



Higher Risk of Airway Obstruction in Male Garment Workers Associated with Smoking and Occupational Exposure

Ni Wayan Rusni¹✉, Tanjung Subrata¹, Luh Gede Sri Yenny¹

¹ Faculty of Medicine and Health Sciences, Warmadewa University, Denpasar, Bali, Indonesia

Article Info

Article History:

Received:

10 April 2026

Revised:

23 June 2026

Accepted:

24 July 2026

Published:

30 July 2026

Keywords:

Airway Obstruction

Lung Function

Garment Workers

Occupational Exposure

Risk Factors

Citation:

Rusni, N.W., Subrata, T., &

Yenny, L.G.S. (2026).

Higher Risk of Airway

Obstruction in Male

Garment Workers

Associated with Smoking

and Occupational

Exposure. *MEDICA*

(*International Medical*

Scientific Journal), 8(7),

619–630.

[https://doi.org/10.53770/me](https://doi.org/10.53770/medica.v8i7.932)

[dica.v8i7.932](https://doi.org/10.53770/medica.v8i7.932)

Abstract

Respiratory disorders remain an important occupational health concern among garment workers due to workplace conditions and individual behavioral and health-related factors. However, evidence regarding factors associated with airway obstruction in this occupational group remains limited. This study aimed to identify factors associated with airway obstruction among garment workers in Badung Regency, Bali. An analytical observational study with a cross-sectional design was conducted among 52 garment workers selected using simple random sampling. Primary data were collected through structured interviews and spirometry examinations. Independent variables included demographic characteristics, clinical factors, occupational characteristics (including working duration), and behavioral factors. Data were analyzed using descriptive statistics, Chi-square tests, and Odds Ratio (OR) analysis with a significance level of $p < 0.05$. Airway obstruction was identified in 34.6% of respondents. Significant associations were observed between airway obstruction and gender, body mass index (BMI), blood pressure, heart rate, working duration, health history, and smoking habits ($p < 0.05$). Higher odds of airway obstruction were observed among male workers ($OR = 26.40$), workers with poor health history ($OR = 12.92$), hypertension ($OR = 8.00$), and smoking habits ($OR = 6.00$). Age and personal protective equipment (PPE) use were not significantly associated with airway obstruction. These findings should be interpreted cautiously because of the relatively small sample size. Airway obstruction among garment workers was associated with multiple demographic, clinical, occupational, and behavioral factors, particularly smoking habits and longer working duration. Since workplace dust exposure was not directly measured, the observed occupational associations should be interpreted as indirect indicators rather than direct measures of exposure. Further studies with larger sample sizes and objective environmental exposure assessments are recommended.

© 2026 Borneo Scientific Publishing

Corresponding Author:

✉ Ni Wayan Rusni

Faculty of Medicine and Health Sciences, Warmadewa University, Denpasar, Bali, Indonesia

Email: rusni@warmadewa.ac.id

1. INTRODUCTION

The textile and garment industry is one of the largest labor-intensive sectors globally, including in Indonesia, employing millions of workers and contributing significantly to economic growth. Despite its economic importance, garment production involves several workplace conditions that can adversely impact respiratory health, including the generation of textile dust during cutting, sewing, and finishing processes (Sun et al., 2025; Seidu et al., 2024). Previous studies have shown that prolonged exposure to airborne textile dust, particularly cotton dust containing endotoxins, is associated with airway inflammation and impaired lung function. However, the extent of exposure varies widely across workplaces, depending on ventilation systems, production processes, housekeeping practices, and occupational health controls (Subramaniam et al., 2024; He et al., 2022).

In Indonesia, occupational respiratory health among garment workers remains poorly documented, especially in small and medium-sized enterprises (Seidu et al., 2024; Subramaniam et al., 2024). Although work environment monitoring data, such as airborne dust concentrations, are rarely available in such settings, workers may experience respiratory risks associated with long work periods, workplace ventilation, inconsistent use of personal protective equipment (PPE), and other job characteristics (Hasle et al., 2021). Despite the rapid growth of the garment sector in regions such as Bali, research focusing on respiratory health among garment workers is still limited, creating a gap in evidence-based occupational health interventions. This lack of local evidence highlights the need for studies assessing factors associated with airway obstruction to support occupational health surveillance and preventive interventions.

The urgency of this issue lies in the potential long-term impact of occupational exposure on lung function (Lytras et al., 2021; Oo TW et al., 2021). Prolonged exposure to textile dust has been associated with both acute and chronic respiratory conditions, including obstructive airway diseases such as byssinosis and chronic bronchitis (Mozaffari et al., 2023; Poole et al., 2024). Previous studies have demonstrated that extended duration of exposure and inadequate workplace protection significantly increase the risk of respiratory symptoms and lung function decline, highlighting the need for early detection and preventive strategies (Sumardiyono et al., 2025).

Recent studies have explored the relationship between occupational dust exposure and lung function decline (He et al., 2022; Zheng et al., 2024). Longitudinal studies have reported progressive reductions in forced expiratory volume in one second (FEV1) among textile workers, while cross-sectional studies have identified significant associations between exposure duration and respiratory impairment (Henneberger et al., 2023). However, findings remain inconsistent, as some studies report weak or non-significant relationships depending on exposure intensity, individual susceptibility, and workplace conditions.

The novelty of this study lies in its focus on integrating individual characteristics, clinical conditions, and occupational factors in assessing airway obstruction among garment workers in Badung Regency, Bali. Unlike previous studies that primarily emphasize exposure duration, this research provides a more comprehensive analysis by incorporating multiple determinants of lung function, including behavioral and health-related variables within a specific local industrial setting.

Although previous studies have emphasized the importance of quantitative exposure assessment through environmental monitoring, such measurements were not available in the present study setting. Consequently, this study does not attempt to quantify workplace dust exposure. Instead, occupational characteristics, including working duration and PPE use, were evaluated as proxy indicators of potential workplace-related

respiratory risk. Therefore, the findings should be interpreted as associations between occupational characteristics and airway obstruction rather than direct effects of measured occupational exposure.

Therefore, the objective of this study is to analyze the association between individual characteristics, clinical conditions, and occupational factors with lung function status, particularly the occurrence of airway obstruction, among garment workers in Badung Regency, Bali.

2. METHODS

This research employed an analytical observational design with a cross-sectional approach, aiming to examine the relationship between individual characteristics, occupational factors, and lung function status among workers at a single point in time. This study was conducted at a medium-scale garment company located in Badung Regency, Bali, Indonesia. The data collection was carried out over the period from September 2024 to January 2025.

The study population consisted of workers employed at a medium-scale garment company in Badung Regency, Bali. A total of 52 workers met the eligibility criteria and participated in this study using a simple random sampling technique. Inclusion criteria were active employment during the study period and willingness to participate by providing written informed consent. Workers with incomplete data or who were absent during data collection were excluded. Because the number of eligible workers in the study setting was limited, no formal a priori sample size calculation was performed. Instead, all eligible workers available during the study period were considered for recruitment to maximize the study sample. Although this approach increased participant inclusion, the relatively small sample size should be taken into account when interpreting the findings and may reduce the statistical precision and generalizability of the results.

The dependent variable was airway obstruction, determined by spirometry examination and classified as obstructive or non-obstructive. The independent variables included demographic characteristics (age and gender), clinical characteristics (body mass index, blood pressure, heart rate, and health history), occupational characteristics (working duration and personal protective equipment [PPE] use), and behavioral factors (smoking habit). Age was categorized into young, adult, and elderly according to the age grouping used in this study. Working duration was classified as moderate and long based on years of employment at the garment company. Health history was categorized as good or poor according to respondents' self-reported history of chronic illness obtained through structured interviews. PPE use was classified as using or not using PPE, while smoking habit was categorized as smoker or non-smoker.

Primary data were collected through structured interviews and spirometry examinations. A standardized questionnaire was used to obtain information on demographic characteristics, occupational history, health status, and behavioral factors. Lung function was measured using a spirometer to assess ventilatory parameters, particularly forced expiratory volume in one second (FEV1), which was used to classify obstructive pulmonary status. All measurements were conducted following standard procedures to ensure accuracy and reliability.

Data analysis was performed using statistical software. Descriptive analysis was conducted to summarize respondent characteristics in the form of frequency distributions and percentages. Bivariate analysis using the Chi-square test was applied to assess the association between independent variables and obstructive pulmonary status. Furthermore, Odds Ratio (OR) analysis with 95% confidence intervals was used to determine the magnitude of risk for each variable. A p-value of less than 0.05 was

considered statistically significant. The results were presented in tables and narrative descriptions to provide a clear and systematic interpretation of the findings.

Ethical considerations were strictly observed throughout the study. Ethical approval was obtained from the Ethics Committee of the Faculty of Medicine and Health Sciences, Universitas Warmadewa (Approval No: 569/Unwar/FKIK/KEP-K/II/2025). All participants provided informed consent prior to data collection, and confidentiality of the respondents' information was maintained.

3. RESULTS AND DISCUSSION

Table 1. Distribution of respondents by demographic, clinical, and behavioral characteristics (n = 52).

Variable	Category	Frequency (n)	Percentage (%)
Age	Young	13	25.0
	Adult	22	42.3
	Elderly	17	32.7
Gender	Female	43	82.7
	Male	9	17.3
Body Mass Index (BMI)	Underweight	5	9.6
	Normal	12	23.1
	Overweight	13	25.0
	Obese	22	42.3
Blood Pressure	Hypotension	1	1.9
	Normal	40	76.9
	Hypertension	11	21.2
Heart Rate	Normal	35	67.3
	Tachycardia	17	32.7
Working Duration	Moderate	35	67.3
	Long	17	32.7
Health History	Poor	13	25.0
	Good	39	75.0
Personal Protective Equipment (PPE)	Not using PPE	27	51.9
	Using PPE	25	48.1
Smoking Habit	Smoker	12	23.1
	Non-smoker	40	76.9
Obstructive Status	Obstructive	18	34.6
	Non-obstructive	34	65.4

Table 1 presents the distribution of respondents based on demographic, clinical, and behavioral characteristics. The majority of participants were female (82.7%) and adults (42.3%). Most respondents had normal blood pressure (76.9%) and normal heart rate (67.3%). Regarding nutritional status, a large proportion of participants were classified as obese (42.3%). Most respondents reported good health history (75.0%) and were non-smokers (76.9%). In terms of occupational factors, 67.3% of respondents had a moderate working duration, and approximately half of them reported not using personal protective equipment (51.9%). The prevalence of obstructive pulmonary condition among respondents was 34.6%, while the majority (65.4%) were classified as non-obstructive.

Table 2. Association between respondent characteristics and obstructive pulmonary status (n = 52).

Variable	Category	Obstructive n (%)	Non- Obstructive n (%)	Total
Age	Young	5 (38.5%)	8 (61.5%)	13
	Adult	8 (36.4%)	14 (63.6%)	22
	Elderly	5 (29.4%)	12 (70.6%)	17
Gender	Female	10 (23.3%)	33 (76.7%)	43
	Male	8 (88.9%)	1 (11.1%)	9
Body Mass Index (BMI)	Underweight	1 (20.0%)	4 (80.0%)	5
	Normal	2 (16.7%)	10 (83.3%)	12
	Overweight	5 (38.5%)	8 (61.5%)	13
	Obese	10 (45.5%)	12 (54.5%)	22
Blood Pressure	Hypotension	0 (0%)	1 (100%)	1
	Normal	10 (25.0%)	30 (75.0%)	40
	Hypertension	8 (72.7%)	3 (27.3%)	11
Heart Rate	Normal	8 (22.9%)	27 (77.1%)	35
	Tachycardia	10 (58.8%)	7 (41.2%)	17
Working Duration	Moderate	8 (22.9%)	27 (77.1%)	35
	Long	10 (58.8%)	7 (41.2%)	17
Health History	Poor	10 (76.9%)	3 (23.1%)	13
	Good	8 (20.5%)	31 (79.5%)	39
Personal Protective Equipment (PPE)	Not using PPE	10 (37.0%)	17 (63.0%)	27
	Using PPE	8 (32.0%)	17 (68.0%)	25
Smoking Habit	Smoker	8 (66.7%)	4 (33.3%)	12
	Non-smoker	10 (25.0%)	30 (75.0%)	40

Based on the cross-tabulation in Table 2, it can be seen that the proportion of obstructive events was higher in the male group, respondents with an obese BMI, hypertensive blood pressure, tachycardia, longer work experience, poor medical history, and respondents with a smoking habit. Conversely, the proportion of obstructive events was lower in the group with normal physiological conditions and no risk factors. The variables of age and PPE use did not show significant differences between the obstructive and non-obstructive groups. These results align with the chi-square test, which indicates that most of these variables have a significant relationship with the incidence of airway obstruction.

Table 3. Results of chi-square test for the association between independent variables and obstructive pulmonary status (n = 52).

Variable	Chi-Square (χ^2)	df	p-value	Interpretation
Age	2.346	2	0.309	Not significant
Gender	22.231	1	0.000	Significant
Body Mass Index (BMI)	11.231	3	0.011	Significant
Blood Pressure	47.346	2	0.000	Significant
Heart Rate	6.231	1	0.013	Significant
Working Duration	6.231	1	0.013	Significant
Health History	13.000	1	0.000	Significant
Personal Protective Equipment (PPE)	0.077	1	0.782	Not significant
Smoking Habit	15.077	1	0.000	Significant
Obstructive Status	4.923	1	0.027	Significant

Based on the Chi-Square test results in Table 3, several variables were found to be significantly associated with the incidence of airway obstruction ($p < 0.05$). Variables significantly associated with these variables included gender, BMI, blood pressure, pulse rate, length of service, medical history, and smoking habits. This indicates that these factors are associated with impaired lung function. Conversely, age and use of personal protective equipment (PPE) did not show a significant association with the incidence of obstructive events ($p > 0.05$). Thus, it can be concluded that individual characteristics and health conditions largely play a role in influencing the incidence of airway obstruction in respondents.

Table 4. Odds ratios and 95% confidence intervals for factors associated with obstructive pulmonary status ($n = 52$).

Variable	Odds Ratio (OR)	95% Confidence Interval (CI)	Interpretation
Gender (Male vs Female)	26.40	2.94 – 237.0	Very high risk
Body Mass Index (Obese vs non-obese)	3.75	1.05 – 13.4	Significant
Blood Pressure (Hypertension vs normal)	8.00	1.80 – 35.5	Strongly significant
Heart Rate (Tachycardia vs normal)	4.82	1.36 – 17.1	Significant
Working Duration (Long vs moderate)	4.82	1.36 – 17.1	Significant
Health History (Poor vs good)	12.92	2.90 – 57.5	Strongly significant
Personal Protective Equipment (No PPE vs PPE)	1.25	0.38 – 4.10	Not significant
Smoking Habit (Smoker vs non-smoker)	6.00	1.54 – 23.3	Significant

Based on the Odds Ratio analysis in Table 4, several variables were found to significantly influence the risk of airway obstruction. Males were 26.4 times more likely to experience obstruction than females. Furthermore, respondents with an obese BMI were 3.75 times more likely to experience obstruction compared to other categories. Hypertension increased the risk of obstruction by eight times, while tachycardia and longer work hours each increased the risk by 4.82 times. Respondents with a history of poor health were 12.92 times more likely to experience obstruction. Meanwhile, smoking increased the risk by six times compared to non-smokers. The use of personal protective equipment (PPE) did not significantly correlate with the incidence of obstruction (OR = 1.25; CI = 1). Overall, the factors most influential in the incidence of airway obstruction were gender, medical history, blood pressure, and smoking.

The distribution of respondents presented in Table 1 shows that the majority of participants were female and in the adult age group. Most respondents were classified as obese, indicating a potential risk factor for impaired lung function. Most participants had normal blood pressure and heart rate, indicating a relatively stable cardiovascular condition. However, the presence of obesity alongside generally normal vital signs may indicate early or subclinical health risks not yet reflected in routine measurements. Regarding behavioral factors, most respondents were nonsmokers and reported a good medical history, which may contribute to the relatively lower proportion of obstructive lung conditions observed in this study. Despite this, a significant percentage of participants were classified as having obstructive lung status, highlighting the importance of early detection and preventive strategies. Occupational exposures, as reflected by work duration and use of PPE, also varied among respondents, which may impact long-term

respiratory health. Overall, these findings suggest that individual characteristics and lifestyle factors play a significant role in determining lung function status.

The findings of this study indicate that the majority of respondents were female and in the adult age group, which may reflect the demographic composition of the study population. The predominance of obesity among respondents is an important finding, as excess body weight has been widely recognized as a significant risk factor for impaired lung function. Obesity can reduce lung compliance, increase airway resistance, and contribute to decreased respiratory muscle efficiency (Poulain et al., 2022). Although most participants had normal blood pressure and heart rate, this does not necessarily indicate the absence of health risks. The coexistence of obesity with normal vital signs may represent early or subclinical conditions that have not yet manifested in overt physiological abnormalities. This finding is consistent with previous studies suggesting that metabolic and respiratory impairments can develop gradually and may not be immediately detectable through routine clinical measurements (Forno et al., 2021). Behavioral factors such as smoking habits and medical history also play an important role. In this study, the majority of respondents were non-smokers and reported good health status, which may explain the relatively lower proportion of obstructive lung conditions. However, the presence of obstructive cases among this population suggests that other contributing factors, including environmental exposure and occupational risks, should be considered. Occupational factors, including duration of work and the use of personal protective equipment (PPE), showed variability among respondents. Prolonged exposure to occupational hazards without adequate protection may lead to chronic respiratory impairment over time. This is supported by studies highlighting the role of occupational exposure in the development of respiratory diseases (Blanc et al., 2020). Based on the cross-tabulation results, this study found that the proportion of obstructive pulmonary events was higher among males, individuals with obesity, hypertension, tachycardia, longer working duration, poor medical history, and those with smoking habits. These findings highlight the multifactorial nature of obstructive pulmonary disease, where both biological and behavioral factors contribute to disease development. Male respondents demonstrated a higher proportion of obstructive conditions compared to females. This finding is consistent with previous studies suggesting that males are more likely to be exposed to environmental and occupational risk factors, as well as higher smoking prevalence, which may contribute to impaired lung function (Aryal et al., 2021). Obesity was also identified as a significant factor associated with obstructive events. Excess adipose tissue can reduce lung volume, impair diaphragmatic movement, and increase airway resistance, ultimately contributing to decreased pulmonary function (Poulain et al., 2022; Forno et al., 2021). Similarly, hypertension and tachycardia may reflect underlying cardiovascular strain, which has been linked to reduced respiratory efficiency and increased risk of pulmonary dysfunction (Chen et al., 2022). Occupational exposure, represented by longer working duration, was associated with a higher proportion of obstructive cases. Prolonged exposure to dust, chemicals, or pollutants in the workplace has been shown to increase the risk of chronic respiratory diseases (Blanc et al., 2020). In addition, individuals with poor medical history were more likely to experience obstructive conditions, suggesting that pre-existing health status plays a crucial role in respiratory outcomes. Smoking habit remains one of the most important modifiable risk factors. In this study, smokers had a higher proportion of obstructive pulmonary conditions, which is in line with extensive evidence demonstrating that smoking causes chronic airway inflammation, mucus hypersecretion, and progressive airflow limitation (GOLD, 2023). Conversely, respondents with normal physiological conditions and without major risk factors showed lower proportions of obstructive events. Interestingly, age and PPE use

did not show significant differences between groups. This may indicate that age alone is not a determining factor without the presence of other risk exposures, and that PPE effectiveness depends on proper and consistent usage.

Based on the Chi-Square test results, several variables were found to be significantly associated with the incidence of airway obstruction, including gender, body mass index (BMI), blood pressure, pulse rate, length of service, medical history, and smoking habits. These findings indicate that both individual characteristics and clinical conditions contribute to impaired lung function. Gender was significantly associated with airway obstruction, with males showing a higher risk compared to females. This is consistent with previous studies suggesting that males are more likely to be exposed to occupational hazards and smoking, which are known contributors to reduced pulmonary function (Aryal et al., 2021; Yu, H., & Yu, Z., 2025). Body mass index (BMI), particularly obesity, was also significantly associated with obstructive events. Obesity has been shown to negatively affect lung mechanics by reducing lung volumes, impairing diaphragmatic movement, and increasing airway resistance (Poulain et al., 2022; Forno et al., 2021; Shah et al., 2023). These physiological changes may predispose individuals to airflow limitation and respiratory disorders. Cardiovascular-related variables such as blood pressure and pulse rate were also significantly associated with airway obstruction. Hypertension and tachycardia may reflect systemic physiological stress, which has been linked to declining lung function and increased risk of respiratory disease (Chen et al.; 2022; Cesanelli et al.; 2024). Occupational exposure, represented by length of service, was found to have a significant relationship with airway obstruction. Prolonged exposure to workplace hazards such as dust, fumes, and chemicals can lead to chronic respiratory inflammation and airway remodeling (Blanc et al., 2020; Zheng XY et al., 2024). Additionally, individuals with poor medical history were more likely to experience obstructive conditions, indicating the importance of baseline health status in respiratory outcomes. Smoking habit was another significant factor associated with airway obstruction. Smoking is well established as a major cause of chronic airway inflammation, mucus hypersecretion, and progressive airflow limitation (GOLD, 2023; Cazzola et al., 2026). In contrast, age and the use of personal protective equipment (PPE) were not significantly associated with airway obstruction in this study. This may suggest that age alone is not a dominant factor without the presence of other risk exposures. Similarly, the effectiveness of PPE may depend on proper usage, consistency, and quality, which were not fully captured in this study.

Based on the Odds Ratio analysis, several variables were identified as significant risk factors for airway obstruction, highlighting the multifactorial nature of respiratory impairment. Male respondents were found to have a substantially higher risk of airway obstruction compared to females (OR = 26.4). This finding is consistent with previous studies indicating that males are more frequently exposed to occupational hazards and have higher smoking prevalence, both of which contribute to decreased lung function (Aryal et al., 2021; Murgia N, Gambelunghe A, 2022). Obesity was also identified as a significant risk factor, with obese individuals having 3.75 times higher odds of airway obstruction. Excess body fat can impair respiratory mechanics by reducing lung volumes, limiting diaphragmatic movement, and increasing airway resistance (Poulain et al., 2022). In addition, obesity is associated with systemic inflammation, which may further contribute to airway narrowing and functional impairment (Forno et al., 2021). Cardiovascular-related factors such as hypertension and tachycardia were also strongly associated with airway obstruction. Hypertension increased the risk by eight times, while tachycardia increased the risk by 4.82 times. These findings suggest a close relationship between cardiovascular health and pulmonary function, where systemic vascular dysfunction may negatively impact respiratory efficiency (Chen et al., 2022). Occupational exposure, reflected by

longer working duration, was associated with increased risk of airway obstruction (OR = 4.82). Prolonged exposure to workplace pollutants such as dust, fumes, and chemicals has been shown to contribute to chronic airway inflammation and structural lung changes (Blan et al;2020). This emphasizes the importance of occupational health interventions in preventing long-term respiratory disorders. A history of poor health was found to be a strong predictor of airway obstruction (OR = 12.92), indicating that pre-existing medical conditions significantly increase susceptibility to respiratory impairment. Smoking was another major risk factor, increasing the likelihood of airway obstruction by six times. Smoking is well established as a leading cause of chronic airway inflammation, oxidative stress, and progressive airflow limitation (GOLD, 2023). In contrast, the use of personal protective equipment (PPE) did not show a significant association with airway obstruction. This may be due to inconsistent usage, improper fitting, or variability in PPE quality. Therefore, the effectiveness of PPE in preventing respiratory disorders depends not only on availability but also on proper and consistent use.

Although several variables showed statistically significant associations with airway obstruction, these findings should be interpreted with caution. Because this study employed a cross-sectional design, the temporal relationship between the identified factors and airway obstruction cannot be established, and causal inferences cannot be made. Therefore, the observed associations should be interpreted as indicators of potential relationships rather than evidence of direct causation. In addition, occupational characteristics, including working duration, were used as proxy indicators because direct workplace exposure measurements, such as airborne dust concentration or environmental monitoring, were not performed. Future longitudinal studies incorporating objective exposure assessments are needed to further clarify these relationships.

This study shows that about one-third of garment workers experience obstructive lung conditions, indicating a meaningful health concern within the workplace. These problems are more commonly found among male workers, those with a poor health history, high blood pressure, and smoking habits. In addition, factors such as obesity, elevated heart rate, and longer working duration also contribute to the risk. This suggests that decreased lung function does not result from a single cause, but rather from a combination of health conditions, lifestyle behaviors, and workplace exposure. Interestingly, age and the use of personal protective equipment were not significantly related, which may reflect issues with how consistently or correctly the equipment is used.

These findings highlight the importance of focusing on preventable factors. Efforts such as reducing smoking, maintaining a healthy body weight, and conducting regular health check-ups, including lung function tests, are essential. At the same time, improving workplace conditions is equally important, particularly in controlling dust exposure and ensuring that protective equipment is not only available but also properly used. A balanced approach that combines healthier lifestyles with safer working environments can help reduce the risk of respiratory problems among workers.

However, these results should be interpreted with caution. Since the study used a cross-sectional design, it cannot confirm cause-and-effect relationships. The relatively small sample size also limits how broadly the findings can be applied. Additionally, some data were based on self-reports, which may introduce bias. The study also did not explore in detail the level of workplace exposure or the quality and consistency of protective equipment use, which could provide a more complete understanding of the risks faced by workers.

4. CONCLUSION

This study found that airway obstruction among garment workers was associated with several demographic, clinical, behavioral, and occupational characteristics, including male gender, obesity, hypertension, poor health history, longer working duration, and smoking habits. These findings suggest that multiple factors may contribute to impaired lung function among garment workers and highlight the importance of comprehensive workplace health promotion and respiratory disease prevention. Because direct workplace exposure measurements, such as airborne dust concentration or environmental monitoring, were not performed, the observed associations related to occupational characteristics should be interpreted cautiously and should not be considered as evidence of the direct effects of occupational exposure. Further studies incorporating objective environmental exposure assessment and larger sample sizes are recommended to better understand workplace-related respiratory risks.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Ni Wayan Rusni contributed to the conceptualized and designed the study, developed the research methodology, supervised the overall research process, interpreted the findings, and drafted the initial manuscript. Tanjung Subrata contributed to the study design, conducted data collection, and participated in manuscript writing and revision. Luh Gede Sri Yenny contributed to the research design, performed data management and statistical analysis, assisted in interpreting the results, and participated in manuscript writing and revision. All authors made substantial contributions to the research, reviewed and approved the final manuscript.

ACKNOWLEDGEMENT

The authors would like to express their sincere gratitude to the management of the garment company in Badung Regency, Bali, for granting permission and support during the data collection process. Appreciation is also extended to all workers who participated in this study for their time and cooperation. In addition, the authors acknowledge the Faculty of Medicine and Health Sciences, Warmadewa University, for providing institutional support and ethical approval for this research.

FUNDING

This research was funded by the Unit of Research and Community Service (UP2M), Faculty of Medicine and Health Sciences, Warmadewa University.

DECLARATION OF ARTIFICIAL INTELLIGENCE USE

Ni Wayan Rusni used generative artificial intelligence solely to improve the language, grammar, readability, and organization of the manuscript. Tanjung Subrata and Luh Gede Sri Yenny reviewed and validated all AI-assisted revisions. All scientific content, study design, data collection, data analysis, interpretation of the findings, and the final manuscript were developed and approved by the authors, who take full responsibility for the accuracy, originality, and integrity of the manuscript.

REFERENCES

- Aryal, S., Diaz-Guzman, E., & Mannino, D. M. (2021). Influence of sex on chronic obstructive pulmonary disease risk and outcomes. *International Journal of Chronic Obstructive Pulmonary Disease*, 16, 1145–1154. <https://doi.org/10.2147/COPD.S300398>
- Blanc, P. D., & Torén, K. (2020). How much adult asthma can be attributed to occupational factors? *American Journal of Medicine*, 133(3), 269–275. <https://doi.org/10.1016/j.amjmed.2019.08.036>
- Cazzola, M., Rogliani, P., Ora, J., et al. (2026). Mucus as a treatable trait in chronic airway diseases. *Drugs*, 86, 443–463. <https://doi.org/10.1007/s40265-026-02294-1>
- Cesanelli, L., Cesanelli, F., Degens, H., & Satkumskiene, D. (2024). Obesity-related reduced spirometry and altered breathing pattern are associated with mechanical disadvantage of the diaphragm. *Respiratory Physiology & Neurobiology*, 325, 104267. <https://doi.org/10.1016/j.resp.2024.104267>
- Chen, Z., et al. (2022). Cardiovascular risk factors and lung function decline. *BMC Pulmonary Medicine*, 22, 210. <https://doi.org/10.1186/s12890-022-02045-9>
- Forno, E., & Celedón, J. C. (2021). The effect of obesity, weight gain, and weight loss on asthma and lung function. *Current Opinion in Pulmonary Medicine*, 27(1), 45–52. <https://doi.org/10.1097/MCP.0000000000000732>
- GOLD (Global Initiative for Chronic Obstructive Lung Disease). (2023). *Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease (2023 report)*. <https://goldcopd.org>
- Hasle, P., & Vang, J. (2021). Interventions to improve occupational safety and health in the garment industry – Development of new integrated strategies. In N. L. Black, W. P. Neumann, & I. Noy (Eds.), *Proceedings of the 21st Congress of the International Ergonomics Association (IEA 2021)* (Vol. 221). Springer. https://doi.org/10.1007/978-3-030-74608-7_58
- He, W., Jin, N., Deng, H., Zhao, Q., Yuan, F., Chen, F., Zhang, H., & Zhong, X. (2022). Workers' occupational dust exposure and pulmonary function assessment: Cross-sectional study in China. *International Journal of Environmental Research and Public Health*, 19(17), 11065. <https://doi.org/10.3390/ijerph191711065>
- Henneberger, P. K., Rollins, S. M., Humann, M. J., et al. (2023). The association of forced expiratory volume in one second with occupational exposures in a longitudinal study. *International Archives of Occupational and Environmental Health*, 96, 919–930. <https://doi.org/10.1007/s00420-023-01979-4>
- Lytras, T., Beckmeyer-Borowko, A., Kogevinas, M., et al. (2021). Cumulative occupational exposures and lung-function decline in two large general-population cohorts. *Annals of the American Thoracic Society*, 18(2), 238–246. <https://doi.org/10.1513/AnnalsATS.202002-113OC>
- Mozaffari, S., Heibati, B., Jaakkola, M. S., et al. (2023). Effects of occupational exposures on respiratory health in steel factory workers. *Frontiers in Public Health*, 11, 1082874. <https://doi.org/10.3389/fpubh.2023.1082874>
- Murgia, N., & Gambelunghe, A. (2022). Occupational COPD: The most under-recognized occupational lung disease? *Respirology*, 27(6), 399–410. <https://doi.org/10.1111/resp.14272>
- Oo, T. W., Thandar, M., Htun, Y. M., et al. (2021). Assessment of respiratory dust exposure and lung functions among workers in textile mill, Myanmar. *BMC Public Health*, 21, 673. <https://doi.org/10.1186/s12889-021-10712-0>
- Poole, J. A., Zamora-Sifuentes, J. L., De las Vecillas, L., & Quirce, S. (2024). Respiratory diseases associated with organic dust exposure. *Journal of Allergy and Clinical Immunology: In Practice*, 12(8), 1960–1971. <https://doi.org/10.1016/j.jaip.2024.02.022>

- Poulain, M., Doucet, M., Major, G. C., et al. (2022). The effect of obesity on lung function. *Respiratory Medicine*, 191, 106709. <https://doi.org/10.1016/j.rmed.2021.106709>
- Seidu, R. K., Ofori, E. A., Eghan, B., et al. (2024). A systematic review of work-related health problems of factory workers in the textile and fashion industry. *Journal of Occupational Health*, 66(1), uiae007. <https://doi.org/10.1093/joccu/uiae007>
- Shah, N. M., & Kaltsakas, G. (2023). Respiratory complications of obesity: From early changes to respiratory failure. *Breathe*, 19(1), 220263. <https://doi.org/10.1183/20734735.0263-2022>
- Subramaniam, S., Raju, N., Ganesan, A., et al. (2024). Impact of cotton dust and endotoxin exposure on textile workers. *Journal of Air Pollution and Health*, 9(1), 75–96. <https://doi.org/10.18502/japh.v9i1.15080>
- Sumardiyono, S., Widjanarti, M. P., Suratna, F. S. N., et al. (2025). The impact of workplace dust exposure and mask usage on pulmonary function. *Jurnal Kesehatan Lingkungan*, 17(1), 12–21. <https://doi.org/10.20473/jkl.v17i1.2025.12-21>
- Sun, Y., Kang, J., Zhang, F.-Y., et al. (2025). Characterization of occupational endotoxin-related small airway disease. *Chest*, 168(1), 43–55. <https://doi.org/10.1016/j.chest.2024.12.037>
- Yu, H., & Yu, Z. (2025). Occupational risk of COPD: Insights from a large cohort study. *Safety and Health at Work*, 16(4), 507–512. <https://doi.org/10.1016/j.shaw.2025.08.003>
- Zheng, X. Y., Zheng, Y. J., Liao, T. T., et al. (2024). Effects of occupational exposure to dust, gas, vapor and fumes on chronic bronchitis and lung function. *Journal of Thoracic Disease*, 16(1), 356–367. <https://doi.org/10.21037/jtd-23-646>
- Zheng, Y., Hu, J., Chen, J., et al. (2024). Association between dust exposure and lung function levels in steelworkers. *International Archives of Occupational and Environmental Health*, 97, 971–980. <https://doi.org/10.1007/s00420-024-02101-y>