



Association of Respiratory Symptoms and the Pulmonary Function Parameters in the Residents of Mine Tailing Community

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ABSTRACT:

Introduction: Mine tailings is type of rock waste from mining industry which reach in immense proportions appearing in the form of large hills on the land scape. Mines without a proper closure has impact on the environment leading to vulnerability for chronic respiratory illness.

Objectives: To estimate the prevalence of respiratory symptoms in the mine tailing community using (ATS – DLD-78A questionnaire and correlate the respiratory symptoms with lung function parameters in mine tailing community.

Methods: A cross sectional study of 400 subjects based on the prevalence of chronic bronchitis was conducted in the mine tailing community. Ethical clearance was obtained prior to the study. (ATS – DLD-78A) Questionnaire was used to record the presence of the respiratory symptoms. Using Spirotech for spirometry all the lung volumes and capacities (FVC, FEV1, and FEV1/FVC) was obtained

Results: The prevalence rates of respiratory symptoms in mine tailing community was found to be 38.3% for cough ,32.8% for shortness of breath, 31% for phlegm & smoking was 12.5%. A significant association was found with duration of stay in & around mine tailing area for obstructive/restrictive lung disease.

Conclusions: The significant decrease in lung function parameters and increase in the prevalence of respiratory symptoms among mine tailing community might be attributed to duration of stay in & around the mine tailing area though clinical disease is not present. Thus the respiratory symptom questionnaire will be an effective tool for screening respiratory illness & an useful add-on to spirometry in mine tailing community where the resources are poor.

1. Introduction

Mine tailings is type of rock waste from mining industry which reach in immense proportions appearing in the form of large hills on the land scape. During the beneficiation process, high-volume waste called 'tailings,'(the residue of an ore that remains after it is milled) will be generated. If a mining project involves the extraction of a few hundred million metric tons of mineral ore, then the mine project will generate a similar quantity of tailings. There are about 32 million tonnes of this tailings, which makes up the 15 dumps spread out along 8-km long distance in the mine area in KGF.[1]

Major constituents of these tailings in KGF are silica, aluminium oxide, ferrous oxide, magnesium oxide and calcium oxide which can be toxic to humans. Some of the worst environmental consequences of mining have been associated with the open dumping of tailings which may contain hazardous chemicals. Mines without a proper closure plan can have an immense impact on the environment.[2] These impacts can persist for decades and even centuries. They are the major generators of windblown dust which are transported and deposited on the communities nearby and are the sources of air pollution exposing the residents to the air and



environmental pollutants, and thus increasing their vulnerability to chronic respiratory illness.

KGF is the ex-gold mining area, where the families of miners lived in close proximity to the gold mines and mine tailings while they were functional and continue to live there after its closure which is almost 17 years. Validated American Thoracic Society Division of Lung Disease questionnaire (ATS – DLD-78A) is a commonly used for identifying the respiratory symptoms, for cough, phlegm, wheeze and shortness of breath.[3]

Spirometry is one of the instruments which is suggested for the diagnosing of the impairment of pulmonary function tests & also for screening.[4]

In Most of the studies, investigators have observed increase in incidence of respiratory diseases in mining area & decrease lung function, but, data on prevalence of respiratory illness & lung function are sparse, in mine tailing community where the mining has been closed long back.

Thus, the present study aims to estimate the prevalence of respiratory illness in the mine-tailing community and to correlate the respiratory symptoms and the lung function parameters in mine tailing community where the mining has been closed for long duration.

2. Objectives

1. To estimate the prevalence of respiratory symptoms in the mine tailing community using American Thoracic Society Division of Lung Disease questionnaire (ATS – DLD-78A).

2. To correlate the respiratory symptoms with lung function parameters in mine tailing community.

1. Methods

Sample Size Estimation:

Prevalence of the population 50% Confidence interval at 95%, Absolute precision at 5% points $d=0.05$ $n= 384$ using the formula $n= Z\alpha^2 \times PQ/d^2$ Considering the prevalence for the chronic bronchitis of 50% in the adults with an allowable error of 5% and confidence interval of 95% the sample size was be 384 with the response rate of 10% required a sample of 400 was studied. Enrolment of the participants took place from June 2018 to August 2018. Ethical clearance was obtained & written informed consent was taken prior to the study from the participants to perform the questionnaire study.

This is a cross-sectional study which was conducted in the mine tailing community where it is nonfunctional for 17 years. The data was collected from June to August

2018 in 400 participants. All the participants who gave the consent were requested to take part in the study if they had stayed there in the mine tailing region for at least 3 years, and aged 18 years to 60 years participated in the study from the exposed area KGF. Recruitment was done during the camp from Monday to Friday from 10am to 2pm.

The American Thoracic Society Division of Lung Disease questionnaire (ATS – DLD-78A) was used to record the presence of the respiratory symptoms which consisted questions regarding Cough (Do you usually have a cough?), Phlegm (Do you usually bring up phlegm from your chest?), Breathlessness (Do you have shortness of breath?), Smoking (defined as Do you smoke), Socio-economic status (education, occupation,) The questionnaire was translated into local language and back translated into English [5]

Pulmonary function measurement

Prerequisites for spirometry: History regarding fitness within the preceding hour was enquired and that individual was requested to avoid exercise for 24 hours. Before starting the lung function tests, the subjects were asked to loosen their tight clothing. The study was conducted at the same time for all the days to rule out diurnal variations. Spirometry was performed using the instrument. SPIROTECH and was carried out after demonstrating the procedure to the participants. The subjects were asked to take deep inspiration from the external air followed by forceful expiration into the mouthpiece of the SPIROTECH in a standing posture. It was ensured that the mouthpiece was inserted without any leakage of air or obstruction by the lips or teeth and forced expiration continued to completion without a pause. The subjects inspired rapidly again to maximum capacity. The subjects were asked to repeat the procedure three times and the best one was taken. All the lung volumes and capacities obtained (FVC, FEV1, and FEV1/FVC ratio, were expressed with correction for Body Temperature at the Ambient Pressure, Saturated with Water vapour (BTPS). The study group comprised of 384 residents (exposed population) who volunteered for the study. In the age group of 18 -60years. The subjects who were suffering from neuromuscular disorders, kyphoscoliosis was excluded from the study. [6]. The predicted values of forced vital capacity (FVC), forced expiratory volume in one second (FEV1) and their ratio (FEV1/FVC) were recorded in ml and percentages. Percent predicted values were based on the standardized equations of the European Respiratory Society 1993, with a correction factor of 0.9 for Asian population. [7] For normal lung function tests, predicted percentage of > 80% for FVC and FEV1 and FEV1/FVC ratio of >0.7



were considered cut-off values [8] Obstructive lung function was defined as having FEV1<80% of predicted and FEV1/ FVC <0.7% and restrictive lung function was defined as having FVC<80% of predicted and FEV1/FVC >0.7%. [4]

Statistical analysis:

Data was analysed using SPSS 20. Descriptive statistics were calculated for socio-demographic variables, respiratory symptoms and lung volumes. Percentage predicted lung volumes were entered as continuous variables and independent samples t-test was applied to determine significant differences in lung function decrements according to presence and absence of respiratory symptoms. Logistic regression analysis was performed to determine odds ratio of respiratory symptoms with percentage predicted lung volumes entered as dichotomous variables (FVC > 80% vs < 80%; FEV1 > 80% vs < 80% & FEV1/FVC ratio > 0.7 vs <

Table-1: Socio Demographic, BMI & % predicted spirometric lung volumes in the study population in mine tailing area

Variable	Demographic profile	N =400(%)
Education	Illiterate	53(13.25%)
	Primary	96(24%)
	Secondary	168(42%)
	University	83(20.75%)
Occupation	Retired	01(0.25%)
	House wife	12(03%)
	Agriculture	173(43.25%)
	Unskilled	50(12.5%)
	Skilled	32(08%)
	Business	88(22%)
	Government service	30(07.5%)
	Others	14(03.5%)
Age-years(Mean±SD)		42.23±10.47
BMI-Kg/M²(Mean±SD)		25.38±5.46
Duration of living in the mine tailing area years(Mean±SD)		39.87±12.22

%predicted spirometric lung volumes in ml		
FVC (L/min) (Mean±SD)		66.54±20.33
FEV1(L/min) (Mean±SD)		69.77±23.44
FEV1/FVC%(Mean±SD)		116.21±14.85

4.Results

Frequencies of socio demographic, BMI and % predicted Spiro metric lung volumes in the study population of mine tailing community is given in Table 1. Majority of the participants had completed secondary education (42%). Predominant type of occupation was agriculture (43.25%). Mean of % predicted Spiro metric lung volumes in the study population 400 participants were recorded as: FVC (66.54+20.33), FEV1 (69.77+23.44) (FEV1/FVC (116.21+14.85).

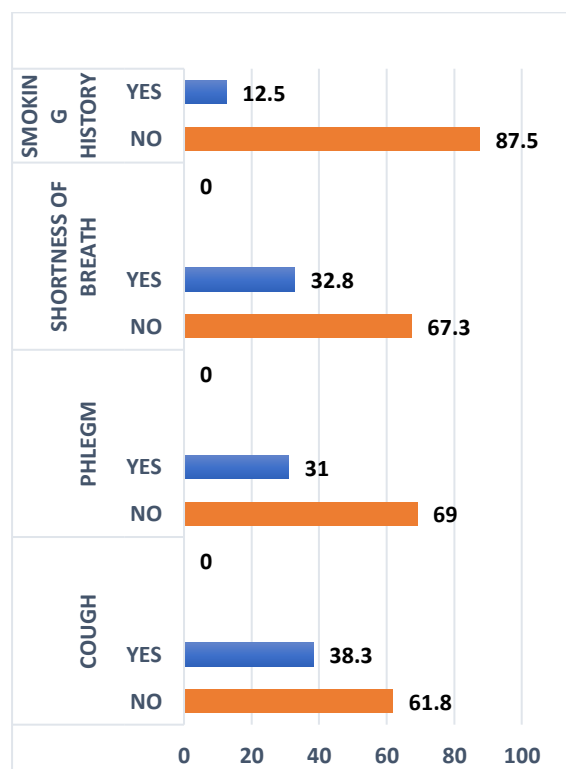


Fig-1: Frequency distribution of respiratory symptoms in mining community



Predominant type of respiratory complaint was cough (38%) followed by shortness of breath (32.8%), phlegm (31%) and smoking (12.5%).

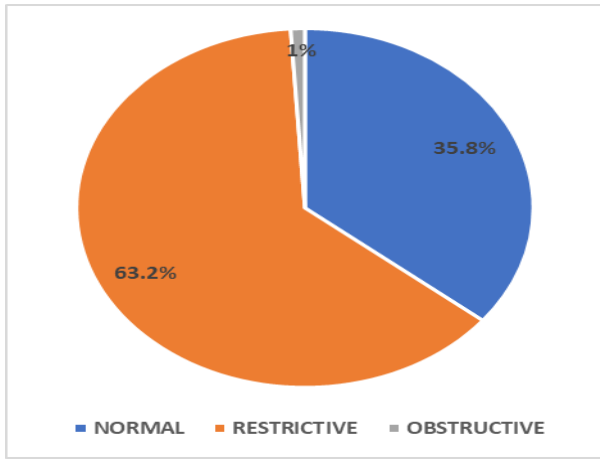


Fig-2 Frequency Distribution Of Lung Function Pattern In Mining Community(n=400)

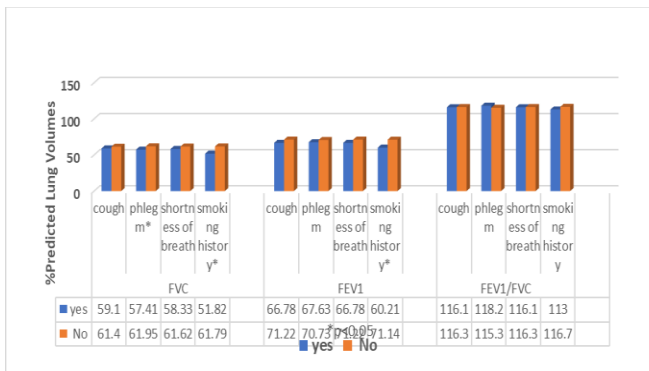


Fig-3 Difference in lung function of study population according to presence & absence of respiratory symptoms

Obstructive -Defined as having FEV1 <80% and FEV1/FVC <70%.
 Restrictive -Defined as having FEV1 <80% and FEV1/FVC >70%.
 Frequency of restrictive pattern on spirometry was 63.2% and that of obstructive pattern was 1%.

Fig 3. Shows a trend of reduced lung function (%predicted FVC, FEV1, FEV1/FVC) among the mine tailing community with presence of respiratory symptoms compared to those without symptoms.

Table-2:Bi-variate logistic regression analysis of respiratory symptoms with spirometric lung function patterns, in mine tailing community

Variable	Odds ratio (confidence Interval)	P value
Constant-0.511, Wald $\chi^2=24.46, p<0.001, Naegelkerke R^2=0.027$		
%Predicted FEV1 volume		
Duration of stay	1.002(0.985-4.018)	0.048
Cough	1.253(0.804-1.951)	0.319
Phlegm	0.961(0.856-2.162)	0.868
Smoking history	1.932(0.965-4.868)	0.043*
Shortness of breath	1.360(0.856-2.162)	0.193
Constant: -1.533, Wald $\chi^2=137.30, p<0.001, Naegelkerke R^2=0.088$		
%Predicted FVC volume		
Duration of stay	1.014(0.993-4.037)	0.03*
Cough	1.246(0.696-2.229)	0.46
Phlegm	2.064(1.052-4.051)	0.035*
Smoking history	10.66(1.436-79.134)	0.021*



Shortness of breath	0.982(0.54 4-1.774)	0.952
%PredictedFEV1 /FVC volume		
Constant:3.566,Wald $\chi^2=136.01,p<0.001$,Naegelker ke $R^2=0.097$		
Duration of stay	0.977(0.92 8-5.029)	0.038 *
Cough	0.177(0.22- 1.441)	0.106
Phlegm	0.607(0.12 2-3.021)	0.542
Smoking history	0.444(0.13 3-1.234)	0.997
Shortness of breath	1.626(0.44 5-5.937)	0.462
Presence of obstructive 20 and/or restrictive lung disease (Total sample N= 257		
Constant:4.143,Wald $\chi^2=67.58,p<0.001$,Naegelker ke $R^2=0.247$		
Duration of stay	0.877(0.76 8-2.003)	0.040 *
Cough	0.135(0.00 5-3.314)	0.22
Phlegm	1.216(0.13 3-11.108)	0.863
Smoking history	5.265(0.26 3-105.383)	0.277
Shortness of breath	6.605(0.55 0-79.307)	0.137

FEV1 & FVC - Entered as dichotomous variable >80% and <80%.

FEV1/FVC-Entered as dichotomous variable >70% and <70%.

Obstructive lung disease: defined as having FEV1 <80% and FEV1/FVC <70%; restrictive lung disease: defined as having FEV1 <80% and FEV1/FVC >70%.

In bivariate logistic regression model, after adjusting for covariates was performed to test effects of respiratory symptoms on %predicted FEV1, FVC, FEV1/FVC lung function & risk of obstructive & restrictive lung disease mine tailing community.

Results of %predicted FEV1 indicated that the three-predictor model provided a statistically significant improvement over the constant-only-model, $\chi^2(N= 400) = 24.46$, $p < 0.001$. The Nagelkerke R^2 indicated that the model accounted for 2.7% of the total variance. The correct prediction rate was about 62.5%. % percentage FEV1 is significantly reduced for duration of stay (OR-1.002,95% CI:0.985-4.018) & smoking (OR-1.932 ,95% CI:0.965-4.868). No significant reduction was found in % predicted FEV1 for other respiratory symptoms.

Results of %predicted FVC indicated that the three-predictor model provided a statistically significant improvement over the constant-only-model, $\chi^2(N= 400) = 137.30$, $p < 0.001$. The Nagelkerke R^2 indicated that the model accounted for 9% of the total variance. The correct prediction rate was about 82.3%. But percentage predicted FVC is significantly reduced for phlegm (OR: 2.064 ,95% CI: 1.052-4.051), duration of stay (OR-1.014,95% CI:0.993-4.037) & smoking (OR:10.66,95% CI:1.436-79.134). No association was found with questions concerning cough & shortness of breath.

Results of % predicted FEV1/FVC indicated that the three-predictor model provided a statistically significant improvement over the constant-only-model, $\chi^2(N= 400) = 136.01$, $p < 0.001$. The Nagelkerke R^2 indicated that the model accounted for 9.7% of the total variance. The correct prediction rate was about 97.3%. But percentage predicted FEV1 /FVC is significantly reduced for duration of stay (OR-0.977,95% CI:0.928-5.029) No significant reduction was found in % predicted FEV1/FVC for another respiratory symptom.

After adjustment, risk of obstructive/restrictive lung disease, Results indicated that the three-predictor model provided a statistically significant improvement over the constant-only-model, $\chi^2(N= 400) = 67.78$, $p < 0.001$. The



Nagelkerke R^2 indicated that the model accounted for 24.7% of the total variance. But obstructive/restrictive lung disease for duration of stay is significantly reduced (OR-0.877,95% CI:0.768-2.003) No significant association was found with obstructive/restrictive lung disease for other respiratory symptoms.

5. Discussion:

This study aimed to assess the respiratory symptoms and lung function parameters among mine tailing community. Around 400 participants living in & around mine tailing area of KGF participated. Our study is the first one which has focused on the prevalence of respiratory symptoms & its association with lung function on population level in mine tailing area.

In the present study prevalence rates of respiratory symptoms in mine tailing community such as cough is 38.3%, shortness of breath 32.8%, phlegm 31% & smoking 12.5%.[9] Though the mining was officially closed for the past 17 years & was no longer considered viable, these findings were in line with those obtained by Bio Etal, in a study on respiratory symptoms in underground gold miners in Ghana. [10] Thus Indicating though mining has been stopped 17 years ago the respiratory symptoms in mine tailing area is equivalent to mining activities areas in Ghana which is a serious concern.

Respiratory symptoms in mining activity area were associated with increase in particulate matter concentration & in lungs these particulates decrease the exchange of oxygen & carbon dioxide, thus leading to shortness of breath. [11] This might be the reason for shortness of breath in mine tailing area.

The prevalence of restrictive lung function was only 63.2% where air trapping in small airways contributes. (Fig-2) The findings of study show that respiratory symptoms like cough, phlegm, shortness of breath, duration of stay in the mine tailing area & smoking are associated with reduced lung function. Some studies have shown increase in particulate matter might cause discomfort in the chest causing cough, phlegm etc. in the mine activity area. Our study though the mining has been stopped long back, it is showing increasing FVC decline with phlegm & smoking & also an increasing FEV1 decline in smokers in mine tailing community in (Fig -3) [12]

Becklake etal, observed an increasing FEV1 decline with increasing exposure in both smokers & nonsmokers.

Sluis cremer et al, observed that occupational breathlessness in some miners is more increased in smokers than nonsmokers. [13]

Fig -3 shows a trend of reduced lung function (%Predicted FVC,FEV1,FEV1/FVC) in the mine tailing community with the presence of symptoms, which showed significance for phlegm & smoking for % predicted FVC.After adjusting for confounding factors ,Odds ratio (95% CI)showed 2.064 & 10.66 times in the mine tailing group.The odds of having decreased FVC among the mine tailing community with phlegm & smoking is 2.064 &10.66 times as high as the odds of having no phlegm & smoking among mine tailing community(Table-2).

A significant association was found with duration of stay in & around mine tailing area for obstructive/restrictive lung disease. The found association is of great interest, as early interstitial or pleural involvement without a clinical disease might be caused by mine dump aerosols or particulate matter concentration. Due to the emission of particulate matter from the mine tailing area health effects may persist for years following exposure.

The use of American thoracic society lung questionnaire to record the presence of respiratory symptoms in mine tailing area has an important public health implication for resource limited settings. It can be utilized as an effective cost saving tool in the diagnosis of respiratory symptoms with-out the need of extra resources & advice necessary prevention to the community living nearby the mine-tailing area.

6.Conclusion:

The significant decrease in lung function parameters and increase in the prevalence of respiratory symptoms among mine tailing community might be attributed to duration of stay in & around the mine tailing area though clinical disease is not present. Thus, the respiratory symptom questionnaire will be an effective tool for screening respiratory illness & an useful add-on to spirometry in mine tailing community where the resources are poor.

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8.Conflicts of interest There are no conflicts of interest.



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