International Journal of Sciences: Basic and Applied Research (IJSBAR)

ISSN 2307-4531
(Print & Online)

http://gssrr.org/index.php?journal=JournalOfBasicAndApplied

Assessment of Respiratory Symptoms and Lung Function among Workers Exposed to Cotton Dust at Arba Minch Textile Factory, Arba Minch, Southern Ethiopia, 2017

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Abstract

Textile industry is considered as a number one priority sector by the Ethiopian government‘s industrial development strategy. In many of the textile industries, workers are largely exposed to cotton dust, which can leave workers with respiratory disorders. So, studies on cotton dust effects have been highly useful in understanding the risks of working in textile mills and lung function impairment in the textile factory workers. This is important to minimize the occurrence of highly rising occupational respiratory problems in peoples working in textile mills. The aim of this study was to assess the prevalence of respiratory symptoms and lung function test impairment among workers exposed to cotton dust at Arba Minch textile factory, Southern Ethiopia.

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A comparative cross sectional study was done, 51 workers exposed to cotton dust in the factory and 51age and sex matched controls were investigated. Their lung function was measured with a pocket size digital Spirometer (Spiro-Pro JAEGER). A standardized questionnaire based on British Medical Research Council Questionnaire was used to assess respiratory system symptoms and use of personal protective devices. The study revealed that the percentage prevalence of cough, phlegm, wheeze, breathlessness and chest tightness was 64.7%, 55%, 39%, 41% and 43% for exposed respondents, respectively and 25.5%, 14%, 8%, 6% and 0% for control subjects, respectively. Lung function indices such as, forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), peak expiratory flow rate (PEFR) & Forced mid Expiratory Flow between 25% and 75% of FVC ($FEF_{25-75\%}$) were higher in control respondents than in exposed respondents and the mean difference was found to be statistically significant ($p<0.05$) and the mean difference of predicted percentage values of FVC and FEV_1 between the groups were found statistically significant ($P<0.05$). FEV1 to FVC ratio x 100 ($FEV_{1\%}$) was higher in control group than in exposed group, but the mean difference was insignificant ($p>0.05$). Respiratory symptoms and lung function impairments were high among exposed workers in the factory. Therefore, the factory management should provide Personal Protective Devices (PPDs) to exposed employees and should train them how to use it properly.

Key words: Cotton dust; Lung functions; Respiratory symptoms; Textile.

1. Introduction

Textile industry is the first manufacturing industry to have a worldwide dimension. This sector is the most geographically widespreaded of all industries across the developed and developing countries including Africa [1]. Ethiopia's textile industry has a relatively longer history of existence compared to the rest of the manufacturing industries. Currently, there are around 130 factories including ginning, spinning, weaving and knitting as well as woven and knitted garment producing companies. The sector employed more than 48,000 workers [2]. In spite of their importance, industries associated with the processing of cotton, specifically yarn, thread and fabric mills are most associated with worker exposure to cotton dust [3,4]. Studies reported that exposure to cotton dust provokes respiratory effects [5, 6]. The effects of exposure to cotton dust are usually evaluated as changes in respiratory symptoms over shift or terms of decline over the years [7]. Currently the world community has been facing increasing risks of respiratory diseases due to smoke, dust exposure, indoor and outdoor air pollution, occupational hazards, and infections in different industrial sectors [8]. Textile industry is one of the largest manufacturing industry, in which workers are exposed to large amount of cotton dust with deleterious effects on their lung function [9,10]. Many investigators from developed and developing countries reported that, exposure to cotton dust results in excessive chronic annual loss of forced expiratory volume in 1second and in higher proportions of persistent respiratory symptoms of diseases. Studies reported longitudinal changes in pulmonary function test as annual decline in lung capacity [10]. Industrial workers in developed countries are very careful about occupational health, but this issue is quite neglected in developing countries [11]. A lot of studies have been done concerning textile workers mostly in Asia [6] Europe [12] but only scantly data is available for Africa, particularly Ethiopia. In Ethiopia only a few cross sectional studies were conducted to explore lung function among workers in a textile mills. As it stands now, further studies have been highly useful in understanding lung function impairment in the textile

factory workers. This study is intended to evaluate the effect of exposure to cotton dust on lung in a textile factory worker. This is useful to minimize the occurrence of highly rising occupational respiratory problems in peoples working in textile mills.

2. Materials and Methods

2.1. Study area

This study was conducted in textile factory of Arba Minch, which is found in Arba Minch town. Arba Minch town is located in southern part Ethiopia at a distance of 454 km from Addis Ababa (the capital of Ethiopia).

Arba Minch textile mill was opened with 193 million Ethiopian birr on May 6, 1992 with the aim of satisfying the enormous need for polyster/cotton blended fabric in the country. The factory supplies high quality yarn and woven fabrics made from cotton and polyster/cotton mixed fibers to the local and international markets.

2.2. Study subjects

Exposed group: Included 51 workers selected from the textile factory within age range 18 to 60 years.

Non-exposed group: Included 51 volunteers from areas free of cotton dust within similar age range.

2.3. Study equipment

The following equipment was used in the study:

- Spirometer -a pocket size digital Spirometer (Spiro-ProJAEGER) was used to measure lung function indices.
- Digital balance and measuring tape was used to measure weight and height of the subjects, respectively.
- A standard questionnaire based on British Medical Research Council (BMRC) questionnaire format was used to assess personal information, occupational history, respiratory symptoms, past illness and use of PPDs.

2.4. Inclusion and exclusion criteria

Exposed subjects

Inclusion Criteria:- workers who had direct involvement in the production unit or cotton processing unit and had exposure to cotton dusts for minimum of one year were included.

Exclusion Criteria:- Workers with abnormalities of vertebral column and thoracic cage, diagnosed cases of pulmonary tuberculosis, bronchial asthma, chronic bronchitis, emphysema and other respiratory diseases were excluded. Those who had past history of abdominal or chest surgery were not be allowed to participate in the study. Workers aged over 60 were excluded as many studies have reported the effect of aging on pulmonary

function. Smokers, pregnant women, individuals with unstable cardiovascular status and workers who stayed at work for less than one year were not included.

Non-exposed subjects: Age and sex matched individuals with exposed subjects from areas free of cotton dust.

2.5. Study design

A comparative cross sectional study design was applied to conduct the present study.

2.6. Sampling method and sample size determination

Simple random sampling method was used to select study participants from the Arba Minch textile factor. Healthy and volunteered subjects who had no direct involvement in processing areas or working in cotton dust free sectors in the factory and in the same town who matched with the age range and sex to the exposed subjects were taken as a control group for better comparison. Sample size was calculated by double proportion population formula, by taking the likely percentage value for exposed group 43% and the likely percentage value for non-exposed 14% from study done on lung function in textile mill workers [13]. So, the total sample size was 102 including 10% non-response rate; 51 for each group.

2.7. Data collection methods and procedures

By using a standardized questionnaire based on British Medical Research Council (BMRC) Questionnaire 1986 version, the study participants were interviewed by the trained interviewers. Before the interview, questionnaire was translated into Amharic language and then translated back into English to verify the accuracy and for statistical data analysis. Weight and height of both the exposed and control subjects were measured with light clothing to the nearest one kilogram and without shoes to the nearest one centimeter, respectively.

Spirometry assessment was done in both control and exposed subjects. Using digital spirometer FVC, FEV_1, $FEV_{1\%}$, $FEF_{25-75\%}$ and PEFR were measured. Three readings were taken by giving three to five minutes rest in between the trials and from those readings the best or the highest was selected and recorded.

2.8. Statistical analysis and interpretation of the data

First, the collected data was checked for completeness and consistency by the investigator and then, the following statistical activities were carried out. Microsoft Excel 2007 was used to arrange and organize the data and Statistical Package for Social Science (SPSS) version 21 was utilized to analyze the data. Descriptive statistics was utilized to summarize service year, job description, use of PPDs and anthropometric measurements of subjects. Chi-square test with Yates continuity correction and Odds ratio were used to analyze and estimate the prevalence of respiratory system symptoms such as cough, phlegm, productive cough, breathlessness, chest tightness and wheezing in both groups. Independent sample t-test was applied to compare the mean respiratory values of exposed and non exposed group in each subgroup (age ranges). One way analysis of variance (ANOVA) was served to check the presence of significant differences in lung

functions of exposed subjects across different service year categories. Pearson's correlation coefficient was used to quantify the degree of linear relationship between respiratory system measurements and duration of exposure. The data was expressed in-terms of Mean± SD (standard deviation), number and percentage. Statistical significance was tested at 5% and expressed in-terms of p- value with $p<0.05$ which was considered to be statistically significant.

2.9. Ethical consideration

Before getting in to the investigation work, ethical clearance and permission was obtained from Physiology Department Research Committee (DRC), Addis Ababa University (AAU), Arba Minch textile factory manager and full voluntariness of the study participants to engage in this work was secured.

3. Result

3.1. Socio demographic characteristics of the study participants

The data was collected from all 102 study participants with 100% response rate. Regarding the job description, from 51 subjects in exposed group 63% (n=32) of the respondents were from spinning department and 37% (n=19) of respondents were from weaving department. Out of 51 subjects in non-exposed group 63% (n=32), 19% (n=10), 8% (n=4), and 10% (n=5) were administration workers in the factory, summer students, instructors and administration staffs in Arba Minch University, respectively. Each group had 53% (n=27) male and 47% (n=24) female participants.

Out of 51 exposed workers, 26(51%) of the study participants had a service year above 20 years and 13(25%) had a service period of 1 to 5 year. The minimum and maximum service year of the exposed respondents was 2 years and 29 years, respectively (Table 1). All participants in both groups were fulltime workers (i.e, employees were working eight hours per day).

Table 1: Service Years of Study Participants at Arba Minch Textile Factory (n=51).

No.	Year of employment	No. of workers	Percentage (%)
1	1-5	13	25
2	6-10	3	6
3	11-15	3	6
4	16-20	6	12
5	>20	26	51

The result of the present study revealed that the mean age of exposed and non-exposed respondents was 38.45 years with a range of 21 to 50 years and 36.20 years with a range of 21 to 53 years respectively. Subjects were grouped by their ages using an interval of five years, majority of respondents in both group were within the range of 41 to 45 years of age (Figure 1). The result of the study showed that the mean height and weight of the

exposed respondents were 157.65 cm (range: 141 to 175cm) and 63.45kg with a range of 40 to 93kg; the mean height and weight of the control respondents were 164.06cm with a range of 152 to 177cm and 63.49kg with a range of 42 to 84 kg, respectively. The result of the study revealed that the anthropometric measurements of exposed and non exposed study participants were found to be near similar. The mean and standard deviations of anthropometric measurements were summarized in (Table 2).

Table 2: Mean ± Standard Deviations (SD) of the Anthropometric Measurements for Exposed and Non-Exposed Respondents in Arba Minch Town 2015/16 (n=51 for Each Group)

Group	Age(years) (Mean± SD)	Height(cm) (Mean± SD)	Weight(kg) (Mean± SD)
Exposed	38.45±8.87	157.65±8.46	63.45±12.73
Control	36.20±9.98	164.06±7.00	63.49±9.89

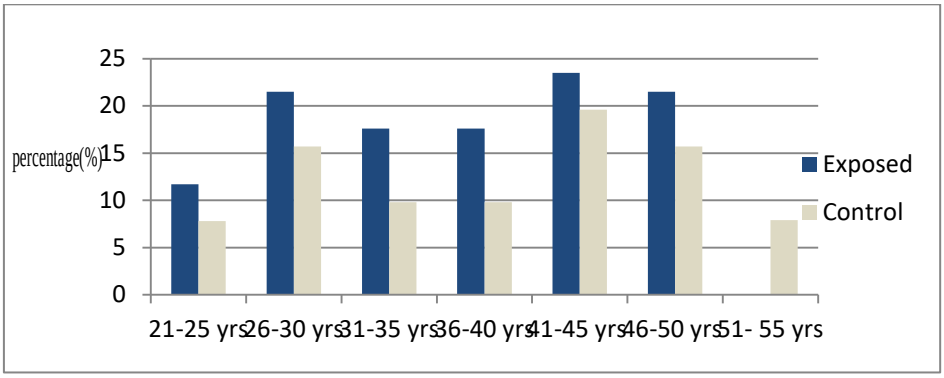

Figure 1: Age Distribution of Exposed and Control Group

3.2. Workers awareness and practice of wearing personal protective devices (PPDs)

All 51 of the respondents agreed with the idea that all textile factory workers should wear personal protective devices. The workers complained that, there is no supply of any personal protective devices in the factory. In addition, all of the workers replied that they did not get awareness about proper utilization of PPDs and its importance from the factory administration. All of workers were aware of the impact of cotton dust on their health. Out of 51 subjects 78% (n=40), 9% (n=4) and 68.6% (n=35) were responded that exposure to cotton dust causes problem to lung and airways, lung and heart, and lung, airways and eyes, respectively.

3.3. Prevalence of respiratory symptoms

This study revealed that the percentage prevalence of cough, phlegm, wheeze, breathlessness and chest tightness was 64.7%, 55%, 39%, 41% and 43% for exposed respondents, respectively and 25.5%, 14%, 8%, 6% and 0% for control subjects, respectively. The result showed higher percentage prevalence of respiratory symptoms

among exposed respondents compared to the control respondents (Table 3). The odds of cough in workers exposed to cotton dust was 2.23 times (OR=2.23, 95% CI: 1.46, 3.4) more than it was in control and the statistical association was found to be significant.

Table 3: Respiratory Symptoms of Study Participants Including OR and 95% CI

Respiratory symptoms	Group		OR	95% CI	p- value
	Exposed	Control			
Cough	33(64.7%)	13(25.5%)	2.23	1.46- 3.4	0.000*
Phlegm	28(55%)	7(14%)	2.33	1.61- 3.37	0.000*
Wheezing	20(39%)	4(8%)	2.10	1.51- 2.91	0.000*
Breathlessness	21(41%)	3(6%)	2.27	1.67- 3.13	0.000*
Chest tightness	22(43%)	0%	2.76	2.06- 3.69	0.000*

*p<0.05- significant

3.4. Pulmonary Function Test

An independent sample t-test was served to compare lung function indices (FVC, FEV_1, $FEV_{1\%}$, $FEF_{25-75\%}$ and PEFR) of exposed and control subjects. Accordingly, FVC, FEV_1, PEFR& $_{FEF25-75\%}$ were higher in control respondents than in exposed respondents and the mean difference was found to be statistically significant ($p< 0.05$) as shown in (Table 4).

Table 4: Mean and Standard Deviation of Lung Function Measurements for Exposed and Control Group with Their Corresponding t-value and P-value (Independent Sample t-test)

Lung function test indices	Group	No	Mean	SD	t-value	P-value
FVC(L)	Exposed	51	2.8131	0.85768	-5.018	0.000 *
	Control	51	3.6973	0.92070		
FEV1(L/S)	Exposed	51	2.7335	0.83284	-4.965	0.000 *
	Control	51	3.5986	0.92449		
FEV1%	Exposed	51	96.6275	8.10175	-0.308	0.795
	Control	51	97.0980	7.30001		
FEF25-75%(L/S)	Exposed	51	4.4322	1.57420	-2.675	0.009 *
	Control	51	5.2086	1.34862		
PEFR(L/S)	Exposed	51	5.9892	2.04271	-2.377	0.019*
	Control	51	6.9016	1.82847		

*p<0.05- significant

Similarly, the percentage of the predicted values of lung function indices were lower in exposed group than in control. And the mean difference of predicted percentage of FVC and FEV_1 between the groups were found statistically significant ($P<0.05$) as shown in (Table 5).

Table 5: Mean and Standard Deviation of Lung Functions (% predicted) of Study Participants with their Corresponding t-value and P-value (Independent Sample t-test)

Lung function test indices	Group	No	Mean	SD	t-value	P-value
FVC(% predicted value)	Exposed	51	76.06	20.796	-2.952	0.004*
	Control	51	89.78	25.888		
FEV1((% predicted value)	Exposed	51	87.12	22.079	-3.612	0.000*
	Control	51	105.37	28.547		
FEV1%(% predicted value)	Exposed	51	118.98	10.891	0.134	0.893
	Control	51	118.71	9.727		
FEF25-75%(% predicted value)	Exposed	51	136.709	46.3889	-1.373	0.173
	Control	51	148.7451	42.0665		
PEFR(% predicted value)	Exposed	51	77.5098	23.7835	-1.908	0.059
	Control	51	86.2157	22.2758		

*p<0.05- significant

Independent sample t -test was used to compare the lung functions of exposed and control group across different age ranges. FVC and FEV_1 values across age ranges of 31-35, 41-45 and 46-50 years of the study participants, controls had greater lung function and the mean difference was statistically significant (P<0.05). Regarding lung function value of FEV_1 for age category (26-30 years), controls had greater lung function than exposed subjects and the difference was statistically significant. The lung function measurement value of $FEV_{1\%}$ across the age category (21-25years) was lower in exposed respondents, and the difference was statistically significant. PEFR and $FEF_{25-75\%}$ values across 46-50 years age category were lower in exposed group and the differences were also statistically significant. The study revealed that, from 51 exposed respondents, 2% (n=1)) had $FEV_{1\%}$ value less than 70%, but all the non-exposed respondents had $FEV_{1\%}$ value greater than 70%. Out of total exposed respondents 39.2% (n=20) had FVC% predicted value less than 80% and 5.8% (n=3) respondents out of 51 non- exposed had FVC % predicted value less than 80% (see Table 6).

Table 6: Number of Exposed and Non-Exposed Subjects who have FEV1 %< 70, FVC and FEV1values less than 80% of Predicted

Group	FVC< 80% Predicted	FEV1<80% Predicted	FVC & FEV1 <80% Predicted	FEV1%< 70% Predicted
Exposed	20(39.2%)	11(21.5%)	8(15.7%)	1(2%)
Control	3(5.8%)	2(3.9%)	0%	0%

Pearson correlation was used to see the relationship between service year and lung function measurements. There was a negative correlation between lung functions and duration of exposure, but it was not statistically significant (P>0.05) (Table 7).

Table 7: Pearson Product-Moment Correlation Coefficient for Service Year and Lung Function

		FVC	FEV1	FEV1%	FEF25-75%	PEFR
Service year	Pearson correlation	-0.242	-0.178	-0.020	-0.059	-0.065
	Sig.(2-tailed)	0.087	0.212	0.287	0.682	0.651
	N	51	51	51	51	51

One way analysis of variance was applied to check the presence of significant difference in means of lung functions of exposed group among different service years, but the mean differences were not found statistically significant ($p>0.05$) as shown in (Table 8).

Table 8: One Way ANOVA Tables of Lung Function Measurements of Exposed Subjects across Service Year Category

ANOVA

		Sum of Squares	Df	Mean Square	F	Sig.
FVC	Between Groups	6.597	4	1.649	2.513	.054
	Within Groups	30.184	46	.656		
	Total	36.781	50			
FEV1	Between Groups	3.460	4	.865	1.275	.294
	Within Groups	31.221	46	.679		
	Total	34.681	50			
FEV1%	Between Groups	282.345	4	70.586	1.082	.376
	Within Groups	2999.577	46	65.208		
	Total	3281.922	50			
PEFR	Between Groups	19.197	4	4.799	1.165	.338
	Within Groups	189.435	46	4.118		
	Total	208.633	50			
FEF25-75%	Between Groups	12.419	4	3.105	1.281	.291
	Within Groups	111.487	46	2.424		
	Total	123.906	50			

4. Discussion

The main purpose of this study was to assess respiratory symptoms and lung function of textile mill workers.

Different techniques and parameters were used to assess the lung function of workers in Arba Minch textile factory. All the exposed subjects agreed with the idea that, factory workers should wear the personal protective devices at work time. Even though they knew the fact that the workers should wear PPDs at working time, all of them agreed that they were not informed about proper usage and purpose of PPDs from the factory management (employers)**.** The result of this study revealed nil supply of the PPDs in the factory.

The percentage prevalence of respiratory symptoms including cough, phlegm, wheeze, breathlessness and chest tightness for the exposed respondents was 64.7%, 55%, 39%, 41% and 43%, respectively. The corresponding percentage prevalence of respiratory symptoms for control subjects were 25.5%, 14%, 8%, 6% and 0% for cough, phlegm, wheeze, breathlessness and chest tightness, respectively. The result of the study showed that cough was the most prevalent respiratory symptom among exposed subjects. The odds of cough was found to be 2.23 times higher in exposed than in non-exposed respondents (OR=2.23). This finding is in agreement with the study conducted among textile factory workers in Kano, Nigeria which showed a higher prevalence of work-related respiratory symptoms in exposed workers than in controls. The prevalence in exposed subjects were cough (43%), phlegm(41%), wheezes (13.5%), breathlessness(24.5%) and chest tightness(22.5%) whereas prevalence in control group were cough(14%), phlegm(23%), wheezes(1.5%), breathlessness(12%) and chest tightness (6%) [13], another related study in Nigeria revealed that the prevalence of respiratory symptoms in the exposed group was higher than in the control with cough and phlegm as the most common symptoms [14]. A study in India, reported a higher prevalence of respiratory symptoms in cotton mill workers, 20% of workers reported to have cough, 15% reported chest tightness and 19% complained of breathlessness [15, 6]. Christiani *and his colleagues* reported a higher prevalence of respiratory symptoms in cotton textile workers [6]. Similar study in Egypt revealed a higher prevalence of respiratory symptoms in exposed group than in controls [16]. The study done in South Tehran, Iran, found a significantly higher prevalence of respiratory symptoms related to textile industrial workers such as cough 30.8%, phlegm 53.8% and dyspnea 65% [17].

Regarding Pulmonary function, the mean values of lung function parameters such as, FVC, FEV_1, $FEV_{1\%}$, PEFR and $FEF_{25-75\%}$ of exposed group were lower than those of the control group. And the mean differences were found to be statistically significant ($p=0.05$), except $FEV_{1\%}$ ($p>0.05$). FVC and FEV_1 values across age ranges of 31-35, 41-45 and 46-50 years were greater in controls and the mean differences were statistically significant ($P<0.05$). Controls had greater mean FEV_1 value than exposed subjects across 26-30 age category and the difference was statistically significant ($P=0.029$). FEV1% across the age category (21-25years) was low in exposed group, and the difference was statistically significant. PEFR and $FEF_{25-75\%}$ values across 46-50 years age category were low in exposed group and the differences were statistically significant. This finding is in line with the work of Nagoda and his colleagues in Kano textile workers, Nigeria in which the mean values of PEFR, FVC, and FEV_1 of exposed group were lower than those of the controls [13]. Subjects exposed to cotton dust in this study showed decreased lung function compared to control group which is in agreement with the report of various related studies [15, 18]. Another studies revealed significantly decreased mean FEV_1 and FVC in cotton workers which are in accordance with result of the present the study [19, 20]. Study in Egypt showed a significant decline in $FEF_{25-75\%}$ in exposed compared to non-exposed subjects [16]. Mohammed and Baybeen reported that there was a statistically significant reduction of FVC, and FEV_1 in cotton textile workers in comparison to controls in all age groups above 40 years; which is agreement with the current study [21]. A

study by Dhanasree and colleagues reported that the overall mean values of lung function parameters like FVC, FEV_1, $FEV_{1\%}$, PEFR and $FEF_{25-75\%}$ were lower in workers exposed to cotton dust as compared to controls [22] which is in accordance with the present study. The present study is also in agreement with the study done in Bahir Dar, Ethiopia, which reported the mean measured values of FEV_1 and FVC were significantly reduced in the exposed group [23].

Pearson correlation analysis showed that there was a negative correlation between lung function measurements and duration of exposure, but it was not statistically significant. In the present study the mean difference of lung function across different service years was found statistically insignificant. The result was found to be in agreement with a study conducted in Kano, Nigeria which showed no consistent variation in mean values of lung function parameters with duration of employment in the factory [13].

When respiratory passages are affected by various factors, they may lead to obstructive or restrictive air way diseases. Based on British Thoracic Society Chronic Obstructive Pulmonary Diseases (COPD) Consortium and Global initiative for Chronic Obstructive Lung Diseases (GOLD) Spirometry guide, restrictive respiratory disease was observed among 20(39.2%) and 3(5.8%) of the exposed and control subjects, respectively and about 2% of the exposed study participants had obstructive respiratory disease [24,25]. Under normal condition, during a forced expiratory maneuver, at least 70% of the FVC should be expelled in the first second. In the presence of airway obstruction, FEV1 is affected more than the FVC and the ratio of FEV1/FVC is reduced below 70%. In case of lung volume restriction, both FVC and FEV1 values are lower than 80% of predicted value proportionally so that FEV1/FVC ratio is normal or exceed 70% [26, 27]. Study conducted in Nigeria found obstructive condition in 10% and 5.5% of exposed and control group, respectively. It showed variation from the present study, this could be probably due to presence of smokers. In similar study restrictive pattern based on FVC less than 80% of predicted value, with a normal FEV1/FVC was found in 80 (40%) workers in the exposed group and 10 (5%) in the control group [13] which is in accordance with the present study.

5. Conclusion and recommendations

The prevalence of respiratory symptoms was found higher among workers exposed to cotton dust in textile factory. Also the overall mean values of lung function parameters like FVC, FEV_1, $FEV_{1\%}$, PEFR and $FEF_{25-75\%}$ were reduced among workers exposed to cotton dust. The study revealed an obstructive pattern in 2% of exposed workers and + restrictive pattern in 39.2% of exposed workers. The duration of exposure was shown to have negative correlation with lung function among the exposed workers. This study showed absence of personal protective devices supply, due to this, workers in the manufacturing sections of the factory were performing their activity without using any PPDs.

The study showed the fact that cotton textile workers are highly vulnerable to occupational lung diseases. So, preventive measures play indispensable role in minimizing the prevalence of respiratory disorders in cotton textile workers. Therefore, the factory management should provide PPDs to exposed employees and should provide additional protective measures like giving fresh milk to improve the wellbeing of workers. The factory management should also arrange training programs to exposed workers, focused on potential health effects of

exposure to cotton dust, proper use and purpose of personal protective devices. Concerned governmental bodies should instruct the employers to supply proper PPDs for workers and regular assess the factory environment

Author contribution

TK has contributed to conception and design of the study, conducted the study, recorded analyzed and interpreted the data and drafted the manuscript; GS was involved in conception of the study and interpreting data; FG and BT were involved in checking the collected data and drafting manuscript; EG and BB were involved in collection and analysis of the data. All the authors read the draft manuscript, improved and approved the final manuscript.

Conflict of interest

The authors report no conflict of interest in this work.

Acknowledgements

The author acknowledges Arba Minch University and Addis Ababa University for scholarship and funding.

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