% and 3.8% of workers respectively. The prevalence of abnormal pulmonary function test among workers was 21.6%, with 20. 1 % of workers had restrictive lung disease and 1.5% showing obstructive lung disease. Multivariate regression, showed that smokers, longer duration of work, and PPE non users have higher risk for developing abnormal pulmonary function test (OR 4.5; CI: 1.01-20.2; p=0.049), (OR 2. 1; CI: 1.03-4.5; p=0.04) and (OR 2. 1; CI; 1.04-4.5; p=0.03) respectively.

Conclusion: Chronic exposure to dust in stone cutting Industry may increase the risk of respiratory problems and impaired lung function; cigarette smokers, long duration of work and non usage of Personal Protective Equipments (PPE) are at higher risk.

Key Words: *Stone cutting – Respiratory problem – Pulmonary function test – Palestine.*

Introduction

OCCUPATIONAL exposure to dust is a well-known phenomenon, especially in developing countries [1,2]. Although sources of air pollutants include power plants, cement factories, refineries and petrochemical industries, the emission of particulates is quite high from quarries [3].

Stone cutters process crude stone into masses and blocks (by cutting, shaping, breaking, processing, polishing, removal of sections, etc.) into desirable sizes, patterns and degrees of finishing; this is done by using manual and mechanical work tools, for the purpose of building, decorating, creation of statues and similar goals. Hazards at stone cutting workshops include pneumoconiosis due to exposure to mineral dust and silicosis as a result of prolonged exposure to dust containing free silica [4].

Inhalable dust is produced when the stone is cut and by the breaking of the stones on the quarry floor during the transit of the vehicles. The bench and block cutting is wet, with minimal exposure to fine dust when assisting the cutting. Nevertheless, when the mud dries on the quarry floor, workers are exposed to the inhalation of dust raised by the wind and the transit of the vehicles. The dust, in the case of stone, contains quartz which can cause silicosis, depending on the amount of quartz actually present in the dust and the diameter of free silica particles [5].

The health impacts of working in stone quarrying industry have been well documented [6,7]. For instance, numerous epidemiological studies have supported the association between respiratory impairment and occupational exposure to dust [6].

Also, high prevalence of silicosis has been reported among workers engaged in quarrying shale sedimentary rock in India. According to Urom, et al., [8] the major respiratory symptoms

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among quarry workers include non-productive cough, chest pain, catarrh and dyspnea. Considerable pulmonary function impairments have been reported in quarry workers [9,10].

In a study by Ghotkar, et al., [11] the prevalence of respiratory morbidity among stone quarry workers was 32.5%, based on radiological study; the severity of pulmonary function impairment was significantly associated with increasing age, duration of exposure to dust, smoking status and presence of chronic obstructive airways disease on radiological study. It was shown that dusts generated from granite quarrying contain 71% silica [12,13]. The occupationally related lung diseases are most likely due to the deposition of dust in the lung and are influenced by the type of dusts, the period of expo-sure, the concentration and the size of the airborne dust in the breathing zone [14].

Palestinian workers in stone cutting workshops are at higher risk of occupational diseases due to the lack of awareness of safety rules and their enforcement. So, it is essential to understand the health related risks associated with stone cutting, particularly in developing countries as Palestine, where there is often a lack of legislation governing the environmental performance of quarrying corporations.

There is also scarcity of research and data about occupational health problems among quarrying workers in Palestine. To our knowledge, no similar studies have been done.

The output of this research will be an approach to improve our knowledge about occupational health in Palestine and will have implications for developing and implementing health and safety interventions and policies within stone industry and for developing new guidelines for health and safety of stone industry workers. It will also be useful for quarrying managers, policy makers, contractors and employees on greater understanding of the personal and environmental factors that influence workers health and will form a base for further research and training in the field of occupational health and safety in the future.

This work aims to determine the prevalence of respiratory problems, and impairment of lung function among stone cutting workers, and to identify the risk factors associated with it. The oveall objective is the promotion of Occupational Health in Palestine through improvement of work conditions of quarrying workers (stone saws) to prevent work-related health problems.

Material and Methods

Study design:

This is a cross-sectional study with analytical component among stone-cutting Palestinian workers.

Study setting:

There are approximately 244 stone-cutting workshops, in which more than 1500 male workers work, in the West Bank and Gaza. Workshops are found primarily in the Hebron, Nablus, Jenin, Taulkarem and Ramallah areas, with less concentration in Gaza. The current study was done in 42 stone-cutting worshops (of all 244, mentioned previously) located around the valley between Nablus and Taulkarem areas in the nothern part of West Bank. These 42 worshops constitute a non random sample of all stone cutting workershops in West Bank; they share the same geographic, climatic and socioeconomic conditions and they are using the same instruments and machines. These workshops consist mainly of iron roofed warehouses and hangars in relatively open areas to ensure the largest volume of ventilation.

Study population and study sample:

All workers in the selected 42 workshops were recruited in the study. They were 259 male workers distributed as 153 (59.1%) workers are working inside the cutting workshops and 106 (40.9%) are working around the cutting workshop as managerial, aiders, clerks and others. The workers have many different tasks; some are directly work inside with the main cutting machine, others involved in manual stone hand polishing and pilling, and many of them are involved in many stages of production process. Workshops are generally open from 7:30 am to 17:00pm, six days a week.

Study period:

The study was conducted during the period from 1 st of April to 30th of June 2012. Selected April to June months because it is a season when a maximum number of workers are usually available at workplace because of increased demand for stones during next summer season as more raw material are needed for buildings construction locally and abroad.

Tool of the study:

1- All available workers were personally interviewed using self formulated questionnaires which collected data about socio demographic characterstics, full occupational history, working conditions/environment, and health related complaints.

2- Medical examination of workers including chest clinical examination.

3- *Pulmonary function test (spirometry):* A portable computerized Spiro-meter was used. The device belongs to the Ministry of Health (Occupational Health Department). Spirometry was performed by trained researcher using a spirometer (Spirovit SP- 1, Schiller America, Doral, FL) and following standard procedures (ATS, 1995; Enright et al. , 1991) **[30,31]** . Prior to spirometry, participants underwent weight and height measurements. The test procedure was explained to the subjects and a demonstration of the test procedure was given. The subjects were allowed to sit quietly for 10 minutes to become mentally and physically relaxed prior to testing. The best forced expiratory volume in one second (FEV_1) and forced vital capacity (FVC) were recorded and the FEV_1/FVC ratio was calculated. Results were automatically printed according to Diagnostic criteria: By spirometry results: A- Normal (free), B- Impairment of lung function: 1- Restrictive, 2- Obstructive, 3- Combined.

Data management and analysis:

Data were entered and analyzed using the Statistical Package for Social Science (SPSS 21). Continuous variables are expressed as mean and Standard Deviation. Categorical variables are expressed as frequencies and percents. Chi square was used to examine the relationship between Categorical variables. Multivariate logistic Regression was used for studying independent factors affecting the occurrence of lung impairment.

Ethical considerations:

No harmful interventions and the tests are accepted by the workers and labor union official approval from the Palestinian ministries of health and labor obtained. The workers were given a short oral introduction in Arabic about the research and its objective. They were informed that their data is confidential and it won't affect their work performance. None of the workers withdraw at any point of the research.

Results

This cross sectional study aims to investigate respiratory health problems of stone cutting workers and risk factors associated with pulmonary function impairment. It was conducted during the period from 1 st of April to 30th of June 2012.

The present study shows that 81.9% of the studied participants were older than 25 years, and 18. 1 % were aged 25 years and less. The mean age was 36.85± 11.41 years. All participants were males, and 79.2% of them were married. About 51.4% were urban residents and 48.6% were rural residents. A minority of workers had university education (13.9%). About 60.2% were currently cigarette smokers. As regard chest complaints, 28.2%, 17.8% and 3.8% of workers reported chronic cough, chest pain and wheezes respectively. Spirometry revealed that 21.6% of participants had abnormal (impaired) lung function test. The vast majority of cases with impaired lung function were restrictive (20.1%), and only 1.5% of workers were obstructive.

Table (2) shows that 59.1% were directly involved with machines inside the workshop, while 40.1% were less involved, being in managerial jobs as for example. The mean duration of work experience of the studied participants was 13 ±9.1 years with the work duration ranging from a minimum of 1 year to a maximum of 40 years. One third (33.6%) of participants were involved in working more than 8 hours daily. Only slightly more than one third (35.9%) of the participants reported that they used Personal Protective Equipments (PPE) most of the time, while 64. 1 % reported that they sometimes used PPE.

Table (3) illustrates the relation between different risk factors and abnormal pulmonary function among workers; there was no significant difference between workers with different age groups as regard Pulmonary Function Test (PFT) as 24.%, 21.2%, 18.7% and 25.4% of workers <25 years, 25-34 years, 25-34 years and >45 years had abnormal PFT respectively. (p=0.806). The current study demonstrates that there is statistically significant association between smoking and abnormal PFT, as 26.9% of smokers had Abnormal PFT, and on the other hand, 13.6% of non smokers had abnormal PFT (p=0. 0 11).

As regards work place characteristics, 18.9% of workers inside the stone cutting firm had abnormal PFT compared to 23.5% of those working outside and this difference is statistically non significant (p=0.370). However, a significant increase in percentage of workers with abnormal PFT was found with the increase of duration of exposure, as 16.1%, 20.9% and 36% of workers with exposure duration ≤ 1 0yrs, 11-20yrs and >21 years had abnormal PFT respectively (p=0.0 16).

The prevalence of abnormal PFT among those who sometimes/rarely use PPE was significantly higher (p=0.025) than that among always/most of the time using it (25.9% Vs 14%).

After adjusting to all factors using backward logistic regression, it is shown in (Table 4) that smoking, longer duration of work, and PPE usage are independent factors affecting PFT, as smokers, workers with longer duration of work, and non users of PPE have higher risk for developing abnormal PFT (OR 4.5; CI: 1.0 1 -20.2; p=0.049), (OR 2. 1; CI: 1.03-4.5; p=0.04) and (OR 2. 1; CI; 1.04-4.5; p=0.03) respectively.

Table (1): Description of personal and medical characteristic of the participants.

Socio-demographic characteristics	Number	Percent (%)
Age group (in years):		
Less than 25	47	18.1
25-34	66	25.5
35-44	75	29.0
45+	71	27.4
Age (mean ± SD)	36.85±11.41	
Residence:		
Urban	133	51.4%
Rural	126	48.6%
Marital status:		
Single	53	20.5
Married	205	79.2
Divorced	1	0.4
Education:		
School level	223	86.1
University level	36	13.9
Smoking status:		
Current smoker	156	60.2
Current non-smoker	103	39.8
Complaints of chronic cough:		
Yes	73	28.2
Complains of chest pain:		
Yes	46	17.8
Complaints of wheezes:		
Yes	10	3.8
Lung functions:		
Normal spirometery	203	78.4
Abnormal spirometry	56	21.6
Detailed lung functions:		
Normal spirometery	203	78.4
Restrictive	52	20.1
Obstructive	4	1.5

Table (2): Description of occupational history and working conditions.

Type of work and working conditions	Number	Percent (%)
Type of work:		
Manual worker inside the workshop	153	59.1
Management (clerk)/other	106	40.9
Duration of work:		
≤ 1 0yrs	118	45.6
11 -20yrs	91	35.1
>21yrs	50	19.3
Duration of work in years (Mean ± SD)	13±9.1	
Work more than 8 hours daily:		
Yes	87	33.6
No	172	66.4
Using PPE:		
Most of the time	93	35.9
Sometimes	166	64.1

Table (3): Association of abnormal PFT with the personal and work characteristics of the participants.

Personal and work characteristics	Normal PFT		Abnormal PFT		p-value
	N	%	N	%	
Age group:					
<25 years	37	78.7	10	21.3	0.806
25-34 years	52	78.8	14	21.2	
35-44 years	61	81.3	14	18.7	
45+ years	53	74.6	18	25.4	
Residence:					
Urban	100	75.2	33	24.8	0.20
Village	103	81.7	23	18.3	
Education:					
School level	174	78.0	49	22.0	0.732
University and higher	29	80.6	7	19.4	
Smoking:					
Smoker	114	73.1	42	26.9	0.011**
Non smoker	89	86.4	14	13.6	
Type of work:					
Worker inside	86	81.1	20	18.9	0.370
Management/others	117	76.5	36	23.5	
Duration of work:					
≤ 1 0yrs	99	83.9	19	16.1	0.016**
11-20yrs	72	79.1	19	20.9	
>21yrs	32	64.0	18	36.0	
Working hours:					
>8 hours	66	75.9	21	24.1	0.484
8 hours	137	79.7	35	20.3	
PPE:					
Always/most of the time	80	86.0	13	14.0	0.025**
Sometimes	123	74.1	43	25.9	

*: Chi-square test. **: Significant.

Table (4): Multivariate logistic regression to study independent factors associated with abnormal PFT.

	Adjusted OR	95% C.I. for adjusted OR		p	Sig
		Lower	Upper		
Smokers	4.516	1.861	10.202	0.028	S
Duration of work	2.181	1.235	4.595	0.036	S
Using PPE (none)	2.178	1.041	4.554	0.039	S

*: Logistic regression.

Discussion

According to the available studies and literature, the stone and marble sector is considered to be one of the most significant and most active industries in Palestine. This sector contributes approximately 5% to Palestine's overall industrial income **[15]**. Various procedures and operations are involved in this work including stone cutting, loading and crushing. Based on these operations, the workers are employed at different places as per the nature of work and are exposed to dust of different concentrations.

The stone-quarry manual workers are exposed to dust from the rocks they cut; especially during

saw-cutting and finishing, theses dust contain silica dust [16] which may lead to pulmonary problems (silicosis). Silicosis appears after prolonged exposure to silica dust. Besides, it depends upon a number of other factors such as size of the particle; concentration of silica particles in the air, duration of exposure, particle surface characteristics including the age of the particle and the concentration of trace metals such as iron [17].

The present study was, therefore, designed to evaluate the respiratory effects (lung function) of occupational exposure to dust in stone cutter workers. The objectives of this study were to study the deterioration of pulmonary function in stone cutter workers and its relation with different personal and work factors.

In the current study more than 70% of the participants were working on a full-time basis (8 hours daily), with 30% of cases working more than 8 hours a day indicating that the workers are at a high risk of exposure to the respirable quarry dust. Moreover, only 13.9% of the respondents had higher level education, suggesting a low level of awareness of the respondents about the health impact of the respirable quarry dust.

The current study showed a relatively low prevalence of respiratory complains of cough (28.2%), chest pain (17.8%) and wheezes (3.8%) when compared with result of previous study conducted in Iran which reported irritating cough in 75% of the respondents [18], also in Nigerian study among quarry workers reported high prevalence of respiratory problems; the most common problems were occasional chest pain (47.6%), occasional cough (40.7%) [19]. On the contrary, our results are similar to another study conducted in Rio De Janeiro, Brazil [20] that reported cough in 31.9% of workers.

The current study showed that 21.6% of participants had abnormal (impaired) lung function test by spirometer with the vast majority of cases (20.1%) had restrictive lung disease (Table 1) which mostly indicated presence of silicosis. This figure is higher than that estimated by Mathur (1996), who reported that about 10% of sand stone quarry workers suffered from silicosis [21].

Among all 259 participants-workers, 153 (59%) of the participants were working inside the site of stone cutting; more exposed to dust and 106 (41%) were mostly workers outside the cutting site but they are close to working area; indicating that inside workers are at a higher risk of exposure to the respirable stone cutting dust. In spite of this, we found no significant difference between workers inside and outside as regard prevalence of pulmonary problem (Table 3). These results are in disagreement with data reported by Subhashini and Satchidhanandam, (2002), who found that all functional values were lower in workers than in controls [22]. This was insignificant effect could be explained by the fact that inside and outside workers shared the same environment with almost equal level of exposures.

Smoking has been demonstrated in this study to be a significant contributing factor in reduction of ventilatory function, as 24.5% of smokers had abnormal PFT, while only 17.3% of non smokers had abnormal PF (Table 3). This agree with a study conducted in Nigeria that reported a significant reduction in lung functions among smokers [23] results of previous studies have also concurred that decline in lung function values is significantly higher among individuals with both silica and tobacco exposure than in those with either one [24,25], however in contrast to this result, Ghotkar, et al., (1995) found no significant difference between mean values of pulmonary function indices of non-smoker and smoker male workers [11].

The current study showed an increase in percentage of workers with abnormal PFT among workers with longer duration of exposure, as 18.6%, 20.9% and 30% of workers with exposure duration ≤ 1 0yrs, 11 -20yrs and >21 years had abnormal PFT respectively (Table 3). Similarly, Singh et al., (2006) noticed that defects in lung ventilation were significantly related to the duration of exposure more than 20 years [26]. This observation was also in agreement with data reported by Urom et al., (2004), who found that the lung function indices correlated negatively with duration of employment [27]. Moreover, Singh et al., (2007) found that exposure duration and exposure concentrations are the main factors responsible for the reduction in forced vital capacity of lungs, and damage the respiratory tract of quarry workers [28]. Furthermore, CH Kiran et al., (2014) reported that the % reduction of pulmonary function values was positively correlated with duration of their work [29].

It was found that those who wear PPE more regularly had lesser percentage of pulmonary restriction compared to those who rarely use, which emphasizes the importance of PPE in decreasing respiratory problem among quarry workers. This agree with Nigerian study that reported lack of PPE usage in the quarry industrial site as one of the causes for the high prevalence of some of the respiratory problems reported in this study [19].

In this study, there was no statistical significant difference between workers with abnormal PFT and those with normal PFT as regard age, residence, and level of education. (Table 3). This was similar to Nwibo et al., (2012) study among quarry worker who reported no association between age and pulmonary function **[19]**.

To study independent factors affecting development of impaired PFT among stone saw workers, a backward logistic regression model was performed to adjust for confounding factors (Table 4). It revealed that the smoking, longer duration of work, and non usage of PPE are independent factors affecting PFT, as smokers, workers working more than 20 years illness, and non users of PPE have higher risk for developing abnormal PFT (OR 4.5; CI: 1.0 1-20.2; p=0.049), (OR 2. 1; CI: 1.03-4.5; p=0. 04) and (OR 2. 1; CI; 1. 04-4.5; p=0. 03) respectively.

Conclusion and recommendation:

Data from the present study suggest that chronic exposure to hazards from cutting of rocks may increase susceptibility to respiratory problems and impaired lung function with cigarette smoking, not usage of PPE and increased length of service as additional predisposing risk factors.

Suggested mitigating measures include provision of safety measures (e.g., face mask), discouraging workers from tobacco/cigarette smoking through public health education, frequent assessment of lung functions and redeployment of workers with severely reduced lung functions to other less hazardous occupations, and above all, provision of legislative instrument by the government making establishment of stone saw workshop without adequate provision of necessary safety measures a punishable offence.

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الملخص العربى

مقدمة: تعتبرالمشاكل التنفسية من المخاطر الصحية عند العمال الذين يتعرضون للغبار، حيث يتاثر العمال بالعديد من المخاطر الصحية وبالاصابة من امراض مهنية متعددة فى جميع انحاء العالم.

الأهداف: الغرض من هذه الدراسة هو تحديد مدى انتشار المشاكل التنفسية وكفاءة الرئة ذات الصلة بالعمل بين العاملين فى ورش مناشير الحجر الفلسطينية، وربطها ظروف العمل وعوامل الخطر بهذه النتائج.

المنهجية: خلال الفترة من بداية ابريل الى نهاية يونيو ٢٠١٢، أجريت دراسة مقطعية تحليلية شملت ٢٥٩ من العمال الذكور، الذين كانوا متوفرين فى كل ورش منشار الحجر (العدد = ٤٢)، والتى تقع حول الوادى بين نابلس وطولكرم فى شمال الضفة الغربية – فلسطين، حيث تم تقييمهم من خلال مقابلات بإستخدام استبيان معد خصيصا، مع التاريخ المرضى والمهنى المفصل وكذلك الفحص السريرى الذى احتوى على قياس كفائة الرئه.

النتائج: كان جميع العمال من الذكور، وكان متوسط الفئة العمرية ٣٦.٨٥ سنة، ومتوسط مدة الخدمة ١٣.٣٦ سنة. وقد شكى ٢٨.٢٪ من سعال مزمن و١٧.٨٪ الام فى الصدر و٣.٨٪ من صفير فى الصدر. وكان معدل انتشار ضعف كفائة الرئة ٢١.٦٪ و٢٠.١٪ من العمال يعانون من مرض محدد للرئة. وقد تم التعرف على العلاقة ذات الدلالة (p>٠.٠٥) من التحليل متعدد المتغيرات بين ضعف كفاءة الرئة والمتغيرات من نوع العمل، التدخين، مدة العمل، عدم استخدام معدات الحماية الشخصية، والتدخين والإقامة.

الخلاصة: التعرض المزمن للغبار فى صناعة مناشير الحجر يمكن ان يزيد خطر الاصابة من المشاكل التنفسية وضعف كفاءة الرئة. العمال الذين يدخنون السجاير، ويقضون فترة اطول فى العمل ولا يستعملون وسائل الحماية الشخصية يعتبرون فى خطر اكثر من غيرهم.