



MENOPAUSAL STATUS AND LUNG FUNCTION AMONG FEMALE TOBACCO FACTORY WORKERS

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ABSTRACT

Tobacco factory workers face significant occupational health risks, particularly with respect to respiratory function. Female workers may be especially vulnerable to physiological factors, including hormonal status. Objective: To investigate differences in forced expiratory volume in 1 s (FEV1) between menopausal and reproductive-aged women working in tobacco factory production sectors and assess associated risk factors. Methods: This cross-sectional study involved 30 female tobacco factory workers (15 menopausal and 15 reproductive) in Jember, Indonesia. Pulmonary function was assessed via spirometry to measure FEV1. Participant characteristics, including age, work duration, and use of respiratory protective equipment, were collected. The data were analyzed via independent t tests and risk assessment calculations. Results: Menopausal women had significantly lower FEV1 values ($67.33 \pm 14.351\%$) than reproductive-age women did ($79.13 \pm 6.346\%$; $p = 0.007$). Overall, 60% of the participants exhibited varying degrees of airway obstruction. Compared with reproductive-aged workers, menopausal workers had a threefold greater risk ($OR = 3.143$) of developing lung obstruction. Notably, 76.67% of workers reported never using respiratory protective equipment. Conclusions: Menopausal status significantly affects respiratory function among female tobacco factory workers, with a combination of occupational exposure and hormonal changes potentially accelerating lung function decline. These findings emphasize the need for enhanced occupational health measures, particularly for menopausal workers in tobacco production facilities.

Keywords: female workers; forced expiratory volume; menopause; occupational health; respiratory function; tobacco dust

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INTRODUCTION

The tobacco industry continues to constitute a significant global economic sector, with substantial implications for worker health and safety. In 2016, SEATCA ranked Indonesia among the world's top 10 tobacco producers (WHO, 2017; Zhang, 2020). According to the 2014 Central Statistics Agency, the export value of the tobacco industry has increased by 2.98% annually. In this context, Jember was one of the largest tobacco-producing cities in East Java in 2012 according to the same statistical agency. According to the Ministry of Industry of the Republic of Indonesia, in 2018, the increasing productivity of tobacco was directly proportional to the need for many workers (Kementerian Kesehatan RI, 2018). This expansion raises concerns about occupational health risks, particularly because the tobacco industry harms the health of workers, particularly women, who constitute many workers in the industry. Dust accumulation in the lungs can cause inflammation and excessive mucus

production in the airway. Inflammation can cause blockage and narrowing of the airways (Garcia et al., 2018).

The forced expiratory volume in 1 s (FEV1) is a critical measure for assessing respiratory health impacts. Female tobacco industry workers exposed to tobacco dust for more than 11 years are likely to experience impaired pulmonary function, resulting in a significant decrease in FEV1 (Rani et al., 2003; Sohrabi et al., 2022). Because the lung volume and capacity are 25% smaller in women than in men, women are at risk of pulmonary physiological disorders due to continuous exposure to tobacco dust (Hall, 2015). FEV1 is the volume of air that is forcefully exhaled in the first second followed by full inhalation. This measurement is employed to determine airflow obstruction and is usually compared with the forced vital capacity (FVC) value to determine the FEV1-to-FVC ratio (Adnyana et al., 2023; Torén et al., 2021; Vestbo & Lange, 1991). The FVC is the maximum amount of air that can be forcefully exhaled after the deepest breath is taken (Uzun et al., 2024). Research has established that decreased FEV1 values can be a strong predictor of COPD morbidity, mortality, and lung cancer, and epidemiological studies related to occupational health (Triebner et al., 2017).

According to research by Triebner et al. (2017) and (Zhai et al., 2022), postmenopausal women tend to experience decreased lung function, as evidenced by decreased FEV1, FVC, and the FEV1-to-FVC ratio. Hormonal changes, especially decreased 17β -estradiol levels, can cause inflammation in body tissues, potentially causing oxidative stress in the lung tissue (Ziller et al., 2023). Recently, few studies have examined the effects of hormonal changes on lung function. The occupational hazard of tobacco dust is caused by very fine particles produced by the mechanical processing of tobacco leaves. These particles can contain tar, nicotine, and other chemical compounds present in tobacco plants (Hajat et al., 2021). Exposure to tobacco dust has the same effect as exposure to cigarette smoke (Romero Guzmán et al., 2021). The minuscule size of tobacco dust sometimes prevents workers from feeling in danger, creating a false sense of safety. The irregular use of respiratory protective equipment also increased worker exposure. However, this environment also acknowledges the harmful effects of tobacco dust. Therefore, this awareness necessitates the implementation of waste management strategies before they are released into the environment (WHO, 2017).

This study aimed to determine the difference in the decrease in FEV1 between menopausal women and women of reproductive age who were tobacco factory workers. We sought to compare the risk of pulmonary obstruction between menopausal women and women of reproductive age who worked in tobacco factories in the production sector. This study is important because, to date, no study has examined the difference in FEV1 values indicating airway obstruction in the reproductive and menopausal stages of tobacco factory workers exposed to dust. Furthermore, most tobacco factory workers are relatively old, and menopause worsens their lung function.

METHOD

Study Design and Ethical Considerations

This observational study employed a cross-sectional design with ethical approval from the Health Research Ethics Commission, Faculty of Medicine, Universitas Jember (approval number 1325/H25.1.11/KE/2019). The investigation was conducted in October 2019 in a Jember, Indonesia.

Study Population and Sampling

The target population comprised female employees working in the production sector of tobacco factories in Jember. Using purposive sampling, we recruited 15 participants from each group (menopausal and reproductive age), resulting in a total sample size of 30 participants (Adnyana, 2021). The sample size was calculated via G*Power software version 3.1.9.2, with $\alpha = 0.05$, power = 0.80, and effect size = 0.8 (Paulus et al., 2023).

Inclusion and Exclusion Criteria

The study established specific eligibility criteria for participant selection. For menopausal women, the inclusion criteria included employment in tobacco factory production for ≥ 5 years, a normal body mass index (18.5–24.9 kg/m²), age ≥ 45 years, and cessation of menstruation for > 1 year. For women of reproductive age, participants were required to have been employed in tobacco factory production for ≥ 5 years, a normal body mass index (18.5–24.9 kg/m²), and regular menstrual cycles. Participants were excluded from both groups if they presented with current or previous respiratory diseases (asthma, bronchitis, pneumonia, tuberculosis), a history of hysterectomy, active smoking, the use of hormonal contraception (pills, implants, injections), pregnancy, metabolic disorders (diabetes, goiter), breastfeeding, or a history of HRT (hormone replacement therapy).

Data collection

All participants underwent systematic health screening and completed a standardized questionnaire capturing demographic information, occupational history, and health status. Anthropometric measurements were conducted following standardized WHO protocols. FEV1 measurements were performed via a calibrated spirometer (model/manufacturer) according to the American Thoracic Society guidelines.

Statistical analysis

Data analysis was performed via IBM SPSS version 25. Descriptive statistics were calculated for the study data, including age, length of work period in the production section, and use of respiratory protective equipment, via univariate analysis. Continuous variables are expressed as the means \pm standard deviations, whereas categorical variables are presented as frequencies and percentages. Differences in FEV1 between women of reproductive age and menopausal women were assessed via bivariate analyses. The Shapiro–Wilk test was used to test the data distribution, and the independent t test was employed to analyze the differences between the two groups. Statistical significance was set at $P < 0.05$.

RESULT

Participant characteristics

This cross-sectional study enrolled 30 female workers in the production sector, including 15 menopausal women and 15 women of reproductive age. The demographic and occupational characteristics of the participants are presented in Table 1. The majority of participants (56.67%) were aged 41–50 years, and 40% had worked for 5–10 years in the industry. A major finding was that the majority of workers (76.67%) reported never using respiratory protective equipment. For operational clarity, respiratory protective equipment usage was categorized as follows: "always" (continuously used during the 8-hour workday), "sometimes" (intermittently used during the 8-hour workday), and "never" (not used during the 8-hour workday).

Table 1.
Characteristics of the participants

Characteristics	f	%
Age (years)		
20-30	3	10
31-40	2	6,67
41-50	17	56,67
51-60	8	26,67
Length of work period (Years)		
5-10	12	40
11-15	5	16,67
16-20	7	23,3
21-25	2	6,67
26-30	4	13,3
Respiratory protective equipment		
Always	0	0
Sometimes	7	2,3
Never	23	76,67

Pulmonary function assessment

Pulmonary function was evaluated via McCarthy's 2012 scoring system, which classifies % predicted FEV₁ (% Pred FEV₁) as follows: > 80%, normal; 70–79%, mild obstruction; 50–69%, moderate obstruction; 35–49%, severe obstruction; and <35%, very severe obstruction. The distribution of the FEV₁ results across these categories is illustrated in Figure 1. The analysis of FEV₁ measurements revealed that the average % predicted FEV₁ in normal respondents was 87.17%, with 12 participants (40%) falling within the normal range. Among those with obstruction, mild obstruction was observed in eight participants (26.67%, mean = 75%), moderate obstruction in nine participants (30%, mean = 60.33%), and severe obstruction in one participant (3.3%, % Pred FEV₁ = 44%). None of the participants exhibited severe obstructions. Notably, 60% of the participants experienced varying degrees of airway obstruction.

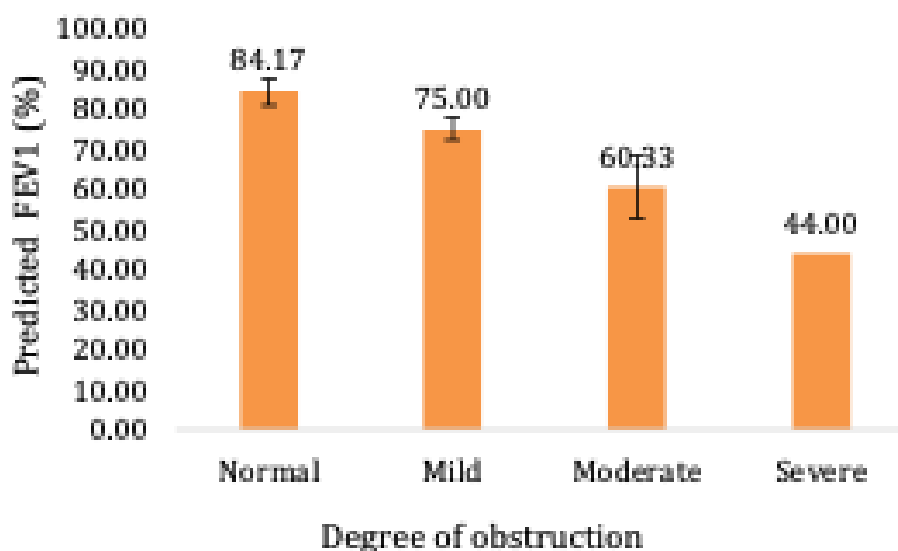


Figure 1. Distribution of predicted FEV₁ values across different degrees of airway obstruction in tobacco factory workers (n=30). The error bars represent the standard error of the mean.

Comparison between Menopausal and Reproductive-Age Groups

Statistical analysis confirmed a normal data distribution in both the menopausal ($p = 0.515$) and reproductive age groups ($p = 0.428$). Independent t tests revealed a significant difference in FEV₁ between menopausal and reproductive-aged women ($P = 0.007$). The mean % pred FEV₁ values were significantly lower in the menopausal group (67.33 ± 14.351) than in the reproductive age group (79.13 ± 6.346), as shown in Figure 2.

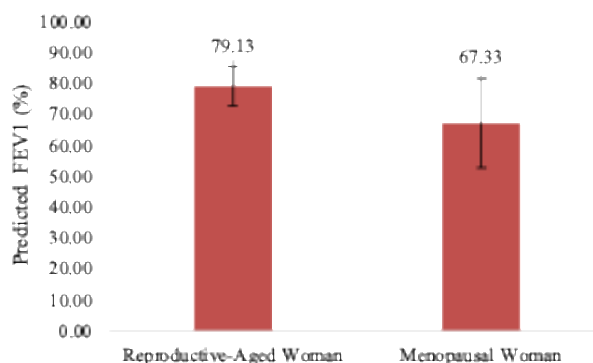


Figure 2. Comparison of the mean predicted FEV₁ values between reproductive-aged and menopausal female tobacco factory workers (n=15 per group). The error bars indicate the standard deviation ($p = 0.007$).

Risk analysis revealed that the risk of pulmonary obstruction was $OD = 3.143$, indicating that menopausal women working in tobacco factories were three times more likely to develop lung obstruction than their reproductive-age counterparts were. These findings suggest that menopausal status is a significant risk factor affecting respiratory health in tobacco factories. Additional factors that potentially affect workers' respiratory health are illustrated in Figure 3.

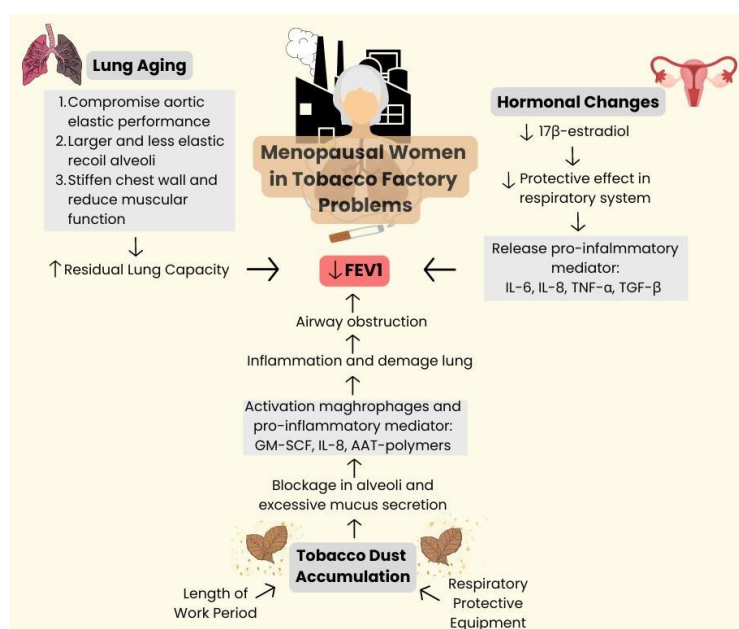


Figure 3. Conceptual framework illustrating the multifactorial pathways leading to decreased FEV₁ in menopausal women working in tobacco factories. The arrows indicate the direction of influence between the factors. Remarks: This diagram presents three primary mechanisms affecting lung function in menopausal tobacco factory workers: lung aging, tobacco dust accumulation, and hormonal changes. The interplay between these factors culminates in a reduced FEV₁ through various pathophysiological processes.

DISCUSSION

Our findings reveal significant demographic patterns related to respiratory health among tobacco factory workers. The predominant age group was 41–50 years (56.67%), which coincided with critical age-related respiratory changes. Age-related remodeling of the artery wall may compromise aortic elastic performance, leading to a shift in the composition of the lining wall from elastic tissue to stiffer collagen fibers (Abdullah et al., 2019; Giudici et al., 2022). This physiological aging process is accompanied by occupational exposure (Eljatin et al., 2023). Miller (2010) demonstrated that age-related changes in the lungs, such as larger alveoli and less elastic recoil, stiffen the chest wall, reduce muscular function, and increase residual lung capacity. Recent advances in imaging have supported these findings. Miura (2020) used a scanning acoustic microscope (SAM) to demonstrate the slowing of sound transmission in aging lung tissue, confirming decreased elastic properties. Furthermore, an increase in type III collagen and a decrease in elastic fibers in the alveolar walls correlate with reduced elastic recoil and pulmonary compliance (D'Errico et al., 1989).

The duration of occupational exposure has emerged as a critical factor, with most workers working for 5–10 years (40%). Significantly, workers in tobacco factories encounter high concentrations of tobacco dust in closed rooms, ranging from 23.56 to 432.59 g/m², exceeding the time-weighted average threshold value (TLV-TWA) (Mohammadyan & Baharfar, 2012). This exposure is particularly insidious, as workers in production areas are often unaware of their exposure to tobacco dust over long periods (Romero Guzmán et al., 2021). A concerning finding was that 76.67% of industrial sector workers had never used respiratory-protective equipment. This parallels findings from a study in an Ethiopian industry exposed to dust, where a lack of occupational health and safety training exacerbated health issues (Asgedom, 2023). The health implications are severe, as Milić et al. (2008) demonstrated that tobacco dust exposure can cause chromosomal abnormalities, micronucleus frequency, and sister chromatid exchanges.

Our analysis revealed that 60% of the respondents had airway obstruction of varying degrees of severity, which is consistent with previous research (Etemadinejad et al., 2009; Ophir et al., 2016; Viegi et al., 1986). The underlying mechanism involves inhalation of tobacco dust blocking alveoli and stimulation of excessive mucus secretion (Abrami et al., 2024). This cascade leads to increased resistance to airflow obstruction and inflammation, characterized by the activation of macrophages and proinflammatory mediators such as GM-CSF and IL-8 and the release of AAT polymers. Like direct smoking, tobacco dust exposure can cause smoking-related interstitial fibrosis (SRIF), which features fibrosis and macrophage accumulation in the alveoli ("smokers' macrophages") (da Silva Alves et al., 2024; Khodayari et al., 2022; Polly et al., 1970; Taniuchi et al., 2024).

A novel aspect of our study is the examination of hormonal influences on respiratory function. We found significant differences in FEV1 values between reproductive-aged and menopausal women (OR = 3.143), with menopausal women showing greater impairment. This difference can be attributed to the protective effect of estrogen on the respiratory system (Ismaniar et al., 2025; Polly et al., 1970). Specifically, 17 β -estradiol modulates the immune response and exerts a protective effect against lung tissue inflammation and damage by inhibiting the release of proinflammatory cytokines, such as IL-6, IL-8, TNF- α , and TGF- β (de Sousa et al., 2023). While hormone replacement therapy (HRT) represents a viable intervention for menopausal respiratory disorders, its application requires careful consideration (Amul et al., 2020; Mackay et al., 2022; Schneider et al., 2021).

Clinical and occupational health implications

The threefold increased risk of lung obstruction in menopausal workers (OR = 3.143) highlights the need for special attention to prevent condition deterioration in menopausal women working in tobacco factories. Preventive strategies should focus on modifying risk factors in women of reproductive age to prevent lung function deterioration during menopause.

Study Limitations and Future Directions

This study had several methodological and practical limitations that warrant consideration. First, the relatively small sample size (n=30) may limit the generalizability of our findings to a broader population of tobacco factory workers. Second, our pulmonary function assessment was restricted to FEV1 measurements, potentially missing other important respiratory parameters. A significant methodological challenge lies in the inherent difficulty of isolating confounding factors, particularly the interconnected effects of lung aging and menopause. The co-occurrence of these physiological processes creates complexity in determining their individual contributions to the decline in respiratory function. Additionally, future investigations should incorporate biomarkers of hormonal status and inflammatory mediators to better elucidate the mechanisms underlying the observed associations between menopausal status and respiratory function in occupationally exposed women.

CONCLUSION

This study demonstrated significant associations between menopausal status and reduced respiratory function in female tobacco factory workers. The findings revealed that menopausal women working in tobacco production face a threefold increased risk of developing lung obstruction compared with their reproductive-age counterparts. This heightened vulnerability appears to result from synergistic effects of age-related changes, hormonal alterations, and occupational exposure to tobacco dust. The observed patterns of nonuse of respiratory protective equipment (76.67%) further compound these risks. Our results highlight the need for targeted occupational health interventions, particularly for menopausal workers in tobacco production facilities. Such interventions should include enhanced respiratory protection protocols, regular health monitoring, and potential adjustments to the work conditions of vulnerable populations. Future research should focus on longitudinal assessments of these relationships and evaluations of specific protective measures for this at-risk group

REFERENCES

- Abdullah, S. S., Taha, J. H., Ahmed, M. H., & Abdullah, K. S. (2019). The Influence of Age on Pulmonary Function, A Cross Sectional Study on a Sample of Healthy Iraqi Males and Females Population. *Journal of Physics: Conference Series*, 1178, 012027. <https://doi.org/10.1088/1742-6596/1178/1/012027>
- Abrami, M., Biasin, A., Tescione, F., Tierno, D., Dapas, B., Carbone, A., Grassi, G., Conese, M., Di Gioia, S., Larobina, D., & Grassi, M. (2024). Mucus Structure, Viscoelastic Properties, and Composition in Chronic Respiratory Diseases. *International Journal of Molecular Sciences*, 25(3), 1933. <https://doi.org/10.3390/ijms25031933>
- Adnyana, I. M. D. M. (2021). *Populasi dan Sampel*. In M. Darwin (Ed.), *Metode Penelitian Pendekatan Kuantitatif* (1st ed., pp. 103–116). CV. Media Sains Indonesia.
- Adnyana, I. M. D. M., Utomo, B., Dewanti, L., Fauziyah, S., Eljatin, D. S., Setyawan, M. F., Sumah, L. H. M., & Al Karina, C. (2023). Effects of exposure to incense smoke associated with impaired lung function and respiratory disease: A systematic review.

- National Journal of Community Medicine, 14(5), 284–293.
<https://doi.org/10.55489/njcm.140520232875>
- Amul, G. G. H., Tan, G. P. P., & van der Eijk, Y. (2020). A Systematic Review of Tobacco Industry Tactics in Southeast Asia: Lessons for Other Low- And MiddleIncome Regions. *International Journal of Health Policy and Management*, 10(6), e97.
<https://doi.org/10.34172/ijhpm.2020.97>
- Asgedom, A. A. (2023). Dust Exposure and Respiratory Health among Selected Factories in Ethiopia: Existing Evidence, Current Gaps and Future Directions. *Journal of Respiration*, 3(2), 49–59. <https://doi.org/10.3390/jor3020006>
- da Silva Alves, C., Barroso, T., Gerardo, A., Almeida, T., Maduro, S., Boléo-Tomé, J. P., & Liberato, H. (2024). Forced Expiratory Volume in One Second Quotient (FEV1Q) as a Prognostic Factor in Amyotrophic Lateral Sclerosis Patients: Comparing Its Predictive Value to Other Lung Function Measurements. *Cureus*, 16(2), 54176.
<https://doi.org/10.7759/cureus.54176>
- de Sousa, M. N., da Anunciação, L. F., de Freitas, P. L. Z., Ricardo-da-Silva, F. Y., Moreira, L. F. P., Correia, C. J., & Breithaupt-Faloppa, A. C. (2023). Evaluation of the therapeutic effects of oestradiol on the systemic inflammatory response and on lung injury caused by the occlusion of the proximal descending aorta in male rats. *European Journal of Cardio-Thoracic Surgery*, 64(3), ezad253.
<https://doi.org/10.1093/ejcts/ezad253>
- D'Errico, A., Scarani, P., Colosimo, E., Spina, M., Grigioni, W. F., & Mancini, A. M. (1989). Changes in the alveolar connective tissue of the ageing lung. *Virchows Archiv A Pathological Anatomy and Histopathology*, 415(2), 137–144.
<https://doi.org/10.1007/BF00784351>
- Eljatin, D. S., Akbar Eljatin, M. R., Adnyana, I. M. D. M., Hutagalung, M. B. Z., & Setyawan, M. F. (2023). Excessive use of Nipah leaf membrane cigarettes increases the severity of Spontaneous Pneumothorax : A case study from Jambi, Indonesia. *Journal of Pharmaceutical and Health Research*, 4(1), 9–13.
<https://doi.org/10.47065/jharma.v4i1.2820>
- Etemadinejad, S., Mohammadian, M., Alizadeh-Larimi, A., & Mohammadpour, R.-A. (2009). Pulmonary function in workers exposed to tobacco dust. *Indian Journal of Medical Sciences*, 63(12), 543–548.
- Garcia, D. D., Sultan, N. M., & Yerba, O. R. (2018). Sílica e tabagismo: associação na produção de dano pulmonar. *Revista Brasileira de Medicina Do Trabalho*, 16(3), 378–386. <https://doi.org/10.5327/Z1679443520180262>
- Giudici, A., Li, Y., Yasmin, Cleary, S., Connolly, K., McEniery, C., Wilkinson, I. B., & Khir, A. W. (2022). Time-course of the human thoracic aorta ageing process assessed using uniaxial mechanical testing and constitutive modelling. *Journal of the Mechanical Behavior of Biomedical Materials*, 134, 105339.
<https://doi.org/10.1016/j.jmbbm.2022.105339>
- Hajat, C., Stein, E., Ramstrom, L., Shantikumar, S., & Polosa, R. (2021). The health impact of smokeless tobacco products: a systematic review. *Harm Reduction Journal*, 18(1), 123.
<https://doi.org/10.1186/s12954-021-00557-6>
- Hall, J. E. (2015). *Guyton and Hall Textbook of Medical Physiology* (12th ed.). Elsevier Ltd.
- Ismaniar, N. I., Wahyudin, W., & Paratama, F. (2025). Organizational, environmental, and sustainability of inputs to the implementation of a smoke-free area policy: A path analysis of Makassar's health facilities. *Svāsthya: Trends in General Medicine and Public Health*, 2(2), e78. <https://doi.org/10.70347/svsthya.v2i2.78>

- Kementerian Kesehatan RI. (2018). Riset Kesehatan Dasar (RISKESDAS) 2018. In Badan Penelitian dan Pengembangan Kesehatan Kementerian RI tahun 2018. Kementerian Kesehatan Republik Indonesia.
- Khodayari, N., Oshins, R., Mehrad, B., Lascano, J. E., Qiang, X., West, J. R., Holliday, L. S., Lee, J., Wiesemann, G., Eydgahi, S., & Brantly, M. (2022). Cigarette smoke exposed airway epithelial cell-derived EVs promote pro-inflammatory macrophage activation in alpha-1 antitrypsin deficiency. *Respiratory Research*, 23(1), 232. <https://doi.org/10.1186/s12931-022-02161-z>
- Mackay, J. M., Dorotheo, E. U., Assunta, M., & Ritthiphakdee, B. (2022). Tobacco control in Asia-Pacific: wins, challenges and targets. *Tobacco Control*, 31(2), 146–149. <https://doi.org/10.1136/tobaccocontrol-2021-056801>
- Milić, M., Kašuba, V., Orešćanin, V., Želježić, D., Kopjar, N., & Rozgaj, R. (2008). Chromosome damage in workers in cigarette manufacturing industry. *Journal of Applied Toxicology*, 28(3), 399–404. <https://doi.org/10.1002/jat.1327>
- Miller, M. (2010). Structural and Physiological Age-Associated Changes in Aging Lungs. *Seminars in Respiratory and Critical Care Medicine*, 31(05), 521–527. <https://doi.org/10.1055/s-0030-1265893>
- Miura, K. (2020). Alteration of Pulmonary Elasticity and Vulnerability to Protease Digestion with Aging. *The FASEB Journal*, 34(S1), 1–1. <https://doi.org/10.1096/fasebj.2020.34.s1.01965>
- Mohammadyan, M., & Baharfar, Y. (2012). Evaluation of Tobacco Dust and Designing of Local Exhaust Ventilation (LEV) Systems in a Tobacco Processing Industry. *International Journal of Occupational Hygiene*, 4(1), 47–52.
- Ophir, N., Bar Shai, A., Alcalay, Y., Schwarz, Y., Korenstein, R., Kremer, M. R., & Fireman, E. (2016). Smoking has a protective effects on functional and inflammatory parameters in workers exposed to artificial stone dust. 6.2 Occupational and Environmental Health, PA4281. <https://doi.org/10.1183/13993003.congress-2016.PA4281>
- Paulus, A. Y., Sulaeman, Mayasari, A. C., Ayu, J. D., Musniati, N., Sari, M. P., Hamdan, D. F., Farid, A., Selly, J. B., Amalia, N., Aulia, U., & Adnyana, I. M. D. M. (2023). *Biostatistika Epidemiologi* (H. Akbar, Ed.; 1st ed., Issue 1). CV. Media Sains Indonesia.
- Polly, Z. A., Begum, S., Ferdousi, S., Begum, N., Ali, T., & Begum, A. (1970). FVC, FEV1 and FEV1/FVC%, In Postmenopausal Women and Their Relationship with Serum Progesterone and Estrogen Level. *Journal of Bangladesh Society of Physiologist*, 4(1), 7–13. <https://doi.org/10.3329/jbsp.v4i1.4063>
- Rani, M., Bonu, S., Jha, P., Nguyen, S. N., & Jamjoum, L. (2003). Tobacco use in India: prevalence and predictors of smoking and chewing in a national cross sectional household survey. *Tobacco Control*, 12(4), e4–e4. <https://doi.org/10.1136/tc.12.4.e4>
- Romero Guzmán, E. T., Reyes-Gutiérrez, L. R., Romero Guzmán, L., Hernández Mendoza, H., Uría Gómez, L. C., & Gutiérrez Reyes, J. (2021). An Overview of Bioaerosols Suspended in the Atmosphere of Metropolitan Zone of Toluca Valley. *Journal of the Mexican Chemical Society*, 65(2), e1445. <https://doi.org/10.29356/jmcs.v65i2.1445>
- Schneider, J. L., Rowe, J. H., Garcia-de-Alba, C., Kim, C. F., Sharpe, A. H., & Haigis, M. C. (2021). The aging lung: Physiology, disease, and immunity. *Cell*, 184(8), 1990–2019. <https://doi.org/10.1016/j.cell.2021.03.005>
- Sohrabi, Y., Sabet, S., Yousefinejad, S., Rahimian, F., Aryaie, M., Soleimani, E., & Jafari, S. (2022). Pulmonary function and respiratory symptoms in workers exposed to respirable silica dust: A historical cohort study. *Heliyon*, 8(11), e11642. <https://doi.org/10.1016/j.heliyon.2022.e11642>

- Taniuchi, N., Saito, Y., Motoda, N., & Seike, M. (2024). Smoking-Related Interstitial Fibrosis and Smoker's Macrophages. *Journal of Nippon Medical School*, 91(1), JNMS.2024_91-113. https://doi.org/10.1272/jnms.JNMS.2024_91-113
- Torén, K., Schiöler, L., Lindberg, A., Andersson, A., Behndig, A. F., Bergström, G., Blomberg, A., Caidahl, K., Engvall, J. E., Eriksson, M. J., Hamrefors, V., Janson, C., Kylhammar, D., Lindberg, E., Lindén, A., Malinowski, A., Lennart Persson, H., Sandelin, M., Eriksson Ström, J., ... Sköld, C. M. (2021). The ratio FEV₁/FVC and its association to respiratory symptoms—A Swedish general population study. *Clinical Physiology and Functional Imaging*, 41(2), 181–191. <https://doi.org/10.1111/cpf.12684>
- Triebner, K., Matulonga, B., Johannessen, A., Suske, S., Benediktsdóttir, B., Demoly, P., Dharmage, S. C., Franklin, K. A., Garcia-Aymerich, J., Gullón Blanco, J. A., Heinrich, J., Holm, M., Jarvis, D., Jørgi, R., Lindberg, E., Moratalla Rovira, J. M., Muniozguren Agirre, N., Pin, I., Probst-Hensch, N., ... Gómez Real, F. (2017). Menopause Is Associated with Accelerated Lung Function Decline. *American Journal of Respiratory and Critical Care Medicine*, 195(8), 1058–1065. <https://doi.org/10.1164/rccm.201605-0968OC>
- Uzun, G. S., Sarı, A., Karcıoğlu, O., Sancar, E. N., Unaldı, E., Fırlatan, B., Bayram, G. S., Kılıç, L., & Akdoğan, A. (2024). Assessing the quality of forced vital capacity measurement in patients with systemic sclerosis. *Seminars in Arthritis and Rheumatism*, 67, 152466. <https://doi.org/10.1016/j.semarthrit.2024.152466>
- Vestbo, J., & Lange, P. (1991). (Forced expiratory volume in 1 second (FEV₁)-a respiratory physiological measurement of considerable prognostic value]. *Ugeskrift for Laeger*, 153(33), 2292–2295.
- Viegi, G., Paggiaro, P. L., Begliomini, E., Vagheti, E., Paoletti, P., & Giuntini, C. (1986). Respiratory effects of occupational exposure to tobacco dust. *Occupational and Environmental Medicine*, 43(12), 802–808. <https://doi.org/10.1136/oem.43.12.802>
- WHO. (2017). Tobacco and its environmental impact: an overview. World Health Organization.
- Zhai, T., Diergaard, B., Wilson, D. O., Kang, H., Sood, A., Bayliss, S. H., Yuan, J.-M., Picchi, M. A., Lan, Q., Belinsky, S. A., Siegfried, J. M., Cook, L. S., & Leng, S. (2022). Early natural menopause is associated with poor lung health and increased mortality among female smokers. *American Journal of Obstetrics and Gynecology*, 227(6), 885.e1-885.e12. <https://doi.org/10.1016/j.ajog.2022.07.031>
- Zhang, Y. (2020). Exploring the role of the ASEAN in fostering human rights approaches to tobacco control in Southeast Asia. In *Human Rights and Tobacco Control*. Edward Elgar Publishing. <https://doi.org/10.4337/9781788974820.00015>
- Ziller, V., Oppermann, T. S., Cassel, W., Hildebrandt, O., Kroidl, R. F., & Koehler, U. (2023). Chronic cough in postmenopausal women and its associations to climacteric symptoms. *BMC Women's Health*, 23(1), 93. <https://doi.org/10.1186/s12905-023-02225-2>