Emerging Risk Factors for Impaired Lung Function in Chemical Industry Workers of Faisalabad

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Abstract

Objective: To determine the impact of obesity and age on the lung functions determined by PEFR of healthy workers of chemical industries.

Materials & Methods: This was a cross-sectional study performed at a private medical college. Three days medical camp was arranged from 2nd to 4th September 2020 after taking approval from the institutional ethical committee. Subjects working in chemical industries were included. All relevant information including age, residence, and, history of inhalation of chemical fumes such as Magnesium Chloride Hexahydrate, sodium hydroxide, Sodium Hypochlorite chlorine, and calcium hydroxide, Fly ash particles, etc. that are common chemicals produced in chemical industries were recorded in a structured proforma. Obesity was determined on basis of BMI grading.

Results: This study was comprised of 151 male subjects. Mean± SD age, height, and weight of the studied population were 38.85±12.1, 170.07±12.0, and 78.12±12.7 respectively. The lowest PEFR value was found in subjects in the age range 61 to 70 years as compared to younger subjects. The mean PEFR values were significantly different concerning various age categories with a p-value= 0.000 Highest mean PEFR values were found in taller subjects having height ≥ 180 cm and the lowest values were found in subjects with height 150-159 cm, the difference in means was statistically significant with p value= 0.05. Morbid obese subjects showed comparatively lower PEFR values than morbid obese with a significant p-value=0.002. PEFR was found to be negatively associated with age (p-value=0.000*) and BMI (p-value=0.001*). Our results also showed a weak positive association of PEFR with height, however, this relation was not found to be statistically significant (p value=0.081).

Conclusion: Peak expiratory flow rate is negatively associated with increasing BMI and age, reflecting that elderly and obese subjects are more prone to have affected lung function due to exposure to chemicals.

Keywords: Age Body mass index, height, Peak expiratory flow rate

Introduction

Environmental pollution caused by rapid industrialization is a serious health threat, especially to workers of industries in this modern era.[1] compromised Health status of workers of chemical factories has been reported by various health surveillance.[1] Occupational exposure to different particles and chemicals including silica, asbestos, ozone (O3), organic dust, sulfur dioxide (SO2), Sodium hydroxide, nitrogen dioxide (NO2), and other synthetic fibers are being inhaled particularly by the factory workers that lead to numerous lung ailments.[1] Moreover, some of this waste's particulate matter remains suspended in the air making people susceptible to airway obstruction.[2] Chronic obstructive lung diseases, lung cancer, and recurrent pulmonary infections are intensified due to exposure to environmental air pollutants emitted from the chemical industries. It is documented that people working in chemical factories or living in the vicinity of chemical industries are more exposed to chemical fumes and hence are more at risk of lung damage.[2]

It is well established that lung diseases are one of the topmost causes of increased morbidity and mortality among elderly people.[2] Reduced respiratory muscle strength and elastic recoil activity causing a decline in lung compliance in elderly subjects make them more susceptible to hazardous impacts of air pollutants compared with young adults.[2]

obesity is also a contributing factor to the decline in lung function most probably the presence of fat in the thoracoabdominal region limits the movement of the musculature of the region especially the diaphragm and thus may resist lung mobility and hence decrease ventilation.[5] Furthermore, pro-inflammatory mediators including cytokines secreted by adipose tissue, have been associated with lung hypo-development and decreased bronchial responsiveness.[4] Advancing age and obesity augmented hazardous effects of chemicals on lung function and deteriorating it further.[2,4]

Spirometric parameters FEV1 and FVC are gold-standard tests assessing lung function, However, deficiency encounters performing these spirometric tests as sometimes patients cannot effectively fully expire to have accurate FVC. Furthermore, according to Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines, these parameters are not reliable for the detection of smaller airway obstruction, especially in asymptomatic early stages of airway obstruction.[5] In contrast to these gold standard tests,

Peak expiratory flow rate (PEFR) is a simple and reliable parameter to evaluate smaller airway obstruction as well as asymptomatic early obstruction.[5] Previous studies have detected airway obstruction by PEFR in asymptomatic school children reflecting that PEFR is a useful tool in deterring early stages of airway obstruction.[3]

Additionally, it can be easily determined by a portable instrument called Wright's peak flow meter.[4] Literature concerning the impact of height, BMI, and Age on variation in PEFR values due to exposure to chemicals is scanty from Faisalabad which is considered the topmost industrial city of Pakistan. The current study aimed to evaluate the impact of age and obesity-related parameters including weight, height, and BMI on the PEFR of the asymptomatic non-smoker healthy workers of chemical industries. The results of this study will help create awareness for the extra care of elderly, tall, and obese workers to prevent adverse outcomes including cardiorespiratory co-morbidities, and will refer the subjects showing signs of early obstruction detected by PEFR, for further pulmonary evaluation.

Materials and Methods

This was cross-sectional study was conducted at a private medical college situated. After taking approval from the institutional ethical committee (Ethical approval# was IEC/23-20), a free medical check-up camp was arranged for three days from 2nd to 4th September 2020 inviting the workers of A total of 200 subjects working in chemical industries have attended the camp voluntarily. Required information including age, residence, history of chemical exposure (Magnesium Chloride Hexahydrate, sodium hydroxide, Sodium Hypochlorite chlorine, calcium hydroxide, Fly ash particles, etc. common chemicals produced in chemical industries), and duration of exposure was recorded on a structured proforma. History of smoking and medical history for cardio-respiratory diseases and allergies were also tailored. The non-smoker healthy male subjects of age ranged 20 to 70 years, working in chemical industries for more than one year were included in the study. The participants having chemical exposure of less than one year, smokers, those diagnosed with COPD and asthmatic subjects, subjects with cardiac diseases, and subjects with any chest deformity were excluded from the study of the total 200 subjects attending camp only 151 participants have fulfilled inclusion criteria and were enrolled in the study. Participants were informed

about the study protocol and informed consent was taken from each of them.

The weight and height were measured by stadiometer at the nearest 0.1Kg and the nearest 0.1.cm respectively. Body Mass Index was then calculated by dividing weight in kilograms by the square of height in meters. As all the incoming participants have BMI greater than 25 kg/m^2 hence we categorize the subjects as obese and morbid obese on basis of BMI cut-off points for data analysis. Subjects having BMI 25-39.9 kg/m^2 were considered obese and BMI ≥40 kg/m^2 were considered morbidly obese.[6]

PEFR was measured using Wright's Peak flow meter. Participants were first demonstrated how to do Pulmonary Expiratory Flow Rate (PFER) in a sitting position. The participants were then asked to blow out after deep inspiration, into the nozzle of the peak expiratory flow meter, sealed tightly by lips. Three readings were taken from each participant and the highest was recorded for data analysis. All readings were taken in Liters/Minutes.

Statistical Analysis: Data was analyzed by SPSS 22.0. Mean and standard deviation was employed for continuous variables. Mean PEFR between the various categories of Age and BMI was compared by ANOVA. Association between PEFR with age, height, weight, and BMI were determined by regression analysis, and results were presented as beta-coefficient and standard errors. A p-value ≤0.05 was taken as significant. (Multivariant regression)

Results

The study was comprised of 151 male subjects. The mean age and SD of the studied population was 38.85±12.1. The mean height of the studied population is 170.07±12.0 and the mean weight is 78.12±12.7. The mean BMI of the participants ranged between 28 to 56 kg/m^2 with a mean and SD of 38.19± 4.72. The mean and SD duration of exposure to chemicals was 9.69 ± 8.2 years. Out of the total population, 94(62.25%) were obese having a BMI of 25-39.9 kg/m^2, and 57(37.7) were morbid obese having BMI ≥40 kg/m^2.

Table 1 is showing that the PEFR values are decreasing with advancing age and the lowest PEFR value was found in subjects in the age range 61 to 70 years and the highest values were found in the youngest age group of study participants with a significant p-value=0.000. On analyzing the impact of height on the PEFR, we noticed an increase in Mean PEFR with an increase in height. The highest mean PEFR values were found in taller subjects with a height ≥ 180 cm and the

lowest values were found in subjects with a height of 150-159 cm, the difference in means was statistically significant with a p-value= 0.00, Table 2.

Table 3 indicates a comparison of PEFR between obese and morbidly obese subjects showing comparatively lower PEFR values in morbid obese with a significant p-value=0.002. Results of regression analysis show a significant negative association of PEFR with age, beta coefficient of -2.951 indicating that increasing in 1 unit of age will result in a reduction in 2 units of PEFR (p-value=0.000). Our results also reveal a significant negative association of BMI with PEFR (p-value=0.001*), however, no significant association of PEFR was found with height (p-value= 0.081) and weight (p-value 0.632), Table 4.

Table 1: Variation in PEFR according to age and anthropometric measurements (n=151)

Age (yrs)	Frequency	Weight (kg) Mean±SD	Predicted PEER (L/min)
21-30	51(33.7)	73.65±11.262	384.80±79.416
31-40	35(23.1)	77.57±11.102	354.09±64.749
41-50	35(23.1)	82.03±15.572	314.37±67.126
51-60	25(16.1)	83.60±11.210	299.68±107.582
61-70	5(3.3)	72.80±8.672	P-value
P value		0.004	0.000

Table 2: Impact of Height on Peak Expiratory Flow Rate (PEFR) (n=151)

Height (cm)	Frequency n(%)	PEFR (l/min) Mean ±Standard Deviation
150-159	5(3.3)	270±99.4
161-169	67(44.3)	329.29 ±85.3
171-179	68(45.0)	354.12± 89.72
≥ 180	11(7.2)	375± 47.69
P-value		0.05*

PEFR= peak expiratory flow rate
P-value ≤ 0.05 is taken as significant

Table 3: Comparison of PEFR between Obese and morbid Obese   (n=151)

BMI(kg/m^2)	Frequency n(%)	PEFR Mean± Std. Deviation	P-value
Obese 25-39.9kg/m^2	94(62.2)	359.87±81.59	0.002*
Morbid obese ≥40 kg/m^2	57(37.7)	316.05± 88.005	

BMI=Body Mass Index
PEFR= peak expiratory flow rate
P-value ≤ 0.05 is taken as significant

Table 4: Association of PEFR with Age, height, and BMI (n=151)

Independent variables	B coefficient	P-value	P value
Age	-2.951	0.524	0.000*
Height	0.927	0.527	0.081
Weight	-0.266	0.553	0.632
BMI	-4.73	1.447	0.001*

BMI=Body Mass Index   Dependent Variable:
PEFR= peak expiratory flow rate
P-value ≤ 0.05 is taken as significant

Discussion

The impact of localized air pollution from industries on health is a prime concern in industrialized cities like Faisalabad. Air pollution from the heavy chemical industries has detrimental effects on lung function.[7,8] Additionally, Age, and obesity influence lung function and intensified the harmful effects of air pollution on respiratory health.[2,9]

The current study was conducted to highlight the impact of age, height, weight, and obesity on PEFR of inhabitants of chemical industries, who are exposed to chemicals and smoke on daily basis. Our study demonstrates a significant relationship between age and obesity and PEFR in workers in chemical industries.

We found a significant negative association between age with PEFR. The beta coefficient of -2.951 indicates that increasing in 1 year of age will result in a reduction of 2 units of PEFR. Our results are reflecting that the aged subjects are more at risk of decline in lung function due to chemical exposure. Our findings are also justified by an Indian study by Samata et al that reported lower PEFR values in workers of chemical industries in the age group 80-70 years as compared to younger workers.[1] Similar relation of age with PEFR was documented by previous research conducted by Polatlý et al. Senile degenerative changes in bronchial epithelium and loss of strength of respiratory muscles with advancing age resulting in a reduction in PEFR.[10] Oxidative stress in older age causes a release of elastases and subsequent attenuation of elastic recoil activity of lung and subsequent decline in PEFR.[10] Our results are justified by the recent Indonesian study also reporting the decline in lung functions of elderly subjects due to sarcopenia i.e. low muscle strength or muscle mass with increasing age.[11] Our findings are also in agreement with Trevisan et al study also reported lower PEFR values in older subjects aged ≥60 years.[12]

Worsening of respiratory muscle strength and compromised lung function with advancing age can result in significant clinical outcomes. Reduced oxygenation due to Impaired ventilation plays a significant role in multisystem organ dysfunction. Poor cardiopulmonary performance and reduced oxygen availability to the brain may affect cognitive performance, leading to a vicious cycle and further deterioration of pulmonary function.[12,13]

The current study did not find any significant relation between PEFR with height in contrast to current results, recent past studies by Ijaz et al in Lahore and Atta et al at Faisalabad reported a significant positive association of height with PEFR.[4,14]

A similar Indian study analyzing the impact of height and weight on PEFR of the workers of chemical industries also reported a significant positive correlation between heights with PEFR.[15] A Malaysian study conducted by Firdous et al also documented the significant positive association between PEFR and height.[16]

We found a negative association between weights with PEFR but it was not statistically significant, this finding is confirmed by Samata et al study, which also did not find a significant relationship between weight and PEFR.[15]

We found a significant negative association between BMI with PEFR. The beta coefficient of -4.73 is indicating that an increase in one unit of BMI will reduce approx: 4.7 units of PEFR. Our findings are in accordance with Patil et al study that found significantly lower PEFR values in obese subjects in contrast to non-obese subjects, reflecting the negative association of BMI with PEFR.[17] Another study conducted in Faisalabad also found lower PEFR values in obese and underweight subjects as compared to normal weight subjects, however, this aforementioned study did not find any significant association with BMI.[14] Study performed in Turkey' by Gundogdu et al also reaffirm our findings and shows lower PEFR with increasing BMI.[18] Our results are justified by the interesting findings of Ijaz et al conducted in Lahore, demonstrating a significant positive correlation between PEFR and BMI in the underweight and normal-weight subjects, however, no statistically sound correlation was found in overweight and obese subjects. Thus results of Ijaz et al indicate that increasing the BMI within normal limits improves PEFR reflecting better lung functionality and quality of life, but when BMI cross threaten physiological limits up to the level of obesity it can adversely affect human health and physical well-being.[4] We recommend

future follow-up studies on a broader scale to explore the impact of adiposity parameters on the PEFR of subjects with exposure to chemical fumes to affirm and corroborate our findings.

Limitation: Small sample size is the limitation of our study. We did not analyze our data for alteration in PEFR with to duration of chemical exposure.

Conclusion

Peak expiratory flow rate is negatively associated with age and BMI, reflecting that elderly and obese subjects are more prone to a decline in lung functionality due to exposure to chemicals.

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