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Exposure to Cotton Fibre and its Impact on Lung Function

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Abstract

Introduction: Respiratory pathologies associated with the work environment, such as in the field of clothing manufacturing, are conditioned by the pollution load given by the aforementioned cotton dust, an agent that can impair lung function. This paper aims to describe the relationship between exposure to cotton dust and lung function. Methods: A descriptive, observational, non-probabilistic sampling study involving 53 workers in the textile sector from all areas with the same workload. Spirometry was performed to assess lung function, and respiratory symptoms were collected using the standardized questionnaire of the American Thoracic Society. The data were analyzed and subjected to descriptive statistics. Results: A total of 27 men (50.9%) and 26 women (49.1%) participated with a mean age of 36.49 (SD±8.37) distributed in areas of assembly (73.5%), cutting (18.8%) and quality control (7.5%). The mean spirometry indices were 3.32 liters (SD±0.74) for forced expiratory volume in the first second (FEV1), forced vital capacity (FVC) 3.82 liters (SD±0.59) and FEV1/FVC ratio 86.50 (SD±10.76). Conclusions: It is mentioned that there is a relationship between cotton dust and a decrease in lung function related to the time of exposure measured in years of work in people who work in the manufacture of clothing whose raw material is denim fabric, decreasing the values for FEV1 along with the FEV1/FVC ratio.

Keywords: *Occupational Health, Cotton Fiber, Lung Function, Spirometry*

Introduction

The garment maquila production sector involves more than 60 million people worldwide (1), participating from the harvest of cotton as a raw material to the final result which is the garment. Ecuador is no stranger to this reality: according to the National Institute of Statistics and Census (INEC), there are 280 companies dedicated to this area, being an important axis of the economic sector, contributing two percentage points to the country's gross domestic product (GDP) (2). Precarious working conditions for workers coexist throughout the production chain, including poor ventilation, no access to personal protective equipment, and constant exposure to chemicals (3). The garment maquila sector is exposed to a high pollutant load of cotton dust resulting from the processing of fabric of the same origin, all this added to a lack of preventive model in occupational and respiratory health converges in a scenario conducive to the appearance of respiratory pathologies such as chronic obstructive pulmonary disease (COPD). asthma, bysinosis, bronchitis, among others (4.5), studies such as those of Dangi et al. mention COPD as the pathology with a high prevalence in the occupational environment due to the inhalation of pathogens capable of airborne, especially affecting workers in the textile industries as a

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result of exposure to cotton dust, leading to a progressive loss of forced expiratory volume in the first second (FEV1). forced vital capacity (FVC) and the FEV1/FVC ratio called the Tiffeneau index, is also cited as a factor for the onset of respiratory symptoms (6). This is especially due to the high endotoxin load accompanied by the particle size of the cotton powder, estimated to be between 0.1 μm to 2.5 μm, a physical property that facilitates the bypassing of the various barriers of the airway and implanting in the capillary alveolus unit, causing structural damage (7,8),

Prolonged exposure to cotton dust can generate changes in lung function reflected in altered spirometric values. On the other hand, acute exposure causes characteristic symptoms highlighting chest pressure, dyspnea, cough, sputum, and bronchial hyperresponsiveness (9). Previous studies mentioned a modification of 39.5 ml of FEV1 per year in workers in the cotton textile sector and 30.6 ml of FEV1 per year for silk workers that were analyzed for 5 years (10), supported by longitudinal studies that show a loss of 10 ml of FEV1 per year in cotton workers in the same period of time (11). Likewise, one of the most recent studies carried out in Pakistan reports the presence of chronic cough in a 13%, chronic bronchitis in 8%, byssinosis in 3% and a feeling of tightness in the chest in 15% of the total population studied (12). To date, there are no reports on this problem in Ecuador, for this reason this study has the following objectives: Objective: To analyze the lung function of people exposed to cotton fiber in textile manufacturing companies.

Materials and methods

A descriptive observational cross-sectional study was carried out within a textile company in the Pelileo canton of the province of Tungurahua - Ecuador, recruiting a total universe of 81 people through non-probabilistic sampling, including workers destined for the manufacture of jeans. The data were collected between May and July 2023, the study was approved by the bioethics committee of the Technical University of Ambato respecting the regulations of the Declaration of Helsinki (13). Participants signed the informed consent form and decided to be part of the study. Exclusion criteria were people with active or presumed transmissible respiratory infections or diseases, pregnant women, dyspnea at rest, people who fail to complete the assessment, uncontrolled arrhythmias and angina, people with clinically unstable pulmonary embolism, people with increased intracranial/intraocular pressure(14).

The total number of participants was 53 to whom a questionnaire was applied based on the questionnaire formulated by the Division of Lung Diseases of the American Thoracic Society ATS-DLD 78A in order to collect information on respiratory symptoms as well as demographic data of the participants in addition to variables corresponding to the work environment such as time in years of work. section where they work, working hours, use of protective equipment and assessment of the work environment (15,16).

The evaluation of lung function was carried out using the Contec BTL spirometer (CardioPoint-Spiro USA) performed by a professional technician in compliance with the regulations and guidelines postulated by the ATS, taking as a reference the predictive equations proposed by the European Respiratory Society ERS (17). A minimum of three attempts with a variability of less than 150 ml in FEV1 or FVC was respected, avoiding the presence of artifacts in the spirometric curves, in addition all the final reports were reviewed by an expert in spirometry, thus achieving quality results (18).

Data were analyzed using the SPSS statistical program, Version 25.0. for Windows (Armonk, NY: IBM Corp. USA) for data entry and analysis. Applying descriptive statistics to obtain frequency, mean and standard deviation (SD±) measurements. The size of the sample conditioned the application of the Kolmogorov-Smirnov normality test, in addition to applying the Student's T test and the Mann-Whitney U test depending on the

normality of the variables. Finally, the Spearman correlation measure was used to demonstrate the association between lung function and the time of exposure to cotton fiber.

Results

The demographic characteristics of all patients are shown in Table 1. Of the total number of participants, 27 were men and 26 were women, with a mean age of 36.49 (SD± 8.37). Working time was estimated in months, obtaining a mean of 150.11 months (12.51 years). The sections within the textile industry, such as the assembly area, had 39 (73.58%) people, 10 (18.87%) people and 4 (7.55%) people in quality control.

Table 1. Demographics

	Average/n	OF ±	%
AGE (years)	36,49	8,37	
GENDER			
MAN	27		50,94
WOMAN	26		49,06
BMI	22,82	2,68	
WORKING TIME (months)	150,11	61,04	
WORK AREA			
ARMED	39		73,58
CUT	10		18,87
QUALITY CONTROL	4		7,55
PROTECTIVE USE			
YES	29		54,72
SOMETIMES	18		33,96
NO	6		11,32
TIFFENEAU INDEX	86,50	10,76	
CVF	3,82	0,59	
FEV1	3,32	0,74	

SD±: Standard Deviation, n: Sample Size, FVC: Forced Vital Capacity, FEV1: Forced expiratory volume at the first second, BMI: Body Mass Index

The assessment of lung function in textile industry workers yielded values expressed in liters for FEV1, FVC and percentages for the FEV1/FVC ratio of 3.32 liters (SD± 0.74), 3.82 L (SD± 0.59) and 86.50% (SD± 10.76) respectively. The group analysis showed a significant difference in lung function values between groups by gender ($p<0.05$) among all workers.

When comparing the means of the subgroups, we found a decreased Tiffeneau index in workers in the cutting area ($p<0.001$), in an age range between 40 and 50 ($p=0.005$) and among smokers and non-smokers ($p=0.000$) Table 2. In contrast, there was no significant difference between workers who mentioned having respiratory symptoms and those who did not report them ($p>0.05$), this can be attributed to the fact that the only symptom reported was mild dyspnea that could be implicitly related to sequelae due to COVID infection, where more than half reported having been infected with the virus and accused dyspnea as a sequelae. Finally, nonparametric correlation tests showed that there is an inversely proportional relationship between working time and decreased lung function ($p<0.05$). (Rho=0.27) results that could be attributed to a small sample.

Table 2. Spirometric data obtained for all variables

	TIFFENEAU INDEX				FEV1			CVF		
Gender	N	%	FROM±	P Value	L	FROM±	P Value	L	FROM±	P Value
Man	27	83,44	13,46	0,086	3,52	0,91	0,043	4,17	0,55	0,000
Woman	26	89,68	5,61	0,086	3,11	0,43	0,042	3,46	0,38	0,000
Smoker	21	83,44	13,30	0,000	3,56	0,92	0,053	4,21	0,56	0,000
Non-smoking	32	88,50	8,34	0,000	3,16	0,55	0,083	3,57	0,45	0,000
Presence of respiratory symptoms	7	81,15	12,01	0,160	2,95	0,70	0,309	3,61	0,40	0,159
Absence of respiratory symptoms	46	87,31	10,46	0,237	3,38	0,74	0,195	3,86	0,61	0,175
Workspace										
Armed	39	90,95	4,99	0,000	3,46	0,66	0,000	3,78	0,61	0,133
Cut	10	66,44	2,84		2,49	0,33		3,75	0,45	
Quality Control	4	93,22	2,59		4,10	0,50		4,39	0,43	
Age Range (Years)										
20 - 30	14	91,59	2,40	0,005	3,44	0,39	0,164	3,75	0,41	0,673
31 - 40	21	88,46	10,21		3,48	0,84		3,91	0,74	
41 - 50	18	80,25	12,63		3,05	0,77		3,78	0,52	
Working time (months)										
12 to 60	7	91,45	1,70	0,001	3,46	0,35	0,078	3,78	0,39	0,058
61 to 120	12	90,32	7,73		3,12	0,46		3,45	0,38	
121 to 180	23	88,20	9,34		3,57	0,85		4,02	0,71	
181 to 240	11	75,62	13,06		2,93	0,77		3,84	0,43	

SD±: Standard Deviation, n: Sample Size, L: Liters, FVC: Forced Vital Capacity, FEV1: Forced expiratory volume in the first second

Discussion

The current research included 53 maquila workers for the manufacture of jeans whose raw material is cotton fabric, whose lung function was measured quantified by spirometry. The results found in these workers show a marked deterioration in the FEV1/FVC ratio associated with the time of exposure to cotton fiber ($p<0.05$), data that agree with a study carried out by Ahmad et al., where with a working time of more than 15 years, they obtained a mean of 73.41 ± 11.87 for the FEV1/FVC ratio (r=-0.45) (19). Likewise, works such as those of Naureen et al with a similar age sample 32,5 ± 10.5 years In fact, they report that the deterioration of lung function is related to exposure to cotton dust and this is mostly limited according to concentration, where for each mg/m3 decreases FEV1/FVC ratio by 3% (20).

Another finding to highlight was to find a decrease in FEV1 and FVC, as reported in the longitudinal study with the largest sample to date of 5 years of follow-up carried out by Glindmeyer et al. in which included 6,037 workers from a total of 6 cotton mills together with 3 textile mills, resulting in annual decreases in FEV1 and FVC of less than 25 ml/year (21), an idea that is supported by Costa et al., with a sample of equal distribution,

47 subjects with a mean age of 42 ± 11 with a workload of 22.5 ± 9.4 years, reported a decrease in FEV1 with a difference of about 200 ml measured at the end of their working hours, this in 47% of the workers evaluated (22). justifying this short-term change in lung function by a physiological response of the respiratory system, stimulating the appearance of bronchial hyperresponsiveness that leads to bronchoconstriction, a situation that could tend to become chronic over time (5). In this study, a decreased FEV1 was found in terms of the work area, specifically in the cutting area ($p<0.001$), results similar to those previously reported (23,24) such as the one made by Sadia et al., where there was a decrease in the Tiffeneau index in areas with greater exposure to cotton fiber, in addition to being associated with respiratory symptoms, reporting a 10% prevalence of COPD. 17% of asthma and 2% of byssinosis, pathologies that several studies report as having a high prevalence among this studied population (25,26).

Although the objective of the present study was to look for changes in lung function as a result of exposure to cotton fiber, it was also expected to find a difference between variables such as gender ($p>0.05$), smoking habits ($p<0.05$) and work area ($p<0.05$). by Anyfantis et al. where they compared spirometric values between a group of workers exposed to cotton dust and a group of unexposed workers where the FEV1/FVC ratio decreased in relation to tobacco consumption and years of work ($p<0.001$), but showed no differences for gender ($p=0.148$) (5) . It seems that the Smoking is the condition that marks a rapid decline in lung function causing a change of between 48.6 and 37.4 ml/year for FEV1, specifically presenting an annual decrease for men aged 41.2 ml/year with a cotton dust load of 150 ug/m3 and with 200 ug/m3 a decrease of 49.3 ml/year, while in women the decrease was 30.2 ml/year and 38.3 ml/year for the same cotton dust load (27-29), data that are consistent with the present study, where there is a decrease in spirometric values in smokers, especially in the FEV1/FVC ratio ($p<0.001$). Population-based studies have described that the deterioration of lung function is multivariable, however, it seems that exposure to cotton dust can indeed accelerate this loss, on the other hand, the decrease in FEV1 is reported as the most sensitive parameter to evaluate the loss of lung function, showing changes between 25 and 54 ml/year (30-32).

Conclusions

It should be noted that there is a decrease in lung function related to the time of exposure measured in years of work in people who work in the manufacture of clothing whose raw material is denim fabric. FEV1 together with FEV1/FVC ratio were the variables affected in older people and in the specific cutting area. No aggravating symptoms or underlying respiratory or cardiac pathologies were reported in the participants. The results of this study aim to generate preventive measures such as optimal control of the work environment while respecting occupational health and safety. Several limitations to the present research stand out, one of them may be the discrete sample size, absence of estimation to measure the size of the cotton dust particle, the type of study per se, since the transversality of the study leaves aside the causality of the phenomenon, and it could not be contrasted with a healthy population outside the textile area, a reason that conditions the interpretation of the results.

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