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ORIGINAL ARTICLE

Impact of Occupational Hazards on Pulmonary Function among Selected Textile Industry Workers in Tirupur

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ABSTRACT

Introduction: The preprocessing and processing activities in the textile industry expose workers to dust, dirt, cotton lint, chemical starch, and dye pollution, leading to respiratory problems. This research aims to find out the impact of occupational hazards on the pulmonary function of workers of Tirupur, Tamil Nadu. **Method:** A mixed-methods study design was adopted. 160 workers of both sexes working not less than 5 years in the textile industry were selected for the conduct of the study using purposive sampling. Perception of occupational hazard and impact on the respiratory illness among the workers was obtained from 38 respondents. A validated interview was used to collect the demographic details, anthropometric measurements, nature of work, pulmonary function, and lifestyle practices. Using the Flow Measuring Spirometer, the pulmonary function was tested for Forced Expiratory Volume in the first second, Forced Vital Capacity, and FEV1/FVC ratio according to the guidelines of the American Thoracic Society. **Results:** Sneezing was a common symptom experienced, followed by allergy, cough, and irritation. The workers had poor pulmonary function with their FEV1, FVC, and FEV1/FVC ratios lower than the reference value. Mild restriction (<80) was observed in 13% of males and 14% of females, while moderate restriction (<64) was reported in 7% of males and 14% of females. **Conclusion:** Prolonged exposure to cotton dust leads to respiratory distress, like coughing, wheezing, and chest tightness, which calls for strong implementable interventions.

Keywords: Occupational hazard, pulmonary function, textile industry, respiratory illness, respiratory functions, respiratory disease

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INTRODUCTION

Respiratory diseases account for 10 to 20% of deaths due to respiratory conditions worldwide and contribute up to 30% of work-related disease (International Labor Organization, ILO 2017).

According to Subramaniam et al. (2024), chronic respiratory diseases (CRDs), particularly Chronic Obstructive Pulmonary Disease (COPD), account for approximately 3.9 million deaths globally, with non-communicable diseases amounting to 63% of all deaths worldwide.

The garment industry is the leading sector and remains a favourite choice for many countries. In 1982-83, the readymade garment sector accounted for 1.1% of total exports. In 2021, the market value of the Indian textile industry was worth 223 billion U.S. dollars. In the fiscal year 2022, India's textile and apparel exports reached approximately US$44.4 billion, underscoring the industry's significant contribution to the global market. Coimbatore and Tirupur, being the Manchester of South India, have more than 3000 garment factories that employ 18 lakh people. The annual exports of Tirupur are in the range of 33000 – 35000crore (1-Nov-2022).

Rahman et al. (2020) reported that exposure to indoor air pollution or dust is the primary factor affecting the health of textile workers. According to the World Health Organization, dust consists

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of solid particles ranging in size from less than 1 micron (μm) to at least 100 μm, and their ability to become airborne depends on their place of origin, the physical characteristics of the fabrics they are processed on, and the surrounding environmental conditions.

Exposure to cotton dust significantly affects pulmonary function, leading to cough, phlegm, wheezing, shortness of breath, chest tightness, chronic bronchitis, and byssinosis (Sadia et al., 2023). Byssinosis is a chronic respiratory disease that commonly affects textile workers who are exposed to cotton dust. (Berlian et al., 2023) claims type, concentration of dust, duration of exposure, and genetic factors are strongly influencing factors of respiratory disorders and occupational hazards.

Islam (2022) reported that workers with longer service in the textile industry are at greater risk of developing respiratory illnesses and breathing problems, including asthma, cough, cold, sneezing, irritation, chest tightness, and shortness of breath.

Murgia and Gambelunghe (2022) reported occupational lung disease as a major health concern in the textile industry. Respiratory diseases associated with cotton dust are on the rise in developing countries due to poor workplace conditions. These problems remain largely neglected in developed countries due to a lack of information on health, safety, and protection.

Studies conducted in Pakistan, Myanmar, Ethiopia, Benin, Taiwan, Sudan, Thailand, Croatia, Turkey, and Vietnam found that textile industry workers have lower pulmonary function and more respiratory symptoms due to exposure to indoor pollutants and elevated dust concentrations (Oo et al., 2021).

A study conducted by Muhammad et al. (2020) indicated that male textile workers are at high risk of having respiratory problems when compared to female workers. Female workers are usually assigned in less hazardous areas in the textile/ garment industry and take up job profiles as helpers, kaja button operators, against men who often perform tasks such as blowing, weaving, spinning, ginning, stitching, and fabric finishing.

Daba Wami et al. (2018) reported that exposure to respirable cotton dust in several working departments, such as blowing, weaving, spinning, and ginning, was significantly correlated with the prevalence of self-reported respiratory complaints among workers. Workers who process cotton are more likely to experience pulmonary difficulties than those employed in silk mills. Though textile industries in developing countries, including India, have more modernization and improved working conditions, preventive measures against occupation-oriented pollution, hazard, and their compliance are insufficient, resulting in distressed respiratory efficiency.

With this background, the study aims to explore the impact of occupational hazards on pulmonary function among selected textile industry workers in Tirupur. The research question of the proposed work is to determine workers' perceptions of occupational risk and hazard in the textile industry, and whether occupational hazards in the textile industry affect workers' respiratory function and health.

METHODS

Study Design and Study Population

A total of 160 workers, men (124) and women (36), aged 20 to 45 years, with at least 5 years of experience in the selected textile industry and without severe illness, were selected for the study through purposive sampling. The purposive sampling technique was used to target textile workers, who are at risk of occupational respiratory symptoms. Workers with less than 5 years of experience, below the age group of twenty years, and above the age of forty-five years with known health issues, namely asthma, COPD, and who did not give consent to participate in the study were excluded.

The study was approved by the ethics committee of Avinashilingam Institute for Home Science and Higher Education for Women, and ethical clearance was obtained [IHEC/22/23/AUW/IHEC/FSMD-22/ FHP-5].

A mixed research design was adopted, and the research was conducted in two phases. In phase I, the perceptions of garment/textile industry workers regarding the impact of occupational hazards on respiratory health were assessed. Thirty-eight textile workers from different sections of the textile industry were interviewed using an open-ended questionnaire, and a focused group discussion was conducted to explore common respiratory symptoms and health distress experienced, and employees' concerns about safety, working hours, and environmental sanitation. The responses of all workers were recorded; in between, prompts and clarifications of doubts were provided to capture unbiased data. The collected data were cleaned of grammatical errors, repetitive

concepts or content, and vague or unrealistic representations. The cleaned data were then coded and entered into NVivo (NVivo 14 2023); the results were displayed as a word cloud, and interpretations were made.

In phase II, with the help of a structured, validated interview schedule, demographic data (age, gender), anthropometric measurements (standard procedures), nature of work, pulmonary function, and lifestyle practices such as physical activity, smoking, pan chewing, and alcohol consumption were investigated in 160 textile workers. Work history, including working time, nature of work, and duration of working hours, was noted. Statistical analysis was carried out using frequency, percentage, mean, standard deviation, t-test, and chi square test.

To ensure the accuracy and reliability of self-reported lifestyle data (such as smoking habits, alcohol consumption, and dietary practices), the study employed standardized, pre-tested questionnaire administered through face-to-face interviews conducted by trained field investigator. Respondents were assured of confidentiality to minimize social desirability bias and encouraged honest reporting and the possible responses were cross-verified (Example, BMI and background details from workplace health records). These measures improved the validity of self-reported lifestyle data and reduced potential biases.

The respiratory functions of the selected workers were evaluated using the Flow Measuring Spirometer (Helios_v3.2.56) for Forced Expiratory Volume (FEV1), Forced Vital Capacity (FVC), and FEV1/FVC ratio. The mouthpiece of the spirometer was removed and checked for proper connectivity. All accessories are clean and free of any obstructions, and the workers perform multiple times for each flow rate. The results were interpreted according to the guidelines of the American Thoracic Society. History of smoking, alcohol consumption, and pan chewing was also elicited. The data collected were statistically analysed.

RESULTS

Perception of Occupational Hazard on Respiratory Illness

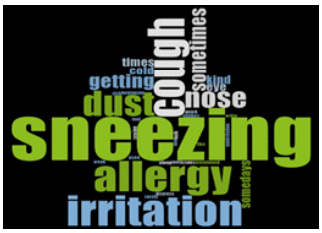

Figure 1. Perception of textile industry workers on exposure to respiratory illnesses in the working unit

Workers reported sneezing, allergies, cough, nasal and throat irritation, and cold as the most common respiratory illnesses experienced in the working units, with word counts of 10, 6, 5, and 4, respectively (Figure 1). As such, numerous studies have reported skin inflammation, a burning sensation in the throat, nose, and eyes, breathing problems, sneezing, and coughing as possible side effects among textile industry workers with prolonged indoor exposure. Chemicals such as dyes, pigments, xylene, and toluene raise the risk for bronchial congestion, elevated blood pressure, and cancer.

Table 1. Demographic Profile of Textile Workers

Variables	Male n=124	Female n=36	Total N=160	%
Age				
20-30	46	6	52	33
30-40	44	11	55	34
40-45	34	19	53	33
Marital Status				
Married	82	26	108	67
Unmarried	42	10	52	33
Types of Family				
Nuclear Family	67	19	86	54
Joint Family	57	17	74	46
Educational Qualification				
Graduate	25	6	31	19
Intermediate or Diploma	4	1	5	3
High School Certificate	70	18	88	55
Middle School Certificate	6	1	7	5

Primary School Certificate	12	9	21	13
Illiterate	7	1	8	5
Monthly Income				
27,654-46,089	17	5	22	14
9,232-27,648	83	31	114	71
≤9,226	24	-	24	15

(Modified Kuppuswamy Scale 2022)

Out of 160 textile workers investigated, 34% of textile workers are aged between 30 and 40 years, 33% of the textile workers fell within the age group of 20-30 and 40 to 45 years. The textile industry employed more male workers (77%) than female workers (23%). More than 50 percent of the workers were married (male – 67, female -19) and lived in nuclear families. Only 19% of male and female garment/textile employees completed their degree; the rest had an educational qualification up to the higher secondary level. Seventy-one percent of males and females earned between Rs 9,232 and 27,648, respectively. Out of 160 workers, 24 textile workers had monthly wages of Rs/- ≤9,226, indicating they have poor socioeconomic status, and 114 textile workers belonged to the lower middle socio-economic class.

Table 2. Anthropometric Measurements of Textile Workers

Male n=124				
Anthropometric Measurements	**WHO Reference**	**Mean±S.D**	**t value**	**P value**
Height	163	164.47±5.4	2.98	0.003**
Weight	65	63.5±13.1	1.26	0.20NS
BMI	18.5-24.9	23.39±4.2	4.43	0.0001**
Female n =36				
Anthropometric Measurements	WHO Reference	**Mean±S.D**	**t value**	**P value**
Height	151	155±6.03	0.72	0.04NS
Weight	55	56.45±11.7	4.03	0.0001**
BMI	18.5-24.9	23.4±4.6	2.19	0.03*

NS-Not significant, **Significant at p<0.01, *Significant at p<0.05

The mean height of male workers was 164.47±5.4, and that of female workers was 155±6.03. Similarly, males reported a higher mean weight of 63.5±13.1 compared to females (56.45±11.7). Irrespective of gender, we observed a normal BMI in the majority of male (62) and female (17) textile workers. We also observed underweight among 14 males and 5 females, with their BMIs ranging from 18.5 to 24.9. Overweight and grade I obesity were observed among 52 (male: 38, female: 14) and 7 workers, respectively

Table 3. Distribution of the study subject according to Work Category

Work Category	**Male N=124**		**Female N=36**		**Total N=160**	
	N	**%**	**N**	**%**	**N**	**%**
Admin	13	10	1	3	14	9
Sewing	42	34	24	67	66	41
Cutting	11	9	2	5	13	8
Checking	29	24	3	8	32	20
Packing	13	10	3	8	16	10
Ironing	12	10	1	3	13	8
Helper	4	3	1	3	5	3
Machine Operators	-	-	1	3	1	1
Total	124		36	100	160	100

The majority of male (34%) and female (67%) workers were engaged in sewing. After that, 24% of male workers were engaged in checking, and 10% in packing, ironing, and administration tasks. We also observed fewer females (3) in the checking and packaging work than males.

Table 4. Association of Working Hours and Spirometry Severity (N=160)

Work Duration	**Normal >80**	**Mild <80**	**Medium <64**	**Total N=160**	**Pearson Chi square**
8 hours	65	16	9	90	20.010

10 hours	54	5	2	61	**P Value**
12 hours	1	-	2	3	.003
More than 12 hours	5	-	1	6	

**significant <0.01, (Normal, Mild and Moderate restriction – Severity thresholds of Spirometry findings)

Out of 160 workers, 90 (male-74, female-16) worked for 8 hours, and 61 (male-42, female-19) worked for 10 hours. We also observed extended working hours of more than 12 hours among 9 textile workers. The Pearson Chi-square test result (χ^2 = 20.010, p = 0.003) indicates a statistically significant association between working hours and pulmonary function status (normal, mild, moderate).

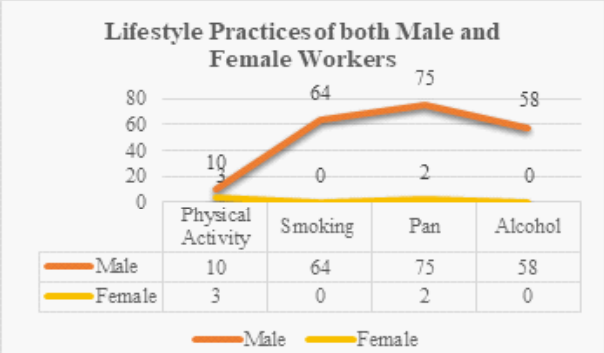

Figure 2. Distribution of confounding factors on respiratory health among the Textile workers

Physical activity, smoking, paan chewing, and alcohol consumption were found to be the cofounding factors for respiratory illness (Figure 2). Most male workers (64) were habitual smokers. Pan chewing and alcoholism were witnessed among 58 and 75 male textile workers. Though we noticed chewing betel nuts by two female workers, we did not find any who had the habit of drinking / smoking among female textile workers.

Table 5. Pulmonary Function in male and female Textile Workers

Male n =124				
Spirometry Finding of Male	**Reference**	**Mean±S.D**	**t value**	**P value**
FEV1	4.75 to 5.5	2.64±0.33	81.47	0.0001**
FVC	3.5 to 4.5	3.20±0.33	25.98	0.0001**
FEV1/FVC	70 to 80	88.57±3.39	16.25	0.0001**
Female n = 36				
Spirometry Finding of Female	**Reference**	**Mean±S.D**	**t value**	**P value**
FEV1	3.25 to 3.75	1.91±0.33	28.04	0.0001**
FVC	2.5 to 3.25	2.41±0.38	7.34	0.0001**
FEV1/FVC	70 to 85	78.85±2.17	3.67	0.0005**

FEV1- Forced Expiratory Volume in the first second, **FVC**- Forced Vital Capacity,

FEV1/FVC- Ratio of FEV1 and FVC.

A significant difference between the mean FEV1, FVC, and FEV1/FVC values and the reference values was observed among male textile workers at the 1% level of significance, indicating poor respiratory function in males. Similarly, we observed that the mean Forced Expiratory Volume in the first second with a capacity ratio of FEV1/FVC was significantly lower than the reference value at the 99% confidence interval for FEV1 and FVC, and at the 95% confidence interval for FEV1/FVC.

Table 6. Spirometry Finding of male and female Textile Workers

Severity	**Male**		**Female**		**Total**	
	n=124	**%**	**n=36**	**%**	**N=160**	**%**
Normal >80	99	80	26	72	125	78
Mild Restriction <80	16	13	5	14	21	13
Moderate <64	9	7	5	14	14	9
	Male		**Female**		**Total**	
	n	**%**	**n**	**%**	**N**	**%**
Early Airway Obstruction	12	10	15	42	27	17

The spirometry findings among textile workers showed differences in lung function between male and female workers. Among males, 80% had normal spirometry readings (>80), compared to 72% of females. Mild restriction (<80) was observed in 13% of males and 14% of females, while moderate restriction (<64) was reported in 7% of males and 14% of females. Early airway obstruction was notably higher in females (15) compared to males (12), highlighting more occupational risk for female workers more.

DISCUSSION

This study was carried out among textile industry workers of Tirupur - one of the largest manufacturing economic hubs in India which meets the production of basic human needs. The textile manufacturing processes involved spinning, printing, bleaching, dyeing, weaving, drying, handling, sizing, and curing.

Finding from various studies highlight serious occupational health risk faced by textile industry workers, particularly in manufacturing hubs like Tirupur and continuous exposure to cotton dust, chemical fumes, synthetic fibres, and inadequate ventilation, predominantly contributes to serious respiratory illnesses such as asthma, bronchitis, byssinosis, and Chronic Obstructive Pulmonary Disease (COPD). Also, poor socio-economic conditions further increase the risk of chronic diseases such as hypertension and diabetes. The mental health of workers is also a growing concern, with prolonged working hours and excessive workload leading to stress, anxiety, and depression.

A study by Ekambaram, G. et al. (2022) reported that textile industry workers are frequently exposed to a variety of airborne contaminants such as cotton dust, chemical fumes, and synthetic fibres depending on nature of work performed. Prolonged exposure to cotton dust and poorly ventilated environments in manufacturing units further aggravate health issues, making respiratory illnesses a major occupational hazard in the textile industry. A study conducted in Tirupur by Venkataramanan et al. (2023) also reported that waste generated by the garment industry contains azo dyes that can cause health issues such as cancer, skin diseases, and respiratory problems.

The findings on textile industry workers' perceptions of exposure to respiratory illness (Fig. 1) were consistent with those of Subramaniam et al. (2024), who reported sneezing, cough, dry cough, irritation, and dust allergy as the most prevalent respiratory problems among textile workers.

A similar study conducted by Islam (2022) clearly outlines the impact of poor socio-economic status among Bangladeshi garment workers on unhealthy food habits, reduced food and water intake, and predicted risk for developing obesity, hypertension, diabetes, and cardiovascular problems in the later stages of life.

Various textile processes, such as cutting, sewing, checking, and packaging, are as hazardous as exposure to risk factors for poor respiratory health. Exposure to airborne fibres, cotton dust, and Particulate matter (PM) from the workplace in textile units was identified as a causative factor in bronchitis, asthma, COPD, and byssinosis (Ramasamy et al., 2024). The above observation calls for strict measures by employers and policymakers to curb employees' exposure to various respiratory hazards, including adequate ventilation systems, personal protective equipment, and scope for best occupational hygiene practices.

As rightly noted by Elshaer et al. (2023), ccupational exposure to cotton dust in the textile industry is associated with cough, phlegm production, shortness of breath, chronic bronchitis, and reduced LFIs for large-airway function. Recent studies show a prevalence of 22.8% for byssinosis among cotton dust-exposed workers. Derso et al. (2021) reported reduced pulmonary functions among workers in cotton ginning factories (FVC, FEV1, FEV1/FVC, PEFR, and FEF 25%-75%) and a higher prevalence of respiratory symptoms due to long-term exposure to cotton dust, and suggested workplace safety measures will prevent occupational respiratory diseases.

The above findings are in concurrence with the study conducted by Kadam and N Patil (n.d.), who reported a significant decrease in Forced Expiratory Volume (FEV1) and a decrease in other spirometry parameters due to the extended hours of indoor exposure to dust, cotton lint inside the working unit.

An experimental study conducted by Derso et al. (2021) showed that reduced pulmonary function parameters and a higher prevalence of respiratory symptoms were observed among cotton-ginning workers compared with controls. Thus, the observation on distressed pulmonary function in the present study calls for tailored workplace safety measures to prevent occupational respiratory disease in the textile industry.

Various studies have reported prolonged working hours as a potential cause of respiratory illness (sneezing, coughing, wheezing, asthma). Also, workers suffer from anxiety, depression, and stress with reduced productivity when they are pressed with a heavy workload and work pressure. Similarly, a study conducted by I J et al. (2024) in Tamil Nadu, India highlighted lifestyle practices among textile workers as one of the contributing factors for respiratory illnesses. Extended working hours led to severe lung diseases, such as byssinosis,

characterized by symptoms including increased chest tightness, breathing difficulties, persistent coughing, and wheezing during working hours (Serly et al., 2025).

The responses of males aged 20 to 40 and above employed in cutting, sewing, and finishing sections revealed frequent experiences of poor vision, nausea, heat stroke, and hearing problems. Greater exposure to occupational hazards was observed among males. Studies indicate that smaller textile fibres and microplastics can be inhaled and retained in respiratory tissues (Bhat et al., 2021) suggesting potential respiratory risks in garment environments. Gender differences are also evident in lung function outcomes. Men usually have larger lung volumes and stronger respiratory muscles, providing higher resistance to airborne chemicals and fibres. Women, with smaller airways and lower diffusion capacity, are more prone to coughing, breathlessness, and airway obstruction even at lower exposure to chemicals, dyes, cotton lint, cotton dust, or any other textile industry-generated pollutant. Continuous low-level exposure in confined sections such as sewing, cutting, packaging, and finishing, poor exposure to sunlight and ventilation, further increased their vulnerability. Hence, protective measures against occupational health hazards, such as providing customised Personal Protective Equipment (PPE), improved ventilation, and regular lung function screening, are essential for workers in garment manufacturing.

The working environment of textile industry is believed to play an important role in the occurrence of asthma as they are more prone to exposure of dust and lint. Thus, care and preventive measures to curtail dust-related allergic asthma among workers in the textile industry is the need of the hour(Ha et al., 2021).

Health education on occupational hazards and their effects, regular health screenings, and lifestyle modifications among workers to reduce health risks and improve the well-being of textile workers, with special reference to respiratory health and overall productivity in the working units. Provision of personal protective equipment (PPE) such as masks, earplugs and gloves, the installation of adequate ventilation and dust control systems, and regular health monitoring through lung function tests, blood pressure checks, and diabetes screening will improve overall health of workers. Also, establishing workplace wellness programs that include health education, brainstorming activities, stress management, and mental health support, as well as assigning suitable working hours and regular breaks, can considerably lower the burden of respiratory, chronic, and psychological ailments among employees.

LIMITATIONS

The cross-sectional design limits the ability to establish causal relationships between occupational exposure and health outcomes, providing only associative insights. Environmental exposure levels such as concentration of cotton dust, chemicals, or particulate matter were not quantitatively measured, which limits objective assessment of workplace hazards. The findings may not be generalizable to all textile units, as the data primarily reflects workers from a particular textile industry of Tirupur, potentially overlooking variability in working conditions across different geographic and industrial settings.

CONCLUSION

The study highlights the serious public health consequences of extended cotton dust exposure of textile workers. The observation with marked respiratory symptoms among textile workers on pulmonary dysfunctioning underscores the critical need for early detection and tailored preventive measures. To nurture a healthy work environment, proactive remedial measures such as provision of Personal Protective Equipment (PPE), frequent monitoring of air quality, adequate infrastructure maintenance, employee friendly working hours and early detection of respiratory symptoms should be enforced. Furthermore, health awareness campaigns on respiratory cleanliness, workplace safety and regular medical checkups should be adopted. Future research needs include longitudinal monitoring of lung health; periodic health checkups will reduce the burden of occupational respiratory diseases.

CONFLICT OF INTEREST

The researcher confirms that there is no conflict of interest between the two researchers involved in this study.

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AUTHOR CONTRIBUTION

The Authors contributed equally to the research work, collaborating on the conceptualization and design of the study. While Shanmukapriya led the data collection, analysis, and manuscript drafting, Premala Priyadharsini played a crucial role in thoroughly proofreading and refining the manuscript at every stage. Both authors shared equal responsibility and contributed throughout the research process, from initiation to publication, to the publication of this research work.

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