**Journal of Health and Nutrition Research**
Vol. 4, No. 2, 2025, pg. 527-536, https://doi.org/10.56303/jhnresearch.v4i2.420
Journal homepage: https://journalmpci.com/index.php/jhnr/index

e-ISSN: **2829-9760**

# Risk Factors of Pulmonary Obstruction Among Textile Industry Workers

**Sumardiyono[1]*, Maria Paskanita Widjanarti[1], Farhana Syahrotun Nisa Suratna[1], Lusi Ismayenti[1], Seviana Rinawati[1], Tutug Bolet Atmojo[1], Warda Yussy Rha[1], Jordan Syah Gustav[1], Bekti Utomo[1], Reni Wijayanti[1], Bachtiar Chahyadhi[1]**

[1] Department of Occupational Health and Safety, Vocational School, Universitas Sebelas Maret, Indonesia

Corresponding Author Email: sumardiyono@staff.uns.ac.id



**ORIGINAL ARTICLES**

*Submitted: 07 May 2025*

*Accepted: 20 June 2025*

***Keywords:***
*Pulmonary obstruction, Cotton dust exposure, Lung function, Textile workers*



## ABSTRACT

Chronic exposure to cotton dust in the textile manufacturing industry has been a possible risk factor for pulmonary obstruction. Not many studies, however, have investigated its impact in combination with personal variables like age, gender, and length of service, particularly in developing countries. The present study investigated the impact of cotton dust exposure, age, gender, and length of service on the incidence of pulmonary obstruction among textile workers in Surakarta, Indonesia. Observational analytic study using cross-sectional design was done on 88 eligible workers. Quantitation of exposure to cotton dust was done with a High-Volume Air Sampler and lung function ascertained using spirometry. Data analysis was done through simple and multiple binary logistic regression at a significance level of 0.05. The incidence of pulmonary obstruction was 56.8%. Being exposed to cotton dust levels exceeding the threshold limit value (TLV) of 0.2 mg/m$^3$ significantly increased the risk of pulmonary obstruction (OR: 4.18; 95% CI: 1.51–11.63; p=0.006). Employment duration was also significantly associated with pulmonary obstruction (OR: 1.21 per year; 95% CI: 1.03–1.44; p=0.023), while age and gender were not significant predictors. The accuracy of the final model was 75%, which is considered to be acceptable in occupational health studies in predictive modeling. The current research reaffirms that long-term exposure to cotton dust and extended working hours are critical risk factors for pulmonary obstruction in textile industry workers. Therefore, it is recommended to long-working-hour employees to have proper control of the exposure and continuous lung function monitoring.

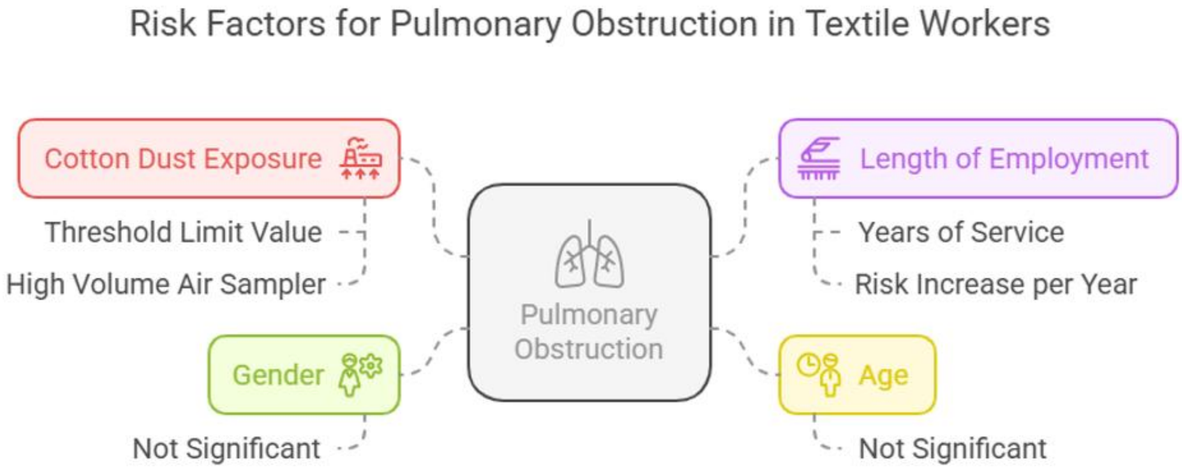
**Key Messages:**

- Long-term exposure to cotton dust is a significant risk factor for pulmonary obstruction among textile workers, indicating the need for strict dust control in the work environment.
- Length of Employment is an important predictor of decline in lung function, and it suggests the need for regular evaluation of lung health, particularly for employees with long durations.

Access this article online

Quick Response Code

**GRAPHICAL ABSTRACT**




## INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is one of the leading causes of morbidity and mortality across the globe, with more than 3.2 million deaths annually (1). COPD is not only a large health burden in developed countries but also increasingly among developing nations due to harmful workplace exposures (2,3). In various occupational groups, textile workers are one of the most susceptible to developing byssinosis (35%), asthma (20%), and chronic bronchitis (10%), particularly those with prolonged exposure to cotton dust (4–6).

Cotton dust generated in spinning and weaving processes contains fine, respirable particles that can penetrate the lower respiratory tract (7,8), resulting in chronic inflammation, airway irritation, and reduced lung function (9,10). Previous studies have also repeatedly linked cotton dust exposure to impaired pulmonary function among textile workers (11,12). Textile workers have also been reported to have a greater annual decline in forced expiratory volume in one second ($FEV_1$) than control populations, indicating progressive ventilatory impairment (13). A study in India reported a 24% prevalence of byssinosis and a positive association between work years and $FEV_1$ and forced vital capacity (FVC) decrements in cotton spinners (14). Furthermore, research in China has shown that long-term cotton dust exposure causes structural changes in the lung and an elevated risk of chronic obstructive pulmonary disease (COPD) (15). Research findings from Greek textile factories revealed that textile workers showed reduced lung function than controls (16).

Nevertheless, the literature on this subject still presents contradictory findings. Although some studies indicate that short-term or low-level cotton dust exposure is not necessarily linked with quantifiable pulmonary function reduction (17,18). Other study have reported that even low-level cotton dust exposure exposure can be harmful if the exposure is long-term (19). These differences are due to exposure time variability, use of personal protective equipment, quality of the production process, and individual characteristics such as age, gender, and length of employment. There is, therefore, an urgent need for a study that accounts for exposure to cotton dust along with these individual-level factors.

In Indonesia, the textile industry remains a labor-intensive industry with millions of workers. To date, very few local studies have investigated the relationship between cotton dust levels and pulmonary obstruction risk, after adjusting for individual factors. This leaves a serious knowledge gap that needs to be filled to support more evidence-based risk control. The aim of the present study is to investigate how cotton dust, age, gender, and length of employment affect the prevalence of pulmonary obstruction in textile industry workers.

## METHODS

This study employed an observational analytic approach using a cross-sectional design to


https://doi.org/10.56303/jhnresearch.v4i2.420

determine the relation between cotton dust level, gender, age, years of working experience, and pulmonary obstruction in textile workers. This research was carried out in Surakarta, Central Java, Indonesia at a textile factory (approx. 850 workers) in November 2024. The exposed group was made up of production (weaving) personnel who had been employed for a period of one year or more and who were exposed to cotton dust beyond the threshold limit value (TLV) of 0.2 mg/m$^3$, as stipulated in the Regulation of the Minister of Health of the Republic of Indonesia Number 70 of 2016 regarding Industrial Workplace Environmental Health Standards and Requirements (20). The comparison group that had exposure below the TLV comprised inspecting, folding, and warehouse personnel. The inclusion factors were: working experience of more than one year, above the age of 20 years, readiness to provide informed consent, and inconsistent or irregular use of respiratory masks. Exclusion factors were: having a previous history of pulmonary conditions such as COPD or asthma.

The sample in the present study was sampled according to a non-probability sampling technique, i.e., purposive sampling with a fixed sample size design. The fixed sample size design was employed due to time efficiency considerations and limited field access. Sample size was calculated using the formula $N = (10 \times k)/p$, where $k = 4$ variables and $p = 0.5$ (no prior reference data were available for comparison, so p was set at 0.5), which calculated a required sample of 80 workers. 10% was added to increase statistical power, so 88 workers were investigated. Data were gathered over two phases. First, a High Volume Air Sampler model TFIA-2F previously calibrated by the Ministry of Environment and Forestry Testing Laboratory No. LK-193-IDN with certificate no. K-211/KAL/PSIKLH/04/2022 was employed to measure the quantity of cotton dust within the workplace environment twice during each workday, 09.00-10.00 and 14.00-15.00, with the two readings' average being used to represent a day's exposure concentrations in each of the departments. Secondly, lung function was assessed with a Chest Graph HI-105 spirometer to establish $FEV_1$ and FVC values. The $FEV_1$ and FVC values were measured by a Ministry of Manpower-certified occupational health physician. Pulmonary obstruction was an $FEV_1$/FVC value of less than 0.70, according to the 2023 Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines (21).

Demographic data such as gender, age, and duration of work were retrieved from employee registration books that the company's human resource department maintained. The data were all kept confidential. The smoking status data in the current study were not numerated, which was a limitation. SPSS version 27 was utilized in data analysis. Data description was conducted through univariate analysis, while simple binary logistic regression was conducted for bivariate analysis. For multivariate analysis, multiple binary logistic regression was used to identify factors associated with pulmonary obstruction after adjusting for potential confounders. Statistical significance was at $\alpha = 0.05$.

## CODE OF HEALTH ETHICS

The research protocol was reviewed and approved by Dr. Moewardi Hospital Surakarta's Health Research Ethics Committee with no. approval 932/IV/HREC/2024 dated April 6, 2024.

## RESULTS

Table 1 shows the demographic characteristics of the textile industry workers according to cotton dust exposure, gender, age, length of employment, and lung function. The 88 workers made up the largest proportion exposed to cotton dust, with more than the threshold limit value (53.4%), were female (52.3%), had a mean age of 37.08 years, and had a mean of 10.18 years of employment. The largest proportion of the participants had pulmonary obstruction (56.8%).

**Table 1. Demographic Characteristics of Textile Industry Workers (N=88)**

| Characteristic | n | % |
|---|---|---|
| **Cotton Dust Exposure** | | |
| > TLV | 47 | 53.4 |
| < TLV | 41 | 46.6 |
| **Gender** | | |
| Male | 42 | 47.7 |
| Female | 46 | 52.3 |



https://doi.org/10.56303/jhnresearch.v4i2.420

| Characteristic | n | % |
|---|---|---|
| **Age (mean ± SD)** | 37.08 ± 8.6 | - |
| **Length of Employment (mean ± SD)** | 10.18 ± 5.6 | - |
| **Lung Function** | | |
| Normal | 38 | 43.2 |
| Obstruction | 50 | 56.8 |

Table 2 demonstrates the prevalence of pulmonary obstruction based on textile worker characteristics. Pulmonary obstruction was highest among workers with exposure over the threshold limit value of cotton dust (74.5%), females (60.9%), above the average age (73.5%), and with the length of employment of ≥10 years (76%). The findings suggest that there may be an association between exposure to cotton dust, gender, age, and length of employment and an increased risk of pulmonary obstruction.

**Table 2. Pulmonary Obstruction by Worker Characteristics (N=88)**

| Characteristic | Pulmonary Obstruction | | Normal | |
|---|---|---|---|---|
| | n | % | n | % |
| **Cotton Dust Exposure** | | | | |
| > TLV | 35 | 74.5 | 15 | 25.5 |
| < TLV | 15 | 35.6 | 26 | 63.4 |
| **Gender** | | | | |
| Male | 22 | 52.4 | 20 | 47.6 |
| Female | 28 | 60.9 | 18 | 39.1 |
| **Age** | | | | |
| Above average | 36 | 73.5 | 13 | 26.5 |
| Below average | 14 | 35.9 | 25 | 64.1 |
| **Length of Employment** | | | | |
| Above average | 38 | 76.0 | 12 | 24.0 |
| Below average | 12 | 31.6 | 26 | 68.4 |

Table 3 presents the result of the simple binary logistic regression analysis of the determinants of pulmonary obstruction. Cotton dust exposure significantly increases the risk of pulmonary obstruction (p < 0.001; OR = 5.05; 95% CI: 2.03–12.66). Workers with exposure levels greater than the TLV are five times more likely to have pulmonary obstruction compared to workers with exposure levels less than the TLV. Age (p = 0.004; OR = 1.08) and working duration (p = 0.001; OR = 1.18) are significantly associated with increased risk. However, gender was not significantly associated (p = 0.423; OR = 1.4).

**Table 3. Results of Simple Binary Logistic Regression for Risk Factors of Pulmonary Obstruction**

| Variable | B | p-value | OR | 95% C.I. for OR |
|---|---|---|---|---|
| **Cotton Dust Exposure (Ref: < TLV)** | -1.620 | <0.001 | 5.05 | 2.03 to 12.66 |
| **Gender (Ref: Female)** | 0.347 | 0.423 | 1.4 | 0.30 to 3.29 |
| **Age (years)** | -0.081 | 0.004 | 1.08 | 1.03 to 1.19 |
| **Length of Employment (years)** | -0.165 | 0.001 | 1.18 | 1.07 to 1.29 |

Dependent variable: Pulmonary obstruction

Table 4 presents the findings of some binary logistic regression testing the impact of different variables on the incidence of pulmonary obstruction. Excessive exposure to cotton dust above the threshold limit remained an independent risk factor (p = 0.006; OR = 4.18; 95% CI: 1.51–11.63), as indicated by the odds ratio, which indicated that those with high exposure had more than four times the likelihood of having pulmonary obstruction after controlling for other variables. Length of service was also strongly related (p = 0.023; OR = 1.21; 95% CI: 1.03–1.44). Gender and age, however, were not significantly related in this model.


https://doi.org/10.56303/jhnresearch.v4i2.420

**Table 4. Results of Multiple Binary Logistic Regression for Risk Factors of Pulmonary Obstruction**

| Variable | B | p-value | aOR | 95% C.I. for aOR |
|---|---|---|---|---|
| **Cotton Dust Exposure (Ref: < TLV)** | -1.430 | 0.006 | 4.18 | 1.51 to 11.63 |
| **Gender (Ref: Female)** | 0.717 | 0.184 | 2.05 | 1.41 to 5.89 |
| **Age (years)** | -0.027 | 0.623 | 1.03 | 0.89 to 1.08 |
| **Length of Employment (years)** | -0.195 | 0.023 | 1.21 | 1.03 to 1.44 |
| **Constant** | 2.334 | | | |

Dependent variable: Pulmonary obstruction

Table 5 contains performance results from the binary logistic regression model, which determines textile industry worker pulmonary obstruction statuses. The results showed that the model achieved 75.0% accuracy while detecting pulmonary obstruction with 80.0% sensitivity alongside 68.4% specificity for normal readings.

**Table 5. Classification Table of Logistic Regression Model Predictions for Pulmonary Obstruction Status among Textile Industry Workers**

| Observed / Predicted | Normal | Obstruction | % Correct |
|---|---|---|---|
| **Actual Normal** | 26 | 12 | 68.4% |
| **Actual Obstruction** | 10 | 40 | 80.0% |
| **Overall** | | | 75.0% |

## DISCUSSION

Researchers studied how cotton dust levels in conjunction with worker age, length of service, and employee gender relate to obstructive pulmonary diseases within Surakarta textile factories. Pulmonary obstruction was significantly associated with cotton dust exposure and length of employment, but not with age or gender.

**Cotton Dust Exposure and Pulmonary Obstruction**

Exposure to cotton dust produces pulmonary obstructions as the primary study result. Pulmonary obstruction demonstrates a substantial connection to contact with cotton dust, which stands as the primary finding from this research. Workers who worked with cotton dust concentrations exceeding demonstrated a greater likelihood of developing pulmonary obstruction than workers with dust levels under TLV. The odds of pulmonary obstruction were elevated five times for workers exposed above the Threshold Limit Value (OR = 5.05, $p < 0.001$, binary logistic regression analysis). The finding is consistent with the literature, which has evidenced a link between cotton dust exposure and reduced lung function among workers in the textile sector (5,10–12). Increased concentrations of respirable dust in the textile work environment have been closely linked to decreased FEV1/FVC ratios and increased COPD prevalence, as demonstrated in earlier research (22). Respirable cotton dust can cause chronic airway inflammation and reduced lung function, which can ultimately progress to COPD over time (9). Although exposure to cotton dust is implicated in the risk of pulmonary obstruction, other factors, such as employment duration, are also involved in the disease. Exposure duration for over 10 years has been identified to have an independent role in increasing the risk of occupational lung diseases in workers in the cotton spinning industry (23). Therefore, occupational control of exposure to cotton dust is quite essential in order to reduce the risk of pulmonary illness in textile workers.

**Age as a Risk Factor**

From the current research, the simple binary logistic regression test (Table 3) revealed that age was significantly related to the incidence of pulmonary obstruction. That is, at an individual level, an increase in age is associated with an increased risk of pulmonary obstruction among textile workers. This finding agrees with research that states that physiological aging makes the lungs less flexible and increases the risk of COPD (24,25). Decline in lung function is also a natural consequence of degeneration and damage to alveolar structure, as well as elastic tissue depletion in the lungs with increasing age (26). However, the


https://doi.org/10.56303/jhnresearch.v4i2.420

result of the multiple binary logistic regression analysis (Table 4) showed that age was no longer significantly associated with pulmonary obstruction once other variables such as cotton dust exposure, employment duration, and gender were taken into account in the model. This suggests the existence of confounding effects of other variables, more precisely length of employment or cotton dust exposure, which are highly correlated with age. In an epidemiological context, if two variables are correlated and one is a direct cause and the other is not, the effect seen in bivariate analysis can disappear after adjustment for confounders in multivariate analysis (27,28). That is, older workers' risk of pulmonary obstruction was elevated not necessarily because of their chronological age, but most likely due to earlier cumulative exposure to cotton dust or longer length of Employment. Controlling for other effects of variables, therefore, age itself was not independently associated with pulmonary obstruction.

**Length of Employment as a Risk Factor**

The findings from the simple binary logistic regression (Table 3) indicated that employment duration had a significant correlation with pulmonary obstruction incidence. Additionally, more discussion is required as regards the accuracy and below average specificity (75% and 68.4%) achieved by the predictive model in this case. This is a corollary of additional validation and an enhancement of the model's specificity for predicting the risks of pulmonary obstruction.

In the multiple binary logistic regression analysis (Table 4), other variables like exposure to cotton dust, age, and gender were controlled for, but the relationship persisted as statistically significant. This, therefore, indicates that employment duration is an independent risk factor in pulmonary obstruction in textile workers. This result can be attributed to cumulative exposure to cotton dust throughout years of employment. The more years one spends being exposed to particulates within the work environment, the greater the chances of cumulative respiratory tract damage (5,7). Epidemiological data show that working duration in settings where there is exposure to cotton dust adds to low lung capacity, even at permissible amounts of exposure (9,13). Moreover, increased employment duration is also usually associated with recurrent exposure to organic dust irritants, whose chronic inflammation can lead to small airway fibrosis and additional obstructive disorders (29–31). Such an effect is progressive and irreversible unless intervened upon by appropriate preventive actions (32). Therefore, while day's exposure to cotton dust is the predominant factor, cumulative exposure duration over years is the most predictive factor of pulmonary obstruction. The findings are indicative of the importance of observing workplaces in terms of exposure-duration and of the periodic assessment of the lung function among the textile workers with histories of long service.

**Gender as a Risk Factor**

Although to multivariate analysis gender was not significant (p= 0.423), the distribution pattern indicates relatively higher prevalence of pulmonary obstruction among female workers (60.9%) than among males (52.4%). It is possible for this finding to be influenced by two main factors. environmental and physiological. According to the environmental approach, female workers in the textile industry are usually allotted to the production departments (such as spinning or carding departments) with high quantities of dust exposure (33). Hence, female workers in the textile industries are exposed to a high amount of cotton dust particles in the air. Physiologically, females have diminished airway lumens and smaller total lung volume than males (34–36), are therefore more prone to deposition of inhaled particulates, and more damaged by obstructive pulmonary effects (37). Such job and biological variation mean female employees will be more likely to be prone to respiratory illnesses even if they are equally exposed. More advanced studies with more detailed designs may be needed to more clearly define the contribution of gender to COPD development in the textile industry.

**Policy Implications and Preventive Actions**

Workplace research data shows important rules to minimize hazardous dust exposure by focusing on both experienced workers as well as older employees. Nevertheless, PPE recommendations should specify the type of mask which is to be used, as per current trends such as N95 masks, and ventilation advice should report the addition of local exhaust ventilation in areas where cotton dust exceeds Threshold Limit Value (TLV). More so, dust monitoring apparatus have to be installed in high-risk manufacturing regions and that of rotation of workers should also be practiced in order to control extended working hours


https://doi.org/10.56303/jhnresearch.v4i2.420

in high dust zones. Focus on personal protective equipment (PPE) implementation should stand as a priority, while enhanced workplace ventilation and minimized dust exposure work in combination with standardized mask usage. Further monitoring must occur for workers who have spent long periods on the job, primarily within industries that expose them to high levels of dust. Widespread implementation of occupational health programs that feature systematic pulmonary function tests enables earlier diagnosis of textile worker pulmonary conditions.

**Limitations of the Study**

The shortcomings of the study have to be addressed. For instance, cross-sectional study cannot make causal inference. A tendency for selection bias can be introduced when a purposive sampling method is applied, and reporting of smoking history may result in over estimation of the cotton dust effect.

**Policy Implications and Preventive Measures**

The research data establishes a need for more rigorous workplace dust standards to protect older workers and those who remain in prolonged exposure conditions. Personal protective equipment (PPE) with standardized masks forms the cornerstone of preventive measures, while improved ventilation systems and reduced workplace dust remain essential for worker safety. Formulated control measures successfully decrease occupational dust exposure to preserve workers' pulmonary function. The research shows that worker surveillance needs to be ramped up during long-term employment periods, especially within industries prone to high dust exposure conditions. Laboratory screenings for lung efficiency form a vital component of essential occupational health management, which detects pulmonary conditions early in textile manufacturing environments.

## CONCLUSION

This study shows independence of dust exposure with > Threshold Limit Value (TLV), work history ≥ 10 years as risk factors for pulmonary obstruction among textile factory workers. (OR 4.18-5.05). Although non-significant gender and age may be used to stimulate additional studies, which would aim at realising the cause behind the difference in the percentage of pulmonary obstruction between female workers (60.9%) and male workers (52.4%). Technical recommendations: 1) Local exhaust ventilation systems to be installed in dusty environments, 2) Routine spirometry screening, especially in employees who have worked for ≥10 years at dusty work surroundings, and 3) The use of standardized N95 respirators. These measures for control come with the Minister of Health Republic of Indonesia Regulation Number 70 of 2016 on Environmental Health Standards and Industrial Workplace Requirements to necessitate controlling the workplace exposure by physical and chemical hazards to ensure the health of the workers. Thus, future studies should be longitudinal and take into consideration control over other risk factors (including smoking) to validate evidence between cotton dust exposure and impaired pulmonary function.

## FUNDING

This research was funded by RKAT PTNBH Universitas Sebelas Maret for the 2025 Fiscal Year through the Penguatan Kapasitas Grup Riset (PKGR-UNS) C research scheme, under the Research Assignment Agreement Number: 371/UN27.22/PT.01.03/2025. The funding was provided by Lembaga Penelitian dan Pengabdian kepada Masyarakat (LPPM) Universitas Sebelas Maret.

## ACKNOWLEDGMENTS

The authors thank the Research and Community Service Institute of Universitas Sebelas Maret for providing the funding used for this study. Appreciative gratitude is also extended to PT. Iskandar Indah Printing Textile Surakarta for their support and cooperation towards conducting this research. The study would not have been carried out successfully without their help.



https://doi.org/10.56303/jhnresearch.v4i2.420

## CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest related to this study.

## REFERENCES


1. Viegi G, Maio S, Fasola S, Baldacci S. Global Burden of Chronic Respiratory Diseases. J Aerosol Med Pulm Drug Deliv [Internet]. 2020;33(4):171–7. Available from: https://www.liebertpub.com/doi/10.1089/jamp.2019.1576
2. Getahun B, Bekel AA. Work - Related Chronic Obstructive Pulmonary Disease. In: intechOpen [Internet]. 2021. p. 1–13. Available from: http://dx.doi.org/10.1039/C7RA00172J%0Ahttps://www.intechopen.com/books/advanced-biometric-technologies/liveness-detection-in-biometrics%0Ahttp://dx.doi.org/10.1016/j.colsurfa.2011.12.014
3. Murgia N, Akgun M, Blanc PD, Costa JT, Moitra S, Muñoz X, et al. The Occupational Burden of Respiratory Diseases, an Update. Pulmonology [Internet]. 2024;31(1):1–16. Available from: https://doi.org/10.1016/j.pulmoe.2024.03.004
4. Islam T. Health Concerns of Textile Workers and Associated Community. Inq J Healthc Provis Public Heal [Internet]. 2022;59:1–8. Available from: https://journals.sagepub.com/doi/10.1177/00469580221088626
5. Sadia A, Ali Y, Tahir HN, Shaukat N, Irfan M, Nafees AA. Effect of Cotton Dust Exposure on Respiratory Health Outcomes Among Textile Workers. J Ayub Med Coll Abbottabad [Internet]. 2023;35(1):104–9. Available from: https://jamc.ayubmed.edu.pk/index.php/jamc/article/view/10901
6. Ahmad S, Kashmiri MJ, Ur K, Khalil R, Shaheen A, Saleemi MA, et al. Chest Tightness and Chronic Cough; Respiratory Symptoms Among Home-Based Textile Industry Workers. Pakistan J Public Heal [Internet]. 2024;14(March):24–7. Available from: https://pjph.org/pjph/article/view/1235
7. Umaiyah C, Savitri RI, Adriyani R. Paparan Endotoksin Sebagai Faktor Risiko Penurunan Fungsi Paru Pada Pekerja di Industri Tekstil Berbahan Baku Kapas: Literatur Review. J Kesehat Lingkung [Internet]. 2022;19(2):239–44. Available from: https://ejournal.kesling-poltekkesbjm.com/index.php/JKL/article/view/490
8. Daba Wami S, Chercos DH, Dessie A, Gizaw Z, Getachew A, Hambisa T, et al. Cotton Dust Exposure and Self-reported Respiratory Symptoms among Textile Factory Workers in Northwest Ethiopia: A Comparative Cross-sectional Study. J Occup Med Toxicol [Internet]. 2018;13(1):1–7. Available from: https://occup-med.biomedcentral.com/articles/10.1186/s12995-018-0194-9
9. Menon B, Mrigpuri P, Tiwari M, Raj P. Diffuse Lung Disease Caused by Cotton Dust Exposure. J Lung, Pulm Respir Res [Internet]. 2018;5(6):176–8. Available from: https://medcraveonline.com/JLPRR/diffuse-lung-disease-caused-by-cotton-dust-exposure.html
10. Elshaer N, Foda N, Shehata S. Respiratory Symptoms and Pulmonary Function Impairment among Textile Industry Workers in Alexandria, Egypt. J Public Health Africa [Internet]. 2023;14(10):10. Available from: https://publichealthinafrica.org/index.php/jphia/article/view/65
11. Kadam PH, Patil SN. Evaluation of Lung Function by Spirometry in Textile Mill Workers. Int J Recent Innov Trends Comput Commun [Internet]. 2023;11(9):3074–82. Available from: https://ijritcc.org/index.php/ijritcc/article/view/9447
12. Ali NA, Nafees AA, Fatmi Z, Syed IA. Dose-Response of Cotton Dust Exposure with Lung Function among Textile Workers: MultiTex study in Karachi, Pakistan. Int J Occup Environ Med [Internet]. 2018;9(3):120–8. Available from: https://ecommons.aku.edu/cgi/viewcontent.cgi?article=1330&context=pakistan_fhs_son
13. Zele YT, Kumie A, Deressa W, Moen BE, Bråtveit M. Reduced Cross-shift Lung Function and Respiratory Symptoms among Integrated Textile Factory Workers in Ethiopia. Int J Environ Res Public Health [Internet]. 2020;17(8):1–13. Available from: https://www.mdpi.com/1660-




https://doi.org/10.56303/jhnresearch.v4i2.420

4601/17/8/2741

14. Ramasamy L, Vignesh D, Kannan S, Sathiyamoorthy R, Selvaraja C, Ojha UC, et al. Pooled Prevalence of Byssinosis in India: A Systematic Review and Meta-analysis. J Assoc Pulmonologist Tamil Nadu [Internet]. 2024;7(1):8–15. Available from: https://journals.lww.com/jatn/pages/articleviewer.aspx?year=2024&issue=07010&article=00004&type=Fulltext
15. Zhao M, Wei L, Zhang L, Hang J, Zhang F, Su L, et al. Proteomic Biomarkers of Long-term Lung Function Decline in Textile Workers: a 35-year Longitudinal Study. J Expo Sci Environ Epidemiol [Internet]. 2024;(September):1–9. Available from: https://www.nature.com/articles/s41370-024-00721-7
16. Anyfantis ID, Rachiotis G, Hadjichristodoulou C, Gourgoulianis KI. Respiratory symptoms and lung function among greek cotton industry workers: A cross-sectional study. Int J Occup Environ Med [Internet]. 2017;8(1):32–8. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC6679635/
17. Muttoo S, Jeena PM, Röösli M, de Hoogh K, Meliefste K, Tularam H, et al. Effect of short-term exposure to ambient nitrogen dioxide and particulate matter on repeated lung function measures in infancy: A South African birth cohort. Environ Res [Internet]. 2022;213(June):1–7. Available from: https://www.sciencedirect.com/science/article/pii/S0013935122009720?via%3Dihub
18. Dimakopoulou K, Tomos I, Manali ED, Papiris SA, Karakatsani A. Effects of Short-term Air Pollution Exposure on Symptoms Development in the Course of Idiopathic Pulmonary Fibrosis. Expert Rev Respir Med [Internet]. 2023;17(11):1069–78. Available from: https://tandf.figshare.com/articles/dataset/Effects_of_short-term_air_pollution_exposure_on_symptoms_development_in_the_course_of_idiopathic_pulmonary_fibrosis/24558359
19. Alonso DE, Richards T, Binkley J. Comprehensive Screening of Pollutants in Household Dust Using High-Resolution Mass Spectrometry with Enhanced Chromatographic Resolution. LCGC North Am [Internet]. 2022;20(1):7–12. Available from: https://www.chromatographyonline.com/view/comprehensive-screening-of-pollutants-in-household-dust-using-high-resolution-mass-spectrometry-with-enhanced-chromatographic-resolution
20. Kementerian Kesehatan Republik Indonesia. Peraturan Menteri Kesehatan Republik Indonesia Nomor: 70 Tahun 2016 Tentang Standar dan Persyaratan Kesehatan Lingkungan Kerja Industri [Internet]. Jakarta: Kementerian Kesehatan Republik Indonesia; 2016. p. 1–197. Available from: https://peraturan.bpk.go.id/Details/114490/permenkes-no-70-tahun-2016
21. GOLD. Pocket Guide to COPD Diagnosis, Management, and Prevention: A Guide for Health Care Professionals [Internet]. 2023 Editi. A Guide for Health Care Professionals. 2023. 1–55 p. Available from: https://goldcopd.org/2023-gold-report-2/
22. Oo TW, Thandar M, Htun YM, Soe PP, Lwin TZ, Tun KM, et al. Assessment of Respiratory Dust Exposure and Lung Functions among Workers in Textile Mill (Thamine), Myanmar: A Cross-sectional Study. BMC Public Health [Internet]. 2021;21(1):1–10. Available from: https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-021-10712-0
23. Chadha S, Kundu D, Sagili K, Das A. Byssinosis and Tuberculosis amongst "Home-Based" Powerloom Workers in Madhya Pradesh State, India. Indian J Tuberc [Internet]. 2019;66(3):407–10. Available from: https://www.sciencedirect.com/science/article/abs/pii/S0019570717304201
24. Górski P, Białas AJ, Piotrowski WJ. Aging Lung: Molecular Drivers and Impact on Respiratory Diseases—A Narrative Clinical Review. Antioxidants [Internet]. 2024;13(12). Available from: https://www.mdpi.com/2076-3921/13/12/1480
25. Budde J, Skloot G. Aging and Susceptibility to Pulmonary Disease. Compr Physiol [Internet]. 2022;12(3):3509–22. Available from: https://onlinelibrary.wiley.com/doi/10.1002/cphy.c210026
26. Schulte H, Mühlfeld C, Brandenberger C. Age-Related Structural and Functional Changes in the Mouse Lung. Front Physiol [Internet]. 2019;10(December):1–15. Available from:



https://doi.org/10.56303/jhnresearch.v4i2.420

https://www.frontiersin.org/journals/physiology/articles/10.3389/fphys.2019.01466/full

27. Mendoza J, Marcus-Mendoza S. Statistical Control [Internet]. The SAGE Encyclopedia of Research Design. 2017. p. 1–4. Available from: https://sk.sagepub.com/ency/edvol/the-sage-encyclopedia-of-research-design-2e/chpt/statistical-control
28. Attia JR, Oldmeadow C, Holliday EG, Jones MP. Deconfounding Confounding Part 2: Using Directed Acyclic Graphs (DAGs). Med J Aust [Internet]. 2017;206(11):480–3. Available from: https://onlinelibrary.wiley.com/doi/abs/10.5694/mja16.01167
29. Poole JA, Zamora-Sifuentes JL, De las Vecillas L, Quirce S. Respiratory Diseases Associated With Organic Dust Exposure. J Allergy Clin Immunol Pract [Internet]. 2024;12(8):1960–71. Available from: https://doi.org/10.1016/j.jaip.2024.02.022
30. Alif SM, Benke G. Unveiling the Occupational Hazards: Exploring the Association Between Organic Dust Exposure and Hypersensitivity Pneumonitis and Other Interstitial Lung Diseases. Thorax [Internet]. 2024;79(9):5–10. Available from: https://thorax.bmj.com/content/79/9/805
31. Lee CT, Johannson KA. Occupational exposures and IPF: When the dust unsettles. Thorax. 2020;75(10):828–9.
32. Tefera Y. Cotton and Other Textile Dusts. Patty's Toxicol [Internet]. 2023;1–13. Available from: https://onlinelibrary.wiley.com/doi/10.1002/0471125474.tox018.pub3
33. Hamza SJ, Abbas AH, Hamoud SS. Physiological Changes And Clinical Findings In Females Textile Factory Workers. Al-Qadisiyah Med J [Internet]. 2017;12(22):65–70. Available from: https://qmj.qu.edu.iq/index.php/QMJ/article/view/511
34. Christou S, Chatziathanasiou T, Angeli S, Koullapis P, Stylianou F, Sznitman J, et al. Anatomical Variability in the Upper Tracheobronchial Tree: Sex-based Differences and Implications for Personalized Inhalation Therapies. J Appl Physiol [Internet]. 2021;130(3):678–707. Available from: https://journals.physiology.org/doi/full/10.1152/japplphysiol.00144.2020
35. Mann LM, Angus SA, Doherty CJ, Dominelli PB. Evaluation of sex-based differences in airway size and the physiological implications. Eur J Appl Physiol [Internet]. 2021;121(11):2957–66. Available from: https://doi.org/10.1007/s00421-021-04778-2
36. Bhatt SP, Bodduluri S, Nakhmani A, Kim Y Il, Reinhardt JM, Hoffman EA, et al. Sex Differences in Airways at Chest CT: Results from the COPDGene Cohort. Radiology [Internet]. 2022;305(3):699–708. Available from: https://pubs.rsna.org/doi/10.1148/radiol.212985
37. Milne KM, Mitchell RA, Ferguson ON, Hind AS, Guenette JA. Sex-Differences in COPD: From Biological Mechanisms to Therapeutic Considerations. Front Med [Internet]. 2024;11(March):1–7. Available from: https://www.frontiersin.org/journals/medicine/articles/10.3389/fmed.2024.1289259/full



https://doi.org/10.56303/jhnresearch.v4i2.420