Research Article

Lung function abnormalities in flour mill workers using spirometry

Cheryl Ann Melo[1], Satyanarayana G Konda[2], Tanvi Shah[1], Yogesh Padwale[1]

[1]Department of Pulmonary Medicine, Terna Medical College, Nerul, Navi Mumbai, Maharashtra, India.
[2]Department of Community Medicine, Terna Medical College, Nerul, Navi Mumbai, Maharashtra, India.
Correspondence to: Satyanarayana G Konda, E-mail: sgkonda@yahoo.co.in

Received November 25, 2015. Accepted December 03, 2015

Abstract

Background: Few studies have been carried out to analyze the impact of flour dust on the lung function of flour mill workers.

Objective: To assess the lung function of flour mill workers and to study the lung function abnormalities using spirometry.

Materials and Methods: An analytical case–control study was carried out on 40 flour mill workers and 40 matched controls. Data were collected using questionnaires, and lung function was assessed using an electronic spirometer. In those showing decreased lung function, postbronchodilator testing was performed. The results were statistically evaluated.

Result: Significant decrease in forced vital capacity (FVC), forced expiratory volume measured at the first second (FEV1), forced expiratory flow (FEF) (25%–75%), and peak expiratory flow (PEF) was noted in 25% subjects compared to 5% controls, which is five times more than that in the controls. Postbronchodilator testing showed a significant increase in FVC, FEV1, and FEF (25%–75%). Of the 25% subjects having decreased lung function, 60% had obstructive and 40% had restrictive airway disorder. Of the 60% having obstructive abnormalities, 83.33% had reversible and 16.67% had irreversible airway obstruction.

Conclusion: We conclude that wheat flour mill workers are at an increased risk of developing lung function abnormalities, reversible airflow obstruction being the most common. The workers should be educated about the hazards of flour dust, advised to use personal protection, advised to make changes in engineering and ventilation at the workplace, and motivated to undergo periodic examination. These measures can go a long way in preventing irreversible airflow obstruction.

KEY WORDS: FEV1, flour mill, FVC, obstructive, restrictive, spirometry

Introduction

In developing countries, a relatively large number of people are employed in industries processing agricultural products, and this makes the problem of exposure to vegetable dusts (grain, cotton, tobacco, tea) more serious there (WHO 1993). Cross-sectional epidemiological studies have shown a higher prevalence of respiratory symptoms among grain handlers compared with workers not so exposed, even after controlling for the effect of smoking.[1–4] An ingredient used in foods, flour dust is a fine powder made by grinding cereals or other edible starchy plant seeds suitable for grinding, and flour contains a high proportion of starch, a complex carbohydrate, known as polysaccharide.[5] Also called grain dust, it is a complex mixture of components including vegetable products, insect fragments, animal dander, bird and rodent feces, microorganisms, endotoxins, and pollen.[6] It also contains a mixture of allergens and has been known to cause respiratory problems among bakers and millers since the eighteenth century.[7] It has been implicated as one of the high-molecular weight asthamagens causing occupational or work-related asthma.[6] It accounts for 7%–9% of all cases of occupational asthma.[8]

Access this article online	
Website: http://www.ijmsph.com	Quick Response Code:
DOI: 10.5455/ijmsph.2016.25112015234	

Grain dust can also result in the development of chronic bronchitis. Studies suggest that the component of grain dust responsible is an endotoxin that activates complement leading to bronchial inflammation.[9] A significant relation is found between dust exposure and airway hyperresponsiveness. This may lead to or be a predisposing factor to subsequent chronic irreversible airflow obstruction.[10] Symptoms suggestive of chronic bronchitis or chronic productive cough have been found in 29% of workers exposed to flour dust in a flour mill.[11] In workers exposed to flour dust, the prevalence of cough, breathlessness, wheeze, and chest tightness was between 8% and 13% but was 20% for rhinitis.[12] Flour dust is also known to cause lung fibrosis, and two cases of mixed dust fibrosis have been reported in poorly ventilated flour mill settings.[13,14] Grain and flour processors and loaders may be exposed to grain that may become colonized with a variety of microorganisms (e.g., *Sitophilus granarius*) that are easily aerosolized.[15] They are also at an increased risk of exposure to storage mites[8,16] and fungi.[8] This exposure may lead to hypersensitivity pneumonitis.[15]

In occupational respiratory disease, spirometry is one of the most important, widely used, basic, effort-dependent pulmonary function test (PFT) and can measure the effects of restriction or obstruction on lung function.[17] Spirometry is regarded as an integral component of any respiratory medical surveillance program. During the preemployment evaluation, it can identify applicants with preexisting respiratory impairments to ensure proper job placement and assist in the selection of appropriate respiratory protection. Periodic retesting of workers can detect pulmonary disease in its earliest stages when corrective measures are most likely to be beneficial. Such intervention could include improvement in industrial hygiene control, job transfer, or medical treatment. In addition, PFTs have assumed a key role in epidemiological studies investigating the incidence, natural history, and causality of occupational and environmental respiratory disease.[18]

Materials and Methods

Sample Size

This study included 40 subjects and 40 controls.

Study Population

This was an analytical case–control study and the subjects were selected using simple random sampling method. The institutional ethics committee (Terna Medical College, Maharashtra, India) had approved of it. Each flour mill measuring approximately 15 m^2 was manned by, on an average, one to two mill workers. As our sample size was 40, around 40 mills had to be visited when we began the project and 60 mill workers were interviewed. A detailed history was elicited to include or exclude the workers on the basis of inclusion and exclusion criteria.

Inclusion Criteria

Workers working in the flour mill and exposed to flour dust (wheat flour) for at least 1 year were included in this study.

Exclusion Criteria

Following are the exclusion criteria:

1. History of smoking.
2. History of bronchial asthma before joining work.
3. Present or past history of severe respiratory infection (extensive pulmonary tuberculosis, bronchiectasis, etc.).
4. Clinical abnormalities of the vertebral column and thoracic cage.

Of the 60 workers interviewed, 20 were excluded and 40 were included. The project was explained to each of these 40 workers in detail and their written informed consent was taken. The workers were given a questionnaire with the following details: Personal—name, age, sex, and address. Work related—previous occupation, number of years spent in the mill, number of hours of exposure per day, whether using any mask or other protective measures at workplace, and time interval between joining job and onset of symptoms. Symptomatology (symptoms during work period)—chest symptoms, nasal symptoms, eye symptoms, and skin symptoms. General examination—height, weight, vertebral column abnormalities, and thoracic cage deformities.

Controls

Forty healthy male nonsmokers, matched for height, weight, and age, working in Nerul, Navi Mumbai, not exposed to flour dust served as controls.

Spirometry

A portable spirometer was taken to mills to test each worker. The controls were tested in Terna Hospital and Research centre (THRC). Spirometry was performed on 40 flour mill workers and 40 controls by a trained doctor. Flow volume loops and FEV1, FVC, FEV1/FVC, FEF (25%–75%) were recorded using a calibrated Schiller Spirovit SP-1 pneumotachometer. The subjects were explained the whole maneuver. According to the current ATS/ERS (American Thoracic Society/European Respiratory Society) statement, spirometry can be performed either in sitting or in standing position.[19,20] The test was carried out in sitting position using a disposable mouth piece, disposable filters, and a nose clip till two constant readings were obtained. Postbronchodilator testing was done on subjects who had decreased lung function after salbutamol nebulization. On the basis of spirometry findings the degree of reduction in pulmonary function was assessed.

Statistical Analysis

The results were evaluated using χ^2-test, *t*-test, and *F*-test.

Result

Spirometry was performed on a group of 40 mill workers (subjects) and 40 controls. The data were collected in terms of variables such as age, height, weight, number of years of exposure, and number of hours of exposure per day; the mean calculated for each of these variables was 28.5 year, 162.68 cm, 60.25 kg, 5.7 year, and 7.43 h respectively. Similarly, the mean age, height, and weight of the 40 controls was 27.75 year, 173 cm, and 66.95 kg.

The mill workers displayed symptoms such as running nose, chest pain, expectoration, cough, watering of eyes, fever, and sneezing. Of 40 workers, 3 workers (7.5%) experienced running nose, 3 (7.5%) complained of chest pain, 1 (2.5%) experienced watering of eyes, and 1 (2.5%) complained of fever. Cough and expectoration was reported by two (5%) workers and sneezing was reported by two (5%) workers. Thus, a total of 12 (30%) workers complained of symptoms and 10 of 40 workers (25%) had respiratory symptoms. Furthermore, 28 (70%) of the total workers did not report any symptoms.

The results of spirometry done on the 40 subjects and 40 controls were compared. Two of 40 controls (5%) and 10 of 40 mill workers (25%) had lung function abnormalities. Thus, the subjects having lung function abnormalities were five times more than the controls [Table 1].

When the values obtained on spirometry were compared using unpaired *t*-test, it was found that the subjects showed decrease in values of FVC (forced vital capacity), FEV1 (forced expiratory volume measured at the first second), FEF (forced expiratory flow) (25%–75%), and PEF (peak expiratory flow) compared to the controls, and this was found to be statistically significant [Table 2].

The *F*-test measures the equality of variance and was performed to compare the variation in lung function parameters between the subjects and the controls. The result showed that there was more variation in lung function parameters (FVC% predicted and FEV1/FVC measured) between subjects and this was statistically significant [Table 3].

The results of paired *t*-test on the measured and predicted values of FVC, FEV1, FEV1/FVC ratio, FEF (25%–75%), and PEF (prebronchodilation as well as postbronchodilation) are shown in Table 4. A significant increase in these values has occurred following bronchodilation. Good bronchodilator reversibility bronchodilator response (BDR) is indicated by postbronchodilator increase in FEV1 by 200 mL or >12%. The mean, standard deviation, and standard error of mean of the measured and percentage predicted values of FEV1 (prebronchodilation and postbronchodilation) of five workers who showed obstructive lung disease with good bronchodilator response are shown in Table 5. A significant increase in measured FEV1 (after bronchodilation) was seen. Since FEV1 is the parameter most sensitive to obstruction, it has been considered separately. Spirometry analysis showed that 6 of 40 (15%) workers had obstructive lung disease. Five (83.33%) of these six workers had a mild obstructive disorder with good bronchodilator response signifying reversible airway obstruction, and one (16.67%) had moderate obstruction with poor bronchodilator response signifying irreversible airway obstruction. Furthermore, 4 of 40 (10%) workers had a mild restrictive disorder [Table 1]. It was also found that number of years of exposure of the workers showing obstructive and restrictive lung disease was greater than the average number of years of exposure of the entire sample.

Thirty-three of 40 (82.5%) workers did not use a mask while working and 7 of 40 (17.5%) workers used a mask. Twenty-one of 40 (52.5%) workers did not have a fan or exhaust at their work place. Fourteen of 40 (35%) workers used fan while at work and 5 of 40 (12.5%) workers switched on the fan only sometimes. Thus, a total of 19 of 40 (47.5%) workers had an exhaust or fan at their workplace. Of the 10 workers showing decreased lung function, only 2 were found to be using protection. This was found to be statistically significant [Table 6]. However, of the 30 workers showing normal lung function, only 5 were found to be using protection.

Discussion

This study was designed to analyze the lung function abnormalities in flour mill workers using spirometry. In our study, 25% of the workers were found to be having respiratory symptoms; 7.5% having chest tightness; and 5% having cough, expectoration, and sneezing each. One study reported

Table 1: Spirometry results of subjects and controls

Spirometry results	No. of subjects	Subjects (%)	No. of controls	Controls (%)
Normal	30	75	38	95
Mild restrictive	4	10	—	—
Moderate obstructive with poor BDR	1	2.5	—	—
Mild obstructive with good BDR	5	12.5	2	5
Total	40	100	40	100

BDR, bronchodilator response.
Only 2 subjects in the control group had abnormal lung function as opposed to 10 (of 40) flour mill workers.

Table 2: Comparison of lung function parameters of subjects and controls

Lung function parameter	*t*-Value	*P*-value
FVC(L) measured	2.44	0.02
FVC(L) % predicted	0.71	0.48
FEV1 measured	2.70	0.01
FEV1 % predicted	0.78	0.44
FEV1/FVC measured	1.27	0.02
FEV1/FVC % predicted	1.71	0.09
FEF(25%–75%) (L/s) measured	2.91	0.01
FEF(25%–75%) % predicted	1.53	0.13
PEF (L/s) measured	2.48	0.02
PEF % predicted	1.24	0.22

FVC meas, FEV1 meas, FEF (25%–75%) meas, and PEF meas values are significantly lower in mill workers compared to controls.

Table 3: Comparison of the variation in the lung function parameters between subjects and controls

Parameter	*F*-test	*P* value
FVC (L) measured	2.41	0.04
FVC (L) % predicted	132.03	0.00
FEV1 (L) measured	1.26	0.60
FEV1(L) % predicted	2.12	0.08
FEV1/FVC measured	4.86	0.00
FEV1/FVC% predicted	2.27	0.06
FEF(25%–75%) (L/s) measured	1.60	0.28
FEF(25%–75%) % predicted	1.40	0.43
PEF (L/s) measured	1.39	0.45
PEF % predicted	1.11	0.84

The subjects showed a significant variation in their values of FVC% predicted and FEV1/FVC measured as compared to the controls.

Table 4: Comparison of prebronchodilator and postbronchodilator values of all lung function parameters (measured and predicted)

Lung function parameters	Paired differences Mean	Std. deviation	*t*–value	*P*–value
FVC(L) measured	–0.31	0.18	–5.51	0.00
FVC % predicted	–9.90	6.40	–4.89	0.00
FEV1(L) measured	–0.24	0.18	–4.16	0.00
FEV1 % predicted	–6.30	11.28	–1.77	0.11
FEV1/FVC measured	0.91	8.53	0.34	0.74
FEV1/FVC % predicted	1.10	10.08	0.35	0.74
FEF (25%–75%) (L/s) measured	–0.30	0.38	–2.50	0.03
FEF(25%–75%) % predicted	–10.10	10.85	–2.95	0.02
PEF(L/s) measured	–8.27	25.75	–1.02	0.34
PEF % predicted	–9.30	11.87	–2.48	0.04

FVC measured, FVC % predicted, FEF (25%–75%) measured, FEF (25%–75%) % predicted, and PEF % predicted values have increased significantly on bronchodilation.

Table 5: Comparison of prebronchodilator and postbronchodilator values of FEV1 (measured) of the five subjects having obstructive lung disease

Pre vs post	Paired differences mean	Std. dev	*t*-value	*P*-value
FEV1 (L) measured	–0.33	0.13	5.93	0.004

The values have significantly increased on bronchodilation indicating that the depression in lung function is reversible.

Table 6: Relationship between protection and decreased lung function among mill workers

Decreased lung function	Protection		Total
	Yes	No	
Yes	2	8	10
No	5	25	30
Total	7	33	40

The number of workers using protection was significantly lower in those having decreased lung function compared to those having normal lung function.

the prevalence of chest tightness, wheeze, breathlessness, and cough to be 8%–13%.[12] However, another study showed a higher prevalence of cough and phlegm, 26% and 29%, respectively,[11] compared to this study (5% each). In this study, we found that rhinitis was the most common symptom (12.5%). Deacon and Paddle[12] too reported the same.

In this study, 25% of the subjects showed a decrease in lung function compared to 5% of the controls. One study reported that in 29% of the workers there was at least one abnormal test result of ventilator function compared to 15% of the external controls and 10% of the internal controls.[21] A decrease in PEFR (peak expiratory flow rate), FEV1, FEF-25%, and FEF-75% due to higher concentration of wheat dust at a wheat processing plant was also reported.[22] These spirometric values diminished in positive correlation with time of exposure. In our results too, we found a significant decrease in FEV1 and FEF (25%–75%) compared to the controls. Further, it was found that the five subjects having significantly lower FEV1 values (and diagnosed with having obstructive lung disease) had, on an average, a higher number of years of exposure compared to the average number of years of exposure of the entire sample.

Respiratory measurements before and after the working shift showed a significant drop in FEV1 and FVC in exposed group and the mean values of FEV1, FVC, and FEV1% were significantly lower than that of the control.[18,23] Flour mill workers recorded significantly lower mean lung function compared to the controls for FEV1 and FVC when observed values were expressed as a percentage of predicted values.[21] Our study is consistent with the above four findings for FEV1, FVC, PEF, and FEV1% ($P < 0.05$). Grain mill workers had significantly reduced spirometric measures of FEV1, FEV1/FVC, and FEF (25%–75%).[24] In our study too, we found a significant decrease in FEF(25%–75%) and FEV1 compared to the controls ($P < 0.05$).

A significant reduction in overall mean values of FVC, FEV1, PEF, and MVV (maximum voluntary ventilation) relative to matched controls,[25] was in accordance with our study for values of FVC, FEV1, and PEF ($P < 0.05$) compared to the controls. A study done in Jalgaon urban center to assess the influence of workplace environment on lung function of flour mill workers found a significant reduction in FEV1, FVC, and PEFR compared to controls.[26] Our findings corroborate with these findings for FEV1 and FVC ($P < 0.05$).[26] All the studies mentioned earlier have performed spirometry but none have performed bronchodilator reversibility testing. In our study, every subject with decreased lung function underwent post-bronchodilator testing, that is, spirometry was repeated after giving the subject salbutamol nebulization to differentiate between reversible and irreversible airway obstruction.

In our study, spirometry analysis showed that 15% worker had obstructive lung disease of which 16.67% showed poor bronchodilator response (indicating irreversible airway obstruction) and 83.33% showed good bronchodilator response (indicating reversible airway obstruction), thus proving that flour is one of the causative factors of chronic bronchitis and occupational asthma. One study reported that 23.16% of the workers suffered from some form of respiratory obstruction,[23] which is close to our results of 15%. Another study demonstrated that grain dust is a common cause of respiratory symptoms and obstructive changes on pulmonary function testing.[27] We too observed obstructive-type changes on lung function testing.

Two cases of mixed dust fibrosis, which occurred in a setting of poorly ventilated flour mills where various kinds of grains, chiefly wheat, were ground using stones whose silica content was analyzed to be >80%, were reported. The term "flour mill lung" was proposed for this form of pneumoconiosis.[14] In our study too, we report four cases (10%) of mild restriction as diagnosed on analysis of spirometry results. Also, most of the mills visited by us were poorly ventilated and the workers used stones to grind the wheat. Wheat infested with micro-organisms such as *Sitophilus granarus*,[15] storage mites,[8,16] and fungi[8] has been implicated as a cause of hypersensitivity pneumonitis among workers exposed to it.[22] Four cases with restrictive lung function could be having pneumoconiosis or hypersensitivity pneumonitis, which needs further evaluation using body plethysmography and CT scan of thorax or lung biopsy.

Conclusion

We conclude that flour dust causes significant decrease in lung function parameters such as FEV1, FVC, PEF, FEF (25%–75%), FVC%, and FEV1/FVC. It causes obstructive as well as restrictive pattern of lung function impairment. Post-bronchodilator testing showed that 83.33% of the 15% having obstructive abnormality had reversible airway obstruction and 16.67% had irreversible airway obstruction. The findings also suggest that occurrence of respiratory signs and symptoms and depression of lung function depends on the number of years of exposure. It was also seen that most of the workers who showed depression in lung function were not using protection and this was statistically significant ($P < 0.05$). Of the 40 subjects, only 7 workers were found to be using protection. In the workers who had normal lung function despite not using protection, it was found that the average number of years for which they were exposed to flour dust, was less than the average of the total number of years of exposure of the entire sample. However, in the workers who were asymptomatic despite not using protection, we could find no such correlation with the number of years of exposure. We attribute this fact to the possibility that such workers worked in mills that had better ventilation due to their proximity to gardens or the main road, as opposed to the other mills that were situated in narrow lanes and overcrowded areas. We recommend the compulsory use of personal protective equipment (face mask, respirator mask) by the flour mill workers during working hours. We also suggest that a regular periodic examination should be carried out to measure the impact of the particulate matter on the health of the flour mill workers. If possible, changes in engineering and ventilation in some form (windows, fan, exhaust) should be made at the work place.[18] Since majority (83.33%) of the subjects with obstructive disorders had reversible airway obstruction as detected with postbronchodilator testing, the above-mentioned measures can go a long way in preventing irreversible airway obstruction.

Acknowledgment

We thank Mr. Abhiram Behera for the statistical analysis.

References

1. Laraqui CH, Caubet A, Laraqui O, Benghalem A, Harourate K, Bichara M, et al. Prevalence of respiratory symptoms and evaluation of sensitization levels in traditional grain market workers in Casablanca. Rev Mal Respi 2000;17(5):947–55.
2. Bachman M, Myerls JE. Grain dust and respiratory health in South African milling workers. Br J Ind Med 1991;48:656–62.
3. Smith TA, Parker G, Hussain T. Respiratory symptoms and wheat flour exposure. A study of flour millers. Occup Med 2000;50(1):25–9.
4. Viet SM, Bucan R, Stallones L. Acute respiratory effects and endotoxin exposure during wheat harvest in Northeastern Colorado. Appl Occup Environ Hyg 2001;16(6):685–97.
5. Wikipedia. Williamson, George (06/02/2002). Introduction to dust explosions retrieved on 2006/10/29. Washburn a mill explosion. Minnesota historical society library history topic. Retrieved on 2006/10/29. The bread and flour regulation 1998-United Kingdom.
6. Kirkhorn Steven R, Garry Vincent F. Agricultural lung diseases. Environ Health Perspect 2000;108(Suppl 4):705–12.
7. Cullinan P, Lowson D, Nieuwenhuijsen MJ, Sandiford C, Tee RD, Venables KM, et al. Work related symptoms, sensitization and estimated exposure in workers not previously exposed to flour. Occup Environ Med 1994;51:579.
8. Kogevinas M, Anto JM, Sunyer J, Tobias A, Kromhout H, Burney P. Occupational asthma in Europe and other industrial areas. A population based study. European community respiratory health survey study group. Lancet 1999;353:1750–4.
9. Cooper JA Jr, Buck NG, Gee JB. Vegetable dust and airway disease: inflammatory mechanisms. Environ Health Perspect 1986;16:7–17.
10. Chan-Yeung M, Malo JL. Occupational asthma. New Eng J Med 1995;333:107–12.
11. Awad el Karim MA, Gad el Rab MO, Omer AA, el Haimi YA. Respiratory and allergic disorders in workers exposed to grain and flour dusts. Arch Environ Health 1986;41(5):297–301.
12. Deacon SP, Paddle GM. Respiratory symptoms and ventilatory performance in workers exposed to grain and gain based food dusts. Occup Med (Lond) 1998;48(4):227–30.
13. Dosman JA, Graham BI, Cotton DJ. Chronic bronchitis and exposure to cereal grain dust. Am Rev Resp Dis 1979;120:477–80.
14. Sundaram P, Kamat R, Joshi JM. Flour mill lung: a pneumoconiosis of mixed etiology. Indian J Chest Dis Allied Sci 2002; 44(3):199–201.
15. Fink JN. Hypersensitivity pneumonitis. Clin Chest Med 1992;13(2):303–9.
16. Tee RD, Gordon DJ, Gordon S, et al. Immune response to flour and dust mites in a United Kingdom Bakery. Br J Ind Med 1992;49:581–7.
17. Ruppel GL. Pulmonary function testing: trends and techniques. Respir Care Clin N Am 1997;3:155–81.
18. Mc Kay, Ray T, Horvath EP. Pulmonary function testing in industry. In: *Occupational Medicine*, 3rd edn. Zenz C, Dickerson OB, Horvath EP (Ed.). London, UK: Mosby, 1994. P. 229.
19. American Thoracic Society (ATS). Statement on standardization of spirometry 1994 update. Am J Crit Care Med 1995;152:1107–36.
20. European Respiratory Society (ERS), Quanjer PH, Tammeling GJ. Standardisation of lung function testing. Eur Respir J 1993; 6(16):1–10.
21. Ijadunola KT, Erhabor GE, Onayade AA, Ijadunola MY, Fatusi AO, Asuzu MC. Pulmonary functions of wheat flour mill workers and controls in Ibadan, Nigeria. Am J Ind Med 2005;48:308–17.
22. Corzo G, Navada R. Spirometry in a wheat-processing industry. Invest Clin 1998;39:175–87.
23. Ige OM, Awoyemi OB. Respiratory symptoms and ventilatory function of the bakery workers in Ibadan, Nigeria. West Afr J Med 2002;21(4):316–18.
24. Schwartz DA, Thorne PS, Yagla SJ, Burmeister LF, Olenchock SA, Watt JL, et al. The role of endotoxin in grain dust induced lung disease. Am J Resp Crit Care Med 1995;152:603–8.
25. Meo SA. Dose responses of years of exposure on lung functions in flour mill workers. J Occup Health 2004;46:187–191.
26. Wagh ND, Panchpande BG, Patel VS, Attarde SB, Ingle ST. The influence of workplace environment on lung function of flour mill workers in Jalgaon urban centre. J Occup Health 2006;48:396–401.
27. Essen VS. The role of endotoxin in grain dust exposure and airway obstruction Curr Opin Pulm Med 1997;3:198–202.

How to cite this article: Melo CA, Konda SG, Shah T, Padwale Y. Lung function abnormalities in flour mill workers using spirometry. Int J Med Sci Public Health 2016;5:743-748

Source of Support: Nil, **Conflict of Interest:** None declared.