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Original Research Paper

Assessment on Acute Effect of Stone Dust on Pulmonary Function Indices among Stone Workers in Ethiopia

Biological Science

KEYWORDS: -
Acute effect, Lung function indices, Stone workers

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ABSTRACT

Manual stone workers are exposed to dust inhalation during cobblestone work activities. Dust exposure induces acute respiratory problems due to proliferation and fibrotic alteration. The study was planed to assess acute effect of dust on lung function indices. Comparative cross-sectional study was applied among manual stone workers. Acute exposure standard was established on eight hours exposure time frame during work of normal intensity and lung function indices were measured using pocket sized digital Spiro meter before and after exposure at early morning and after exposure for about 8-10 hours. The study showed change in Spiro metric lung function indices. Acute exposure changes the pulmonary functions indices very significantly ($p<0.010$). The mean values and percent predicted mean values of lung functions (FVC, FEV1, FEV1/FVC, PEFR, PIFR and FEF25-75) were reduced ($p< 0.05$). Reduction in spirometric values was more marked in chiseling (shaping stone) workers. Thus, dust emission during cobblestone preparation and acute exposure to dust for some hours leads significant changes in pulmonary functions. Further researches need to be done on stone workers how exactly this dusts affect the lungs.

INTRODUCTION

Manual stone work projects in Ethiopia create job opportunity constructing side and mini roads. However, workers are exposed to dust inhalation during excavating, cutting, drilling, handling, loading, transporting, chiseling and paving activities. Studies show activities involving stone materials expose to stone dusts that induce acute respiratory problems because dust particle in the ground is quite different from dust that we mostly breathe [1]. Dust in the ground and from stone could have metals and substances risky for human health [2,3]. The dust particles affect transport and removal of air and deposited within the respiratory system associated with acute and chronic change in lung volumes and lung capacities [4-6]. It might induce proliferation and fibrotic alteration that change in spirometric lung function indices (FVC, FEV1, FEV1/FVC, PEFR, PIFR and FEF25-75) [7,8].

Forced spirogram (volume over time) and flow-volume loop (flow against volume) are used to evaluate lung function indices [9]. Forced expiration after a complete inhalation determines forced vital capacity (FVC) and the forced expired volume during the first second (FEV1). Airways and lung functioning can be measured by Ratio of FEV1/FVC, mean forced expiratory flow during middle half of FVC (FEF25-75%), peak expiration flow rate (PEFR) and peak inhalation flow rate PIFRs [9]. Other indices (IRV, ERV, VT, FRC, VC, TLC, RV, FET etc) can be derived. Environmental and occupational conditions may change in these lung function indices resulting normal, obstructive, hyperinflation or restrictive lung function patterns[8,10].Therefore, the study was designed to determine acute changes on spirometric lung function indices of cobblestone workers in Addis Ababa, capital city of Ethiopia.

MATERIALS AND METHODS

The study was conducted among cobblestone workers in Addis Ababa, Ethiopia. Comparative cross-sectional study was applied. Participants were within 18-35 years age range had working for one and above years. The study protocol was approved by ethical committee and consent was obtained from study participants. Inclusive criteria were used. The quarry workers were all males while the chiseling workers were both male and female workers. Acute exposure standard was established on eight to ten hours exposure time frame. Spirometric lung function indices were taken early morning and after work exposure from eight to ten working hours. Pocket sized digital spirometer, digital balance and measuring tape were used.

RESULTS

Anthropometric measurements were closer among study participants.

Table1: Anthropometric measurements in both exposed and controls groups

Group	Age range (years)	Age years (MeanSD)	BMI(kg/m^2)
Workers	N=151	26.524.12	20.993.13
	18-26(n=88)	23.551.99	21.133.31
	27-35(n=67)	30.52 2.55	20.802.89
Quarry	(n=73)	27.593.98	22.122.56
	18-26(n=41)	24.211.83	22.192.65
	27-35(n=32)	30.792.20	22.042.48
Chiseling	(n=82)	25.564.02	19.983.26
	18-26(n=47)	23.202.01	20.203.57
	27-35(n=35)	29.932.89	19.672.81

Difference in duration in cobblestone work activities indicated difference in pulmonary function indices. Workers exposed for more than three years had lower value compared to those exposed for below three years duration.

Lungs Function Indices	Workers exposed for [1-3) years (n= 63)	Workers exposed for (3) years (n=92)	t-value	p-value
VC(L)	3.350.86	3.170.96	1.248	0.214
FVC(L)	3.560.91	3.651.08	0.559	0.577
FEV1(L)	3.520.80	3.530.89	0.060	0.952
FEV1%	87.0318.62	89.3621.01	-0.709	0.479
PEFR(L)	8.562.62	8.682.38	0.296	0.768
FEF25-75(L)	6.042.17	6.24631.45	0.690	0.491
PIFR(L/s)	6.251.62	6.67992.01	1.708	0.090

Table 3: Paired t-test showing the difference of pre and post measured lung function indices in chiseling workers

Lungs Function Indices	Chiseling workers		Mean difference	t-value	p-value
	At early morning of working day (before work)	After 8-10 hours work			
VC(L)	3.0400.873	2.8990.753	0.141	19.616	0.000*
FVC(L)	3.3270.866	3.1350.753	0.192	22.326	0.000*
FEV1(L)	3.2800.796	3.1260.751	0.154	19.870	0.000*
FEV1%	86.75019.450	80.58018.635	6.170	32.858	0.000*
FEV1/FVC%	98.9283.289	98.2213.743	0.706	39.344	0.000*
FEF25-75 (L/s)	5.7191.645	5.5971.516	0.122	7.057	0.000*
PEFR(L/s)	7.7022.112	7.3241.773	0.378	19.241	0.000*
PIFR(L/s)	6.1012.461	6.0562.333	0.045	1.954	0.051

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Table 4: Paired t-test showing the difference of pre and post measured lung function indices in quarry workers

Lungs Function Indices	Quarry workers		Mean difference	t-value	p-value
	At early morning of working day	After 8-10 hours work			
VC(L)	3.609 0.859	3.4400.778	0.169	3.541	0.001*
FVC(L)	3.9081.009	3.7240.969	0.184	4.609	0.000*
FEV1(L)	3.8100.753	3.5850.687	0.225	7.885	0.000*
FEV1%	90.31520.529	88.16418.908	2.1516.90	2.663	0.010*
FEV1/FVC%	98.4937.054	98.8779.416	-0.383	-0.494	0.623
FEF25-	6.6581.946	6.3771.787	0.280	3.358	0.001*
PEFR(L/s)	9.6752.417	9.2072.473	0.467	3.026	0.003*
PIFR(L/s)	6.7592.431	6.6422.383	0.117	5.070	0.000*

DISCUSSION

Types of work, gender, age, BMI, race and geographical location contribute to lung function indices variability [11]. Cobblestone workers are exposed to various dusts associated with respiratory symptoms and impairment [12,13]. Stone cutting and crushing workers to stone dust could have different kinds of respiratory diseases [14, 15]. Inhaling dust over periods of time leads to proliferation of alveolar epithelium and fibrotic changes [12-14,16]. The severity depends on chemical nature, physical state of the inhaled substance, size, concentration of dust particles, duration of exposure and individual susceptibility [16]. Proximity to sensitive receptors, prevailing wind direction, speed and nature of works topography influence level of impact [17].

Lung function values (VC,FVC, FEV1, %FEV1/FVC and PEFR) of male workers in both sub groups (quarry and chiseling) were compared one to the other. The meanSD values of VC, FVC, FEV1 and FEF25-75% were significantly (p<0.02) lower in chiseling workers. The PEFR reduction was very significant (p=0.000). The FEV1% and PIFR were lower. Unlike other values, FEV1/FVC% was higher in quarry workers than in chiseling workers (p=0.883).

Chiseling workers were very proximate to dust. They have done the chiseling (shaping stone) without machinery support and nature of the work activities increase potential of exposure..

The pulmonary function tests were carried out before starting the work and after 8 hours of exposure to dust. Pulmonary functions before and after chiseling or quarrying was compared. They showed a significant reduction in mean values of VC, FVC, FEV1, FEV1%, PEFR and FEF25-75% after chiseling or quarrying for about eight hours.

The lung function indices (VC, FVC, FEV1, FEV1%, FEV1/FVC, PEFR and FEF25-75%) showed very significant decrement (p=0.000) in chiseling workers. PIFR was lower after chiseling but it was not significant (p=0.051). When we see the quarry workers, mean values such as FVC, FEV1 and PIFR showed very significant reduction (p=0.000) while FEF25-75% and VC (P=0.001). FEV1% (p=0.010) and PEFR (p=0.003) also showed significant reduction compared to the pre or morning measurement results. Pulmonary functions before and after quarrying were compared. After working 8 to 10 hours, the mean value of FEV1/FVC% was increased compared to the value recorded early morning. A study on effect of acute exposure to different occupational dusts in Ethiopia found that significant difference between the post shift and pre shift values of lung functions in factory workers [18]. A number of subjects showed reduction in many of the lung function indices in response to acute exposure to cotton-yarn, tobacco and cement dusts. Similar study on acute respiratory effect of dust exposure in sweepers conducted in India found a relationship between the exposure and acute response of lung to the dust and they also observed a significant decrease in the after mean values and predicted mean values [19].

CONCLUSION

From the present study it could be concluded that dust emission during cobblestone work has acute affect on pulmonary function. The mean values and percent predicted mean values of lung functions (FVC, FEV1, FEV1/FVC, PEFR and FEF25-75%) were reduced (p< 0.05). Reduction in pulmonary functions indices in chiseling workers was more significant compared to quarry workers.

RECOMMENDATION

Medical surveillance of early detection contributes to reduce the burden of lung function impairments. Further studies should be conducted for to address the mechanism and to make standing decisions and regulations. Concentration, composition and nature should be studied. Workers should be trained and appropriate personal protective devices should be provided. Dust emissions should be reduced to minimize its impacts.

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REFERENCES

[1] TsunJen Cheng, Jing-Shiang Hwang. Effects of Concentrated Ambient Particles on Heart Rate and Blood Pressure in Pulmonary Hypertensive Rats. Environmental Health Perspectives. 2003
[2] MattLoxham. Microscopic dust particles found in underground railways may pose health risk. Phys.org. University of Southampton.2013.
[3] Nwibo, Ugwuja, Nwambeke. Pulmonary Problems among Quarry Workers of Stone Crushing Industrial Site. IJOEM.2012; 3:178-185.
[4] A guideline for managing the impacts of dust and associated contaminants from land development sites, contaminated sites remediation and other related activities. Department of Environment and Conservation. March, 2011.
[5] Praxsnih V. The Effects of Particulate Matter Air Pollution on Respiratory Healthand on the Cardiovascular System. Jure Praznikar Prispelo 2011; 27:5
[6] World health organization (WHO). Hazard Prevention and Control in the Work Environment: Airborne Dust, Dust Definitions and Concepts. WHO/SDE/OEH/1999/99.14
[7] BarreiroT. Timothy J. and Perillow J.An approach to interpreting spirometry. American academy of physicians. 2004 vol. 69: 5
[8] Fauci's and Longo's. Harrison's Principles of InternalMedicine. 17th Edition The McGraw- Hill Companies,2008.
[9] Miller M. Retal. Standardization of spirometry, Eur. Respir.J. 2005; 26:319–338
[10] Feyrouz A. Interpreting pulmonary function tests: Recognize the pattern, and the diagnosis will follow. Cleveland Clinic Journal of Medicine. 2003; 70:10
[11] Yoseph A Mengesha, Yalemtsehay Mekonnen. Spirometric Lung Function Tests in Normal Non-Smoking Ethiopian Men and Women. Thorax 1985; 40:465-468
[12] Dino Pisaniello, Michael Tkaczuk and Sharyn Gaskin. Evaluation of Dust Inhalation Risk Factors A research study to reduce lung disease risks in SA quarries. Occupational and Environmental Hygiene, Discipline of Public Health, School of Population Health, University of Adelaide. April 2013.
[13] Mbbs Moeh Fracp. Respiratory problems, Occupational and environmental exposures Websites: http://www.racgp.org.au Published 2012. Accessed on May 10, 2013.
[14] Shaikh K.. Sweeper's lung disease: a cross-sectional study of an overlooked illness among sweepers of Pakistan. International Journal of COPD.2013; 8:193–197
[15] Smilee J. Dust Exposure and Lung Function Impairment in Construction Workers. Journal of Physiol Biomed Sci. 2011;24:1: 9-13.
[16] Petr Brhel. Occupational Respiratory Diseases in the Czech Republic. Industrial Health.2003; 41:121–123
[17] Canadian Centre for Occupational Health & Safety. What are the Effects of Dust on the Lungs? Website: Last updated on October 1, 2012.Accessed on 30/5/13 10:30 PM.
[18] Mengesha Y. A. and Bekele A. Effect of acute exposure to different occupational dusts on pulmonary function indices of factory workers in Ethiopia. Afr newslett on occup health and safety 1997; 714-16
[19] United States Department of Veterans Affairs. Sand, Dust and Particulates. Reviewed/Updated Date: June 3, 2013