Elghazally *et al.*
The Egyptian Journal of Bronchology (2023) 17:32
https://doi.org/10.1186/s43168-023-00206-5

The Egyptian Journal of Bronchology

RESEARCH Open Access

Assessment of respiratory health status of workers in flour mills of Assiut

Shimaa A. Elghazally[1], Hussein H. Zayet[2], Maha M. Elkholy[3] and Ayah A. Alkarn[4*]

Abstract

Background Working environment should not present a risk of injury or disease but many thousands of workers worldwide remain exposed to hazardous substances particularly in developing countries. Flour dust is one of those hazardous substances to which the flour mills workers are exposed to, inhalation of flour dust may cause diverse lung diseases with different severity of symptoms ranging from simple irritation to allergic reaction and chronic respiratory disorders, including asthma. Therefore, the present study was done to detect the prevalence of respiratory problems among flour mills workers.

Methods The study was carried out in the flour mills of Assiut, it was a cross-sectional study among 203 workers. The study instruments were a semi-structured questionnaire about respiratory symptoms, chest examination and pulmonary function tests (PFT).

Results The age of the study workers ranged from 19 to 60 years old, 94.1% were males, 50.7% were from urban regions. Pulmonary function abnormalities were found in 36.4% of them and 20.7% were diagnosed with bronchial asthma. Significant relationships were detected between abnormal pulmonary function tests and workers ≥ 40 years old, low educational level and those who worked in the flour mills for ≥ 10 years.

Conclusions Flour dust cause respiratory symptoms and impair the pulmonary function of the flour mills workers and they may develop bronchial asthma which affect their work efficiency.

Recommendations Medical care must be provided regularly to the flour mills workers and safety measures are mandatory.

Trial registration ClinicalTrials.gov. NCT03678519. Registered August 10, 2022.

Keywords Flour mills workers, Respiratory symptoms, Occupation, Asthma, Pulmonary Functions Tests

Background

The wheat milling industry is one of the most important agricultural industries found everywhere in Egypt. The total investment in this industry is 1.3 billion LE and more than 35,000 workers are working in flour mills in Egypt [1].

Flour milling involves the processing and grinding of cereals into flour. Exposure to the flour dust occurs in the milling operations, where grain is processed into flour [2]. Working environment may be unsafe and unhealthy for workers and the risk of adverse health outcome occurrence is closely related to the flour dust exposure levels [3].

*Correspondence:
Ayah A. Alkarn
Ayahatefalkarn@yahoo.com
[1] Occupational and Environmental Medicine, Faculty of Medicine, Assiut University, Assiut, Egypt
[2] Occupational and Environmental Medicine, Faculty of Medicine, Cairo University, Cairo, Egypt
[3] Chest Diseases, Faculty of Medicine, Assiut University, Assiut, Egypt
[4] Public Health and Community Medicine Department, Occupational and Environmental Medicine, Faculty of Medicine, Assiut University, Assiut, Egypt

Flour dust is defined as a complex organic fine dust containing cereals or other edible starchy plant seeds as wheat, rye, barley, oats, rice or corn or a combination of these, which have been processed by milling. In addition, flour may contain a diverse number of storage related contaminants [4].

Inhalation of flour dust may cause diverse lung diseases with different severity of symptoms ranging from simple irritation to allergic reaction and chronic respiratory disorders, including asthma. With continuing occupational exposure, these respiratory symptoms among flour mills workers can lead to worker disability [3].

Occupational asthma is common among flour mills workers due to exposure to organic dust full of allergens either from the grain components itself or from contaminants [5].

The aim of this work is to detect the effects of occupational hazards on the respiratory system of the flour mills workers.

Methods

Study design

A cross-sectional study was conducted in the flour mills of Assiut. The sample size was calculated using Epi-Info7, a total of 203 flour mills workers were included in the study based on the prevalence of asthma related to work among mills workers in a study carried out in Helwan (25%), at confidence interval 90% [5].

The workers in our study were categorized into 2 groups according to the exposure into:

- High exposure group which includes individuals working inside flour mills rooms.
- Low exposure group including individuals working outside flour mills rooms (in offices) [6].

Data of the workers was collected through personal interview by using semi-structured questionnaire. The collected data in the questionnaire included: demographic data, work characteristics and respiratory symptoms guided by the Medical Research Council Questionnaire (MRCQ) [7]. The study workers were then subjected to chest examination.

PFT was also assessed using a computerized spirometer "SPIROLAB III". Before the test height and weight were measured for each participant. The testing procedures were simple, non-invasive and harmless. In a comfortable sitting position subjects were asked to inhale and exhale into the disposable mouthpiece of the spirometer. The maneuvers were repeated three times and the best of the three readings were taken. At the end of the procedure, the instrument showed the detailed pulmonary function test readings and graphs.

The following ventilatory functions indices were calculated: Forced vital capacity (FVC%), Forced expiratory volume in the 1st second (FEV1%), the Forced expiratory volume in the first second as a percentage of the Forced vital capacity (FEV1/FVC) and the Forced expiratory flow at 25% and 75% of the pulmonary volume (FEF25-75%), the spirometry results were given as percentage of predicted normal values and were interpreted using the American Thoracic Society and European Respiratory Society of pulmonary function tests [8, 9].

Operational definitions for chest diseases diagnosis:

- Bronchial Asthma: A heterogeneous disease, usually characterized by chronic airway inflammation. It is defined by the history of respiratory symptoms, such as wheezes, shortness of breath and cough that vary over time and in intensity, together with variable airflow limitation which may later become persistent [10].
- Chronic obstructive pulmonary diseases (COPD): common disease characterized by airflow limitation and persistent respiratory symptoms including cough, dyspnea, and sputum production with the presence of risk factors (smoking) [11].
- Pre-COPD: persons who experience respiratory symptoms but have an FEV1/FVC ratio in the normal range [12].
- Interstitial lung diseases (ILD): group of diseases that cause lung fibrosis. The most common symptoms are shortness of breath, dry cough with a restrictive pattern in PFT [13].
- Small Airway Disease (SAD): is a cardinal feature of COPD and asthma and is greatly linked to smokers. It is diagnosed by FEF 25%–75% of less than 60 [14, 15].

Statistics

Data was coded and entered using the statistical package SPSS (Statistical Package for the Social Science; SPSS-Inc., Chicago, IL, USA) version 22. Data was summarized using mean and standard deviation in quantitative data and using frequencies for categorical data. Significance tests (chi-square for categorical data) and correlation were applied. Logistic regression analysis was used to determine the predictors for respiratory symptoms and bronchial asthma. *P*-values less than 0.05 were considered statistically significant. Graphic presentations were done using the Excel program.

Results

Table 1 shows demographic characteristics of flour mills workers who participated in this study. Age ranged from 19 to 60 years with a mean of 40.1 ± 10.84. The majority of the studied workers (94.1%) were males. Illiterate workers represented 31%. More than half (55.7%) of the studied workers were smokers. Mild, moderate and heavy smokers represented 38.9%, 27.4% and 33.7%, respectively. Those who worked for ten years and more represented 62.1% and about half (52.7%) were working in areas with high exposure levels.

Table 2 shows that 40.9% of the flour mills workers complained of respiratory symptoms. Cough, shortness of breath and wheezes were complaints in 29.6%, 32.5% and 31%, respectively. The majority of the complaining workers started to complain after joining the work in 96.4%, the condition worsened by presence at work in 83.1%, 78.3% claimed that their symptoms were more severe in the first working day after the weekend and 77.1% of them felt improved when away from work.

Table 3 reveals the parameters of the PFTs. The mean FVC% was 87.89 ± 12.78, the mean FEV1% was 84.25 ± 14.94, the mean FEV1/FVC was 80.05 ± 10.25 and the mean FEF25%-75% was 73.88 ± 23.43. According to the PFT, 63.3% of the workers were normal, 9.8% were diagnosed with restriction, 9.2% with obstruction, 8.2% as mixed and 9.2% with small airway disease.

Figure 1 showed the percentages of chest diseases among flour mills workers as follows: 20.7% were asthmatic, 8.3% with SAD, 7.4% had COPD, 5.9% as pre-COPD and 3.4% were diagnosed with interstitial lung diseases.

Table 4 demonstrates the presence of significant relationships between the presence of respiratory problems and low educational levels ($p=0.008$*), rural residency ($p=0.021$*), smoking ($p=0.0001$*) and exposure to high flour level ($p=0.038$*).

Table 5 illustrates significant relationships between abnormal pulmonary function tests and workers ≥ 40 years old ($p=0.005$*), low educational level ($p=0.032$*), those who worked in the flour mills

Table 1 characteristics of the flour mills workers, Assiut

Characteristics	No. ($n=203$)	%
Age: (years)		
< 40	111	54.7
≥ 40	92	45.3
Mean ± SD (Range)	40.10 ± 10.848 (19–60)	
Sex:		
Male	191	94.1
Female	12	5.9
Residence:		
Urban	103	50.7
Rural	100	49.3
Education:		
Illiterate, read &write	63	31.0
Primary or preparatory	42	20.7
Secondary or technical	66	32.5
University	32	15.8
Smoking habit:		
Smokers	113	55.7
Ex-smoker	19	9.3
Non-smokers	71	35.0
Smoking index: ($n=113$)		
Mild smokers (< 200)	44	38.9
Moderate smokers (200–400)	31	27.4
Heavy smokers (> 400)	38	33.7
Duration of work:		
< 10 year	77	37.9
≥ 10 years	126	62.1
Level of exposure:		
High exposure level	107	52.7
Low exposure level	96	47.3

Table 2 Respiratory symptoms among flour mills workers, Assiut

	No. ($n=203$)	%
Complaining from any respiratory symptoms:	83	40.9
History of chronic respiratory symptoms:		
- Cough:	60	29.6
- Sputum:	48	23.6
- Shortness of breath:	66	32.5
- Wheezes:	63	31.0
Work-related respiratory symptoms:	**$n=83$**	
History of postemployment chronic respiratory symptoms:	80	96.4
Condition worsens by presence at work:	69	83.1
Symptoms more severe in the first working day after the weekend than the rest days of the week:	65	78.3
Feel improvement in the chest symptoms when away from work:	64	77.1

Table 3 Pulmonary function tests (PFT) of flour mills workers, Assiut

PFT Parameters	No. ($n=184$)* Mean ± S.D. (range)	
FVC%	87.89 ± 12.78 (52 – 120)	
FEV1%	84.25 ± 14.94 (29 – 116)	
FEV1/FVC	80.05 ± 10.25 (43 – 100)	
FEF25%-75%	73.88 ± 23.43 (16 – 128)	
PFT disorders	**No**	**%**
Normal	117	63.6
Restriction	18	9.8
Obstruction	17	9.2
Mixed	15	8.2
Small airway disease (SAD)	17	9.2

for ≥ 10 years ($p=0.002$*) and among workers who suffered from respiratory problems ($p=0.0001$*).

Figures 2 and 3 show that there were statistically significant negative correlations between FEV1%, FVC% and duration of work in the flour mills ($r=-0.16$, $p=0.028$*) and ($r=-0.19$, $p=0.007$*) respectively.

Table 6 shows logistic regression analysis of the predictors of respiratory symptoms and Bronchial asthma. As regards the respiratory symptoms, It revealed that being illiterate (OR = 5.574, 95% CI = 1.903 – 16.324; $p=0.002$*), rural residency (OR = 1.950, 95% CI = 1.105 – 3.440; $p=0.021$*), higher exposure level (OR = 1.821, 95% CI = 1.821 – 3.218; $p=0.039$*) and smokers (OR = 3.967, 95% CI = 2.042 – 7.707; $p=0.0001$*) were predictors for respiratory symptoms. While in the adjusted regression model, only smoking was significant (OR = 3.536, 95% CI = 1.675 – 7.464; $p=0.001$*). While the predictors of bronchial asthma were as follows: the workers younger than 40 years old (OR = 8.700, 95% CI = 3.252 – 23.273; $p=0.0001$*), smokers (OR = 3.299, 95% CI = 1.381 – 7.880; $p=0.007$*), workers who worked for less than 10 years old (OR = 3.083, 95% CI = 1.532 – 6.202; $p=0.002$) and high exposure level (OR = 2.374, 95% CI = 1.151 – 4.894; $p=0.019$*). Regarding the adjusted regression model, the younger age group and smoking were significant (OR = 9.145, 95% CI = 3.220 – 25.969; $p=0.0001$*) and (OR = 4.101, 95% CI = 1.491 – 11.280; $p=0.006$*), respectively.

Discussion

The flour mills workers are exposed to chemical health hazards due to the presence of flour dust in the work. The working environment was quite unsafe and unhealthy for workers and the occurrence of various health problems were due to work pressure, long working hours and insufficient cleaning at the workplace [3].

Smokers represented more than half of the workers (55.7%). This was higher than the Global Adult Tobacco Survey 2009 (GATS) where 19.4% of adults in Egypt were smokers and 37.7% of men were smokers [16].

The smoking percentage in our study was higher than other studies carried out in flour mills in Iran, Nigeria and Ethiopia [17–20]. Also, higher than reported in three Egyptian studies in Al-Fayoum (2022), Cairo (2017) and Giza (2019) [21–23].

On the other side, the percentage of smokers in the present study was lower than in previous two Egyptian studies conducted by Mohammadein et al. (2013) in Sohag and by Saied et al. (2018) in Helwan [5, 6].

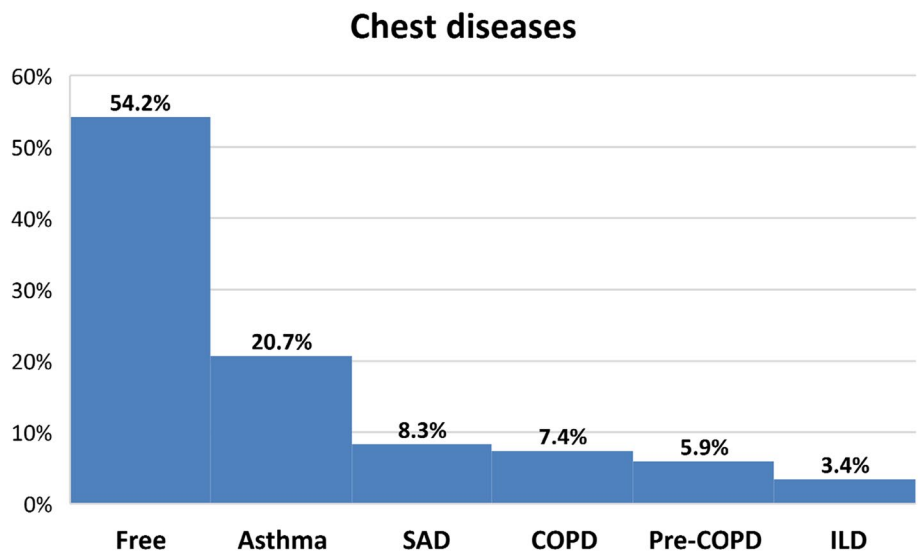

Fig. 1 Chest diseases among flour mills workers, Assiut

Table 4 Demographic and occupational factors in relation to respiratory problems among flour mills workers, Assiut

	Respiratory problems (*n* = 83)		No Respiratory problems (*n* = 120)		*P*-value*
	No	%	No	%	
Age:					0.186
< 40 years old	50	60.2	61	50.8	
≥ 40 years old	33	39.8	59	49.2	
Sex:					0.079
Male	81	97.6	110	91.7	
Female	2	2.4	10	8.3	
Education:					0.008*
Illiterate, read and write	32	38.6	31	25.8	
Primary and preparatory	20	24.1	22	18.3	
Secondary and technical	26	31.3	40	33.3	
University	5	6.0	27	22.5	
Residence:					0.021*
Urban	34	41.0	69	57.5	
Rural	49	59.0	51	42.5	
Smoking:					0.0001*
Smoker	68	81.9	64	53.3	
Nonsmoker	15	18.1	56	46.7	
Duration of work:					0.663
< 10 year	30	36.1	47	39.2	
≥ 10 years	53	63.9	73	60.8	
Level of exposure:					0.038*
High exposure level	51	61.4	56	46.7	
Low exposure level	32	38.6	64	53.3	

* Chi-square test was used

Table 5 Demographic and occupational factors in relation to pulmonary function tests among flour mills workers, Assiut

	Abnormal PFTs (*n* = 67)		Normal PFTs (*n* = 117)		*P*-value*
	No	%	No	%	
Age:					0.005*
< 40 years old	28	41.8	74	63.2	
≥ 40 years old	39	58.2	43	36.8	
Education:					0.032*
Illiterate, read and write	29	43.3	31	26.5	
Primary and preparatory	14	20.9	26	22.2	
Secondary and technical	20	29.9	38	32.5	
University	4	6.0	22	18.8	
Residence:					0.365
Urban	35	52.2	53	45.3	
Rural	32	47.8	64	54.7	
Smoking:					0.073
Smoker	53	79.1	78	66.7	
Nonsmoker	14	20.9	39	33.3	
Duration of work:					0.002*
< 10 year	16	23.9	55	47.0	
≥ 10 years	51	76.1	62	53.0	
Level of exposure:					0.494
High exposure level	39	58.2	62	53.0	
Low exposure level	28	41.8	55	47.0	
Respiratory problems:					0.0001*
Yes	40	59.7	38	32.5	
No	27	40.3	79	67.5	

* Chi-square test was used

The higher percentages of smoking in this study specifically and in Egypt generally can be explained by viewing smoking as a part of lifestyle and moreover a habit especially in low socioeconomic areas.

Flour mills workers who complained of one or more respiratory symptoms in this study represented 40.9% of the workers. Cough, shortness of breath and wheezes were complaints in 29.6%, 32.5% and 31%, respectively. The findings of this study were nearly similar to what concluded by Mekonnen et al. (2021) [24].

Our results were higher than that reported by Melo and his colleagues (2016), Abdulrahman and Murad (2022), Seema et al. (2020), Saied et al. (2018), Uzoma et al. (2021) and Demeke and Haile (2018) studies [4, 5, 19, 25–27].

On the other hand, higher prevalence of respiratory symptoms were found in previous three studies conducted in Egypt by Mohammadien et al. (2013), said et al. (2017) and Shaaban et al. (2019) [6, 22, 23].

Our findings were also contrary to previous two Indian studies carried by Ahire et al. (2017) and Gurli et al. (2019) [3, 28] and two Ethiopian studies, carried out by Lagiso et al. (2020) and Alemseged et al. (2020) [17, 18] who found higher respiratory symptoms.

The respiratory symptoms are major problems among flour mills workers as the fine flour dust particles are of tiny sizes which can easily enter the respiratory tract of exposed workers, causing irritation in the respiratory tract which is the primary symptom of respiratory disorder [6].

In addition to this, longtime exposure, bad ventilation in the work place and the non-utilization of personal protective equipment (PPE) increase the possibility of occurrence of respiratory symptoms among the flour mills workers [29].

The difference in the respiratory symptoms prevalence among different studies from different countries might be attributed to variations in the levels of health and safety implementation, effective use of PPE, differences in data collection techniques and prevalence of other concomitant symptoms [24].

Our study was in line with two previous Ethiopian studies, in that flour mills workers with primary school

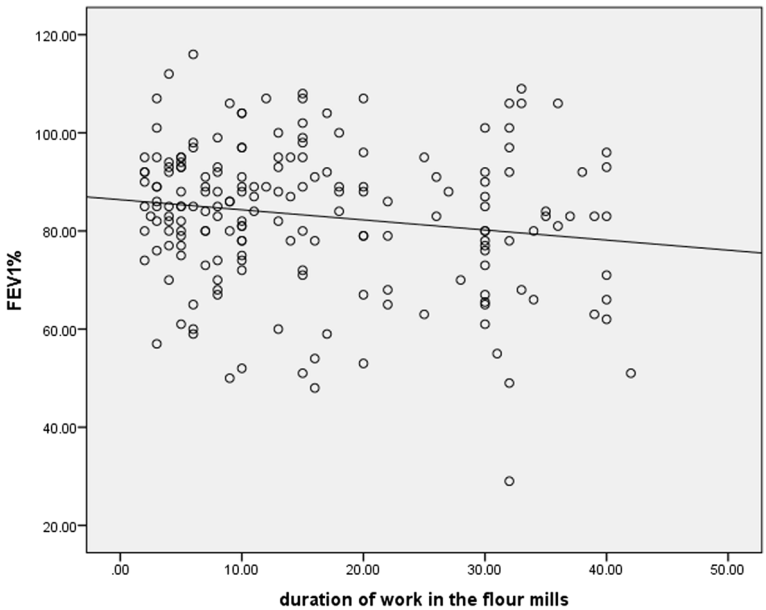

Fig. 2 Correlation between mean FEV1%and duration of work of flour mills workers, Assiut

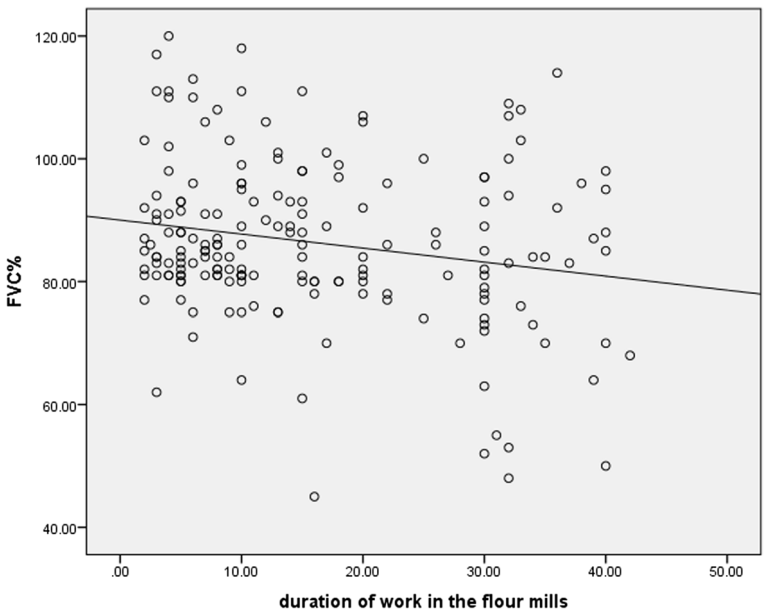

Fig. 3 Correlation between mean FVC% and duration of work of flour mills workers, Assiut

education and no education had more respiratory symptoms than workers who got secondary education or higher levels. Low educated workers might be assigned in risky jobs or they might not understand the risks of dust exposure, so, they might not take necessary precaution measures, as education is likely advances employees' knowledge about workplace health risks and mechanisms to prevent and control workplace hazards [18, 24].

Our study agreed with the studies of Mohammadien et al. (2013), Said et al. (2017) and Ulanga et al. (2021), as statistically significant associations were detected between the presence of respiratory symptoms and smoking [6, 23, 30]. Also, our findings were matched with Mohammadien et al. study (2013), which reported statistically significant associations between the occurrence of respiratory symptoms and the level of exposure to flour dust [6].

Table 6 Predictors of respiratory symptoms and Bronchial Asthma among flour mills workers, Assiut

Respiratory symptoms predictors	COR (95% C.I.)	*p*-value	AOR (95% C.I.)	*p*-value
Age (Ref = 40 years and older)	1.465 (0.831 -2.583)	0.186	1.629 (0.845 -3.143)	0.145
Sex (Ref = Female)	3.682 (0.785 -17.261)	0.098	0.802 (0.136 -4.714)	0.807
Education (Ref = university education)			-------	
Illiterate, read and write	5.574 (1.903 -16.324)	0.002*	3.294 (0.997 -10.885)	0.051
Primary and preparatory	4.909 (1.586 -15.199)	0.006*	2.231 (0.631 -7.880)	0.213
Secondary and technical	3.510 (1.199 -10.278)	0.022*	2.087 (0.655 -6.652)	0.214
Residence (Ref = urban)	1.950 (1.105 -3.440)	0.021*	1.505 (0.806 -2.812)	0.200
Smoking (Ref = nonsmokers)	3.967 (2.042 -7.707)	0.0001*	3.536 (1.675 -7.464)	0.001*
Duration of work (Ref = less than 10 years)	1.137 (0.638 -2.029)	0.663	-------	
Exposure level (Ref = low exposure)	1.821 (1.821 -3.218)	0.039*	1.167 (0.589 -2.310)	0.658
Bronchial Asthma predictors				
Age (Ref = 40 years and older)	8.700 (3.252 -23.273)	0.0001*	9.145 (3.220 -25.969)	0.0001*
Sex (Ref = Female)	3.007 (0.377 -23.972)	0.299	0.683 (0.061 -7.645)	0.757
Education (Ref = university education)				
Illiterate, read and write	2.045 (0.527 -7.928)	0.301	1.114 (0.229 -5.427)	0.893
Primary and preparatory	4.333 (1.116 -16.830)	0.034*	1.247 (0.250 -6.232)	0.788
Secondary and technical	2.843 (0.759 -10.651)	0.121	1.149 (0.254 -5.198)	0.857
Residence (Ref = urban)	1.686 (0.846 -3.361)	0.138	-------	
Smoking (Ref = nonsmokers)	3.299 (1.381 -7.880)	0.007*	4.101 (1.491 -11.280)	0.006*
Duration of work (Ref = less than 10 years)	3.083 (1.532 -6.202)	0.002*	-------	
Exposure level (Ref = low exposure)	2.374 (1.151 -4.894)	0.019*	1.488 (0.620 -3.573)	0.374

Significant relationships between the presence of respiratory problems and rural residency was detected in the present study and this might be attributed to several factors, including rural environmental exposures, low socioeconomic status, smoking patterns and limited access to health care.

A higher percentage of respiratory problems was found among the studied workers with longer duration of employment than those with shorter duration but with no significant relation. This finding is consistent with the results of Said et al. (2017) and Alemseged et al. (2020) studies [17, 23].

However, the longer work duration was found to had significant relation with the occurrence of respiratory symptoms in other studies held in flour mills in Tanzania, Nigeria, Ethiopia and Egypt [6, 18, 29, 30].

The possible suggestion is as the duration of work increases, exposure to predisposing factors will increase, which increases the accumulation of inhalable hazards in the respiratory systems, also, the work-related respiratory conditions can have long latency periods and are more noticeable after long employment stay [24].

Regarding the predictors of respiratory symptoms, we agreed with Mekonnen et al. study (2021), as lower levels of education and working in areas with high exposure levels of flour dust were significantly associated with respiratory symptoms [24]. Also, we were in agreement with Ulanga et al. study (2021), about smoking as a predictor for respiratory symptoms [30].

The mean FEV1/FVC in the current study was higher than mentioned in Nigerian, Indian, Ethiopian and Iranian studies [18, 19, 31, 32]. However better pulmonary function parameters were found in the following studies; In Said et al., Abdulrahman and Murad (2020) and Demeke and Haile (2018) studies [23, 25, 27].

The differences in the means of the pulmonary function parameters might be due to differences in environmental conditions, workload, ventilation systems and equipment used in the process [32].

Our result was different from Mohammadien et al. study (2013), which found statistically significant

differences in lung function between smokers and non-smokers [6].

A statistically significant relation was found in the current study between PFT parameters and those who worked in the flour mills for 10 or more years. We were in consistent with two Egyptian studies carried out by Said et al. (2017) and Mohammadien et al. (2013) and an Indian study [6, 23, 33]. But, in Melo et al. study (2016) no statistical significant relation was detected [4].

The present study detected higher occurrence of abnormal PFT among workers exposed to high levels of flour dust compared to those exposed to lower levels but without significant difference. In the contrast, Mohammadien et al. (2013) and Zamani et al. (2021) found significant decline in PFT parameters [6, 20].

Statistically significant negative correlations were found in this study between FVC%, FEV1% and the duration of work which agreed with two studies on flour mills workers held by Lohani et al. (2020) and Demeke and Haile (2018) [27, 34].

The reduction in FVC%, FEV1% and FEV1/FVC among the flour mills workers might be due to the increased dust accumulation in the respiratory system associated with prolonged work duration. In addition to the poor ventilation, improper use of PPE and unawareness of health hazards in the workplace which increase the exposure of the workers [6].

In the current study, lung function abnormalities represented 36.4%. This was higher than their prevalence in Said et al. (2017), Melo et al. (2016) and Abdulrahman and Murad (2022) studies, where abnormal pulmonary functions were found in 16.6%, 25% and 31.7%, respectively [4, 23, 25].

Obstructive disorders in lung functions were found in 9.2% of the study workers and this was nearly similar to the studies of Said et al. (2017) (10%) and Demeke and Haile (2018) (11%) [23, 27]. However, higher obstruction disorders were detected in Melo et al. (2016) (15%), Abdulrahman and Murad (2022) (19%) and Ulanga et al. (2021) (26%) studies [4, 25, 30].

Restrictive disorders were found in 9.8% in our study which agreed with that in Melo et al. study (2016) (10%) and higher than that of Said et al. study (2017), (3.3%) [4, 23]. On other side, higher percentages were found in Abdulrahman and Murad (2022) (12.7%), Ulanga et al. (2021) (23%) and Demeke and Haile (2018) (27.7%) studies [25, 27, 30].

Restrictive disorders might be found in this study, because older workers worked in the traditional stone milling which based on grinding the wheat between two large stone wheels which was the used method in the past until 2005, this can explain restrictive disorders as they used to work by this method which may be associated with the occurrence of interstitial fibrosis (silicosis).

Mixed abnormalities were found in 8.2% of the flour mills workers in our study and 9.2% had SAD, while in Said et al. study (2017) 3.3% had mixed disorders and 13.3% had SAD [23].

Asthmatic workers in our study constituted one fifth (20.7%) of the flour mills workers. Our prevalence of asthma was near to the prevalence of asthma in a previous study carried out in flour mills in Helwan (25%) [5]. However, higher percentage were found in a previous Indian study as 68.2% of the flour mills workers were found to have asthma [35].

Lower prevalence was found in Zamani et al. study (2021) (13.8%) and in Ade et al. study (2020) (12.6%) [20, 36].

Cases of COPD represented 7.4% of the workers in our study, while in Mohammadien et al. study (2013), it was 42.5% [6]. According to the Global Initiative for Chronic Obstructive Lung Disease (GOLD), cigarettes smoking is associated with higher prevalence and mortality from COPD, also, occupational exposure to organic dust, chemical agents used and dust released in industries are considered under-appreciated risk factors for COPD [11].

Conclusions

Respiratory problems especially asthma were common among flour mills workers. There were high prevalence rates of respiratory symptoms among flour mill workers especially among those with low educational levels, rural residency. Also, higher occurrences were found among smokers and those with high flour level exposure. The pulmonary functions of the flour mills workers were affected by their work with the flour dust. Abnormal PFTs were found more with increasing duration of exposure.

Recommendations

More attention must be directed to the health and safety of the flour mills workers in the form of pre-placement, periodic medical examination and application of regular health education sessions. Personal protective devices must be available to all the workers, especially the masks, in addition to continuous engineering improvements, through enclosure of dusty process and proper ventilation of the workplace.

Abbreviations

COPD	Chronic obstructive pulmonary diseases
FEF 25%-75%	Forced expiratory flow at 25 and 75% of the pulmonary volume
FEV1%	Forced expiratory volume in the first second
FEV1/FVC	Forced expiratory volume in first second to the forced vital capacity
FVC%	Forced vital capacity

GATS	Global Adult Tobacco Survey
GOLD	Global Initiative for Chronic Obstructive Lung Disease
ILD	Interstitial lung diseases
MRCQ	Medical Research Council Questionnaire
PFT	Pulmonary function tests
PPE	Personal protective equipment
SAD	Small airway disease
SPSS	Statistical Package for the Social Science

Acknowledgements
The authors thank all the workers in the flour mills of Assiut who participated in this study.

Authors' contributions
Hussein H. Zayet, and Maha M. Elkholy: manuscript editing and final revision. Shimaa A. Elghazally; concept, design, literature search, manuscript preparation, editing and review. Ayah Alkarn; data collection, data analysis, manuscript writing and editing. The authors read and approved the final manuscript.

Funding
No funding was required.

Availability of data and materials
The data analyzed during the current study are available from the corresponding author on request.

Declarations

Ethics approval and consent to participate
Ethical approval was carried out via the Ethics Review Committee of Assiut Faculty of Medicine, with reference no.17200259. Aim of the study was explained to each participant and verbal Consents were obtained from all participated workers before filling the questionnaire. Confidentiality was assured by removing names of the subjects from data entry file.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

Received: 4 June 2023 Accepted: 24 June 2023
Published online: 11 July 2023

References

1. Fatheya Salem; Mahmoud M. Fawaz; Ehab M.Essa. (2020). Evaluating the Allocative Performance and Efficiency of The Middle and West Delta Flour Mills Company. J Sustain Agricult Sci, 46(1):37–45. https://doi.org/10.21608/JSAS.2019.17543.1172
2. Patel, N. S., Patel, D. K., & Sarvaiya, J. (2019). Effect of flour dust on forced vital capacity in flour mill workers. Natl J Physiol Pharm Pharmacol. 9(5). https://doi.org/10.5455/njppp.2019.9.0309422032019
3. Ahire KD, Kulkarni AR, Desai AA, Chavan KK (2017) Effects of Flour Dust on the Health of Flour Mill Workers in Kolhapur City. Int J Latest Res Eng Technol 03(05):67–71
4. Melo CA, Konda SG, Shah T, Padwale Y (2016) Lung function abnormalities in flour mill workers using spirometry. International Journal of Medical Science and Public Health 5(04):743–748. https://doi.org/10.5455/ijmsph.2016.25112015234
5. Saied M, Gewily E, El Husseini M., Beshir S, Elserougy S, Hafez SF, El Hamshary MS (2018) Diagnosis of Occupational Asthma in Flour Mills at South Cairo Introduction. Egypt J Commun Med. 36(1):95–103
6. Mohammadien HA, Hussein MT, El-Sokkary RT (2013) Effects of exposure to flour dust on respiratory symptoms and pulmonary function of mill workers. Egypt J Chest Dis Tubercul 62(4):745–753. https://doi.org/10.1016/j.ejcdt.2013.09.007
7. Cotes J, Chinn D (2007) MRC questionnaire (MRCQ) on respiratory symptoms. Occup Med Oxford 57:388. https://doi.org/10.1093/occmed/kqm051
8. Graham BL, Steenbruggen I, Barjaktarevic IZ, Cooper BG, Hall GL, Hallstrand TS, Kaminsky DA, McCarthy K, McCormack MC, Miller MR, Oropez CE, Rosenfeld M, Stanojevic S, Swanney MP, Thompson BR (2019) Standardization of spirometry 2019 update an official American Thoracic Society and European Respiratory Society technical statement. Am J Respir Crit Care Med 200(8):E70–E88. https://doi.org/10.1164/rccm.201908-1590ST
9. Hirai T (2021) Pulmonary function tests. In: Medical Radiology. StatPearls Publishing, pp 11–20. https://doi.org/10.1007/978-3-030-43539-4_2
10. GINA. (2022). Global Initiative for Asthma. 2022 GINA Main Report.
11. GOLD (2015) Global initiative for Chronic Obstructive Pulmonary Disease (GOLD). ATS 1(3):261–266
12. Han MLK, Agusti A, Celli BR, Criner GJ, Halpin DMG, Roche N, Papi A, Stockley RA, Wedzicha J, Vogelmeier CF (2021) From GOLD 0 to pre-COPD. Am J Respir Crit Care Med 203(4):414–423. https://doi.org/10.1164/rccm.202008-3328PP
13. ALA. (2023). American Lung Association. Interstitial Lung Disease (ILD). https://www.lung.org/lung-health-diseases/lung-disease-lookup/interstitial-lung-disease
14. Higham A, Quinn AM, Cançado JED, Singh D (2019) The pathology of small airways disease in COPD: historical aspects and future directions. Respir Res 20(49):1–11
15. Cottini, M., Licini, A., Lombardi, C., & Berti, A. (2021). Prevalence and features of IOS-defined small airway disease across asthma severities. Respiratory Medicine, 176(December 2019), 106243. https://doi.org/10.1016/j.rmed.2020.106243
16. GATS (2010) Global Adult Tobacco Survey: Egypt Country Report 2009
17. Alemseged EA, Takele AK, Zele Y, Abaya SW, Kiros KG, Mehari M, Bezabh YA, Atsbaha AH, Awoke TY, Goyteom MH (2020) Assessment of chronic respiratory health symptoms and associated factors among flour mill factory workers in addis ababa, ethiopia, 2019: a cross-sectional study. J Asthma Allergy 13:483–492. https://doi.org/10.2147/JAA.S273820
18. Lagiso ZA, Mekonnen WT, Abaya SW, Takele AK, Workneh HM (2020) Chronic respiratory symptoms, lung function and associated factors among flour mill factory workers in Hawassa city, southern Ethiopia: "comparative cross-sectional study." BMC Public Health 20(1):1–9. https://doi.org/10.1186/s12889-020-08950-9
19. Uzoma I, Ugwu C, Ozoamusi E, Okhuevbie D, Okenwa C (2021) Evaluation of human allergen-specific immunoglobulin G, total immunoglobulin E, hematological parameters, and lung function in mill workers exposed to grain dust in South-East Nigeria. Egypt J Chest Dis Tubercul 70(1):128–134. https://doi.org/10.4103/ejcdt.ejcdt
20. Zamani A, Khanjani N, Bagheri Hosseinabadi M, Ranjbar Homghavandi M, Miri R (2021) The effect of chronic exposure to flour dust on pulmonary functions. Int J Occup Saf Ergon 27(2):497–503. https://doi.org/10.1080/10803548.2019.1582853
21. El-Sherbiny NA, Elsary AY (2022) Smoking and nicotine dependence in relation to depression, anxiety, and stress in Egyptian adults: A cross-sectional study. J Fam Community Med 29(1):8–16. https://doi.org/10.4103/jfcm.jfcm_290_21
22. Shaban M, Abdou NM, Abdel Rehim AI (2019) Occupational asthma severity among flour mill workers and adherence to preventive guidelines. Indian J Public Health Res Dev 10(10):1245–1250. https://doi.org/10.5958/0976-5506.2019.03002.X
23. Said AM, AbdelFattah EB, Almawardi AAM (2017) Effects on respiratory system due to exposure to wheat flour. Egypt J Chest Dis Tubercul. 66(3):537–548. https://doi.org/10.1016/j.ejcdt.2016.11.006
24. Mekonnen TH, Dessie A, Tesfaye AH (2021) Respiratory symptoms related to flour dust exposure are significantly high among small and medium scale flour mill workers in Ethiopia: a comparative cross-sectional survey. Environ Health Prev Med 26(1):1–10. https://doi.org/10.1186/s12199-021-01019-y
25. Abdulrahman, M., & Murad, I. (2022). Pulmonary Functions and Respiratory Symptoms of Wheat Flour Mill Workers in The Duhok District. J Life Bio Sci Res. 3(02):65–70. https://doi.org/10.38094/jlbsr30276
26. Seema P, Kumar S, Deepthi R (2020) Screening of flour mill workers for respiratory morbidities: a cross-sectional study in rural Bangalore. Int J Comm Med Public Health 7(6):2216

27. Demeke D, Haile DW (2018) Assessment of respiratory symptoms and pulmonary function status among workers of flour mills in Addis Ababa, Ethiopia : comparative cross-sectional study. Pulmonary Med 2018:7. https://doi.org/10.1155/2018/9521297
28. Gurli HP, Diwate A, Das A, Mahadik A (2019) Prevalence of impaired lung function and quality of life in flour mill workers in ahmednagar city: an observational study: impaired lung function and quality of life in flour mill workers. Vims J Phys Therapy 1(2):91–93
29. Tosho A, saliu, Adeshina, abdus salaml smael, Tope, A. james, & Salawu, M. (2015) Prevalence of Respiratory Symptoms and Lung Function of Flour Mill Workers in Ilorin, North Central Nigeria. Int J Res Rev 355:364
30. Ulanga, A. J., Mamuya, S. H., & Mlimbila, J. (2021). Respiratory symptoms , lung function and dust exposure among workers in grain milling industries in Dar Es Salaam , Tanzania. MedCrave Online Journal of Public Health. 10(1), 23–29. https://doi.org/10.15406/mojph.2021.10.00354
31. Patel N, Patel D, Sarvaiya J (2019) Effect of flour dust on forced vital capacity in flour mill workers. Natl J Physiol Pharm Pharmacol 9:1. https://doi.org/10.5455/njppp.2019.9.0309422032019
32. Bagheri Hosseinabadi M, Krozhdeh J, Khanjani N, Zamani A, Ranjbar M, Mohammadian M (2013) Relationship between lung function and flour dust in flour factory workers. J Commun Health Res 2(2):138–146
33. Kaur SKD, H. (2011) Study of effect of flour dust and rice husk dust on pulmonary functions. Indian J Fundament Appl Life Sci 1(4):100–106
34. Lohani, D., Vinay, D., & Shilla, K. (2020). Evaluation of pulmonary functions of flour mill workers using Medspiror. The Pharma Innovation, 9(4S), 33–35. https://doi.org/10.22271/tpi.2020.v9.i4sa.4697
35. Lohani D, Vinay D, Shilla K (2020) Occupational and respiratory abnormalities among grain mill workers. Pantnagar J Res 18(1):29–34
36. Ade S, Adjobimey M, Agodokpessi G, Kouassi MS, Gounongbe FA, Cisse I, Hounkpatin SHR (2020) Asthma symptoms in bakeries at Parakou. Benin Pulmon Med 2020:6

Publisher's Note