



ANALYSIS OF RISK FACTORS FOR PULMONARY FUNCTION DISORDERS AMONG WORKERS AT PT X COAL DIVISION, EAST KALIMANTAN

Lisa Septiana*, Irfansyah Baharuddin Pakki, Akhmad Azmiardi, Ratno Adrianto, Iriyani K, Ida Ayu Indira Dwika Lestari

Faculty of Public Health, Universitas Mulawarman, Jl. Kuaro, Gunung Kelua, Samarinda Utara, Samarinda, Kalimantan Timur 75119, Indonesia

*lisa_160992@yahoo.com

ABSTRACT

Pulmonary function impairment remains a critical occupational health issue among coal industry workers due to prolonged exposure to airborne pollutants. Despite the implementation of occupational health regulations, respiratory disorders continue to be prevalent, leading to decreased work capacity and increased health risks. Identifying key risk factors is essential to developing targeted preventive measures. Objective: This study aims to analyze the relationship between occupational risk factors and pulmonary function impairment among workers at PT X Coal Division, East Kalimantan. A cross-sectional study was conducted on 183 coal division workers selected through cluster random sampling. Data were obtained through structured questionnaires, spirometry tests, and workplace dust level measurements. Multivariate logistic regression analysis was used to determine the most influential factors associated with pulmonary function impairment. The analysis identified significant associations between pulmonary function impairment and a history of other diseases ($p = 0.001$; OR = 11.709; 95% CI: 2.901–47.257), work tenure of ≥ 3 years ($p = 0.032$; OR = 3.319; 95% CI: 1.109–9.934), heavy physical workload ($p = 0.036$; OR = 2.807; 95% CI: 1.071–7.361), and inadequate personal protective equipment (PPE) usage ($p = 0.015$; OR = 2.566; 95% CI: 1.205–5.463). Other factors such as age, body mass index (BMI), work location, dust exposure, exercise habits, and smoking were not significantly associated with pulmonary function impairment. Work-related exposures and individual health conditions play a crucial role in pulmonary function impairment among coal workers. Strengthening workplace safety measures, enforcing PPE compliance, and implementing regular health screenings are necessary to mitigate respiratory risks. Ensuring a safer work environment through targeted preventive strategies is essential for protecting workers from long-term pulmonary complications while enhancing occupational health policies in the coal industry.

Keywords: coal workers; pulmonary function impairment; occupational health; respiratory disorders; workplace safety

How to cite (in APA style)

Septiana, L., Pakki, I. B., Azmiardi, A., Adrianto, R., K., I., & Lestari, I. A. I. D. (2025). Analysis of Risk Factors for Pulmonary Function Disorders among Workers at PT X Coal Division, East Kalimantan. *Indonesian Journal of Global Health Research*, 7(3), 431-438. <https://doi.org/10.37287/ijghr.v7i3.6146>.

INTRODUCTION

Occupational health is a crucial global concern, especially in high-risk work environments where exposure to hazardous substances can lead to occupational diseases (ODs). These diseases, while largely preventable, continue to pose a significant global health burden. According to the International Labour Organization (ILO), occupational diseases account for approximately 160 million cases annually, resulting in 2.78 million deaths each year outnumbering fatalities from occupational accidents. In Indonesia, data from BPJS Ketenagakerjaan indicate a steady increase in OD cases, from 210,789 in 2019 to 234,370 in 2021 (Adiratna dkk, 2022). The coal mining sector has seen a particularly sharp rise in OD cases, increasing from 2,494 in 2019 to 6,565 in 2021. These statistics highlight the urgency of addressing occupational health risks, particularly in industries with high exposure levels.

The economic and social consequences of occupational diseases are profound, affecting workforce productivity, escalating healthcare costs, and exacerbating poverty due to loss of

income. Respiratory disorders, especially those linked to prolonged exposure to coal dust, are among the most common health issues among coal mining and processing workers. Inhalation of fine coal dust particles contributes to chronic pulmonary conditions such as pneumoconiosis, chronic bronchitis, and lung cancer, ultimately reducing affected workers' quality of life and work capacity (Kamanzi et al., 2023). Despite the implementation of occupational health regulations and preventive measures, cases of respiratory impairment among coal industry workers remain alarmingly high, highlighting the need for further investigation into the specific risk factors associated with pulmonary function decline in this sector.

Identifying risk factors for pulmonary impairment at an early stage is critical to preventing long-term health deterioration among coal industry workers. Understanding these factors enables the development of targeted preventive measures, reducing the incidence of occupational lung diseases. Additionally, this study contributes to the broader field of occupational health by providing empirical evidence on respiratory risks in coal analysis work an understudied sector compared to direct coal mining. By identifying modifiable risk factors, the study supports policy recommendations for workplace safety improvements, particularly within Indonesia's coal industry.

Existing studies indicate that coal industry workers are more vulnerable to lung function impairment compared to workers in other sectors (Tomášková et al., 2022). Research by (Helmalia, 2024) suggests that long-term exposure to coal dust significantly reduces lung elasticity and vital capacity. Furthermore, exposure to hazardous airborne chemicals such as sulfur dioxide (SO₂), carbon dioxide (CO₂), and nitrogen oxides (NO_x) exacerbates respiratory complications (Surya et al., 2021). Studies by (Shi et al., 2019) highlight that lung capacity declines with age, particularly among individuals over 30 years old, while additional factors such as smoking and poor nutritional status further heighten susceptibility to pulmonary impairments (Mayang et al., 2020; Suryadinata & Lorensa, 2023). However, no prior research has specifically examined pulmonary function impairment among coal analysis workers in East Kalimantan, leaving a critical gap in the literature. This study aims to identify the risk factors associated with pulmonary function impairment among workers at PT X-Coal Division. By understanding these risk factors, the research seeks to facilitate the implementation of preventive measures, ultimately improving worker health and enhancing company productivity.

METHOD

This study employed a quantitative approach with a cross-sectional design to investigate the risk factors associated with pulmonary function impairment among coal division workers. A total of 183 workers from seven operational areas of PT. X Coal Division Samarinda, Bontang, Sangatta, Balikpapan, Melak, Berau, and Grogot were selected using a cluster random sampling method. Randomization was conducted utilizing a random number generator to ensure adequate representation based on work tenure and age. The study was conducted from January to February 2025. Data were collected through structured questionnaires, spirometry test, and environmental dust level measurements in the workplace. Before implementation, the research instrument underwent a validity test, demonstrating a total score greater than the r-table value of 0.36. Additionally, a reliability test was conducted on a separate pilot sample, yielding a Cronbach's Alpha value of 0.792, which exceeds 0.6, indicating a high level of internal consistency. Collected data were analyzed using univariate, bivariate, and multivariate methods. Univariate analysis was used to determine the frequency distribution and percentage of risk factors associated with pulmonary function impairment among workers. Bivariate analysis examined the relationships between independent variables

including age, body mass index (BMI), medical history, work tenure, working hours, work location, physical workload, average dust exposure, personal protective equipment (PPE) usage habits, exercise habits, and smoking habits using the Chi-square test. Multivariate analysis was conducted using logistic regression to identify factors that simultaneously influenced pulmonary function impairment. This study received ethical approval from the Health Research Ethics Committee of the Faculty of Medicine, Universitas Mulawarman, Samarinda, under approval number 02/KEPK-FK/I/2025.

RESULT

Tabel 1.

Frequency Distribution of Research Variables at PT X Coal Division

Variable	f	%	
Worker Characteristics			
Age	< 30 years	49	26.8
	≥ 30 years	134	73.2
BMI	< 25	110	60.1
	≥ 25	73	39.9
History of comorbid diseases	No	165	90.2
	Yes	18	9.8
	Heart disease/sinus arrhythmia	7	3.8
	Asthma	4	2.2
	COPD	3	1.6
	Whooping Cough	1	0.5
	Pneumonia	2	1.1
Suspected Tuberculosis (TB)	1	0.5	
Occupational Environment			
Work tenure	<3 years	42	23
	≥ 3 years	141	77
Long working hours	≤ 8 hours/day	83	45.4
	> 8 hours/day	100	54.6
Work location	Outdoor	57	31.1
	Indoor	126	68.9
Physical workload	Light ≤ 5 METs	53	29
	Heavy > 5 METs	130	71
Dust exposure	Low ≤ 3 mg/m ³	152	83.1
	High > 3 mg/m ³	31	16.9
Individual Habits			
PPE	Adequate	102	55.7
	Inadequate	81	44.3
Exercise Habits	Good	105	57.4
	Poor	78	42.6
Smoking Habits	Non Smoker	85	46.4
	Smoker	98	53.6
	1 – 6 cigarettes	27	14.8
	7 – 12 cigarettes	30	16.4
	> 12 cigarettes	41	22.4
Pulmonary Function Impairment	Normal	131	71.6
	Abnormal	52	28.4

Most workers (73.2%) were aged ≥ 30 years, and 60.1% had a BMI < 25, indicating normal or underweight status. The majority (90.2%) reported no history of comorbid diseases, with heart disease/sinus arrhythmia (3.8%) being the most prevalent among those with comorbidities. A significant proportion (77%) had worked for ≥3 years, and 54.6% had long working hours >8 hours/day. Indoor work was more common (68.9%), while 31.1% worked outdoors. Heavy physical workload was dominant (71%), and 83.1% were exposed to low dust levels. Regarding individual habits, 55.7% demonstrated good PPE usage, 57.4% exercised regularly, but smoking habits

prevalence was high (53.6%), with 22.4% smoking >12 cigarettes per day. A total of 131 workers (71.6%) had normal pulmonary function, while 52 workers (28.4%) experienced pulmonary function impairment.

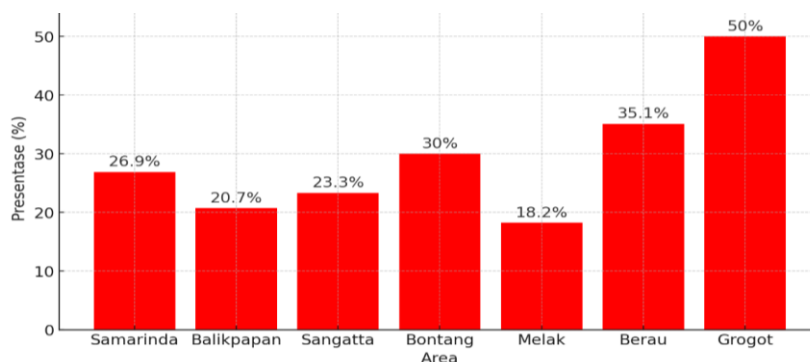


Figure 1. Distribution of Pulmonary Function Impairment by Area

Based on Figure 1, the highest percentage of pulmonary function impairment cases was observed in Grogot, accounting for 50% of the cases.

Tabel 2.
Analysis Results

Variable	Pulmonary Function Impairment				Total		P value	OR (95% CI)
	Abnormal		Normal		f	%		
	f	%	f	%				
Age							0.808	1.163
≥ 30 years	45	33.6	89	66.4	134	100		
< 30 years	7	14.3	42	85.7	49	100		(0.344-3.932)
BMI							0.450	1.285
≥ 25	23	31.5	50	68.5	73	100		
< 25	29	26.4	81	73.6	110	100		(0.670 – 2.463)
History of comorbid diseases							0.001	11.709
Yes	15	83.3	3	16.7	18	100		
No	37	22.4	128	77.6	165	100		(2.901-47.257)
Work tenure							0.032	3.319
≥ 3 years	47	33.3	94	66.7	141	100		
< 3 years	5	11.9	37	88.1	42	100		(1.109–9.934)
Long working hours							0.060	2.551
>8 hours/day	34	34	66	66	100	100		
≤8 hours/day	18	21.7	65	78.3	83	100		(0.961 - 6.771)
Work location							0.672	1.164
Indoor	37	29.4	89	70.6	126	100		
Outdoor	15	26.3	42	73.7	57	100		(0.576 - 2.352)
Physical workload							0.036	2.807
Heavy > 5 METs	45	34.6	85	65.4	130	100		
Light ≤ 5 METs	7	13.2	46	86.8	53	100		(1.071-7.361)
Dust exposure							0.319	1.607
High > 3 mg/m ³	14	45.2	17	54.8	31	100		
Low ≤ 3 mg/m ³	38	25.0	114	75	152	100		(0.632-4.085)
Personal Protective Equipment							0.015	2.566
Inadequate	35	43.2	46	56.8	81	100		
Adequate	17	16.7	85	83.3	102	100		(1.205–5.463)
Exercise Habits							0.294	1.423
Poor	35	43.2	46	56.8	81	100		
Good	17	16.7	85	83.3	102	100		(0.735–2.757)
Smoking Habits							0.062	2.926
Smoker	35	35.7	63	64.3	98	100		

Variable	Pulmonary Function Impairment				Total	P value	OR (95% CI)
	17	20	68	80			
Non-smoker					85	100	(2.923–49.176)

The multivariate analysis showed that a history of comorbid diseases, work tenure, physical workload, and PPE usage habits were the most influential factors associated with pulmonary function impairment. Workers with a history of other diseases had a significantly higher risk (OR = 11.709, 95% CI: 2.901–47.257, $p = 0.001$), making them 11.7 times more likely to experience impairment. Employees with a work tenure of ≥ 3 years were also at a significantly higher risk (OR = 3.319, 95% CI: 1.109–9.934, $p = 0.032$). Heavy physical workload increased the likelihood of impairment (OR = 2.807, 95% CI: 1.071–7.361, $p = 0.036$), and inadequate PPE usage significantly elevated the risk (OR = 2.566, 95% CI: 1.205–5.463, $p = 0.015$). Other variables, including age, BMI, work location, dust exposure, exercise habits, and smoking habits, did not show statistically significant associations with pulmonary function impairment.

DISCUSSION

This study identified a history of diseases, work tenure, physical workload, and PPE usage habits as the most influential factors associated with pulmonary function impairment among coal workers. Workers with pre-existing medical conditions had a significantly higher risk of pulmonary impairment, reinforcing findings from (Geddes, 2023) and (Rathod et al., 2024), which indicate that chronic diseases such as cardiovascular conditions, COPD, tuberculosis, and pneumonia contribute to lung function decline through chronic inflammation and fibrosis. This highlights the importance of regular health monitoring and early intervention programs to mitigate further deterioration among workers with underlying medical conditions. Furthermore, a study by (Arum Sari et al., 2020) indicated that individuals with a history of lung disease or other respiratory-related conditions are at a higher risk of impaired lung function, leading to disruptions in alveolar oxygen exchange and blood oxygen circulation.

Longer work tenure was also a significant risk factor, aligning with studies by (Bratandhary & Azizah, 2022) and (Widiyaristi et al., 2023) which emphasize that prolonged exposure to coal dust increases the likelihood of restrictive and obstructive lung diseases. According to (Akbar & Kallawicha, 2024), this lung disease is primarily caused by prolonged inhalation of coal dust among coal miners with long-term occupational exposure, leading to lung damage. Accumulated dust inhalation over extended periods accelerates pulmonary damage, underscoring the need for strict exposure control measures, regular medical screenings, and workplace policies to reduce long-term occupational health risks. According to (Azafilmi Hakiim, 2018), excessive workload can lead to employee fatigue or illness. Similarly, heavy physical workload was associated with pulmonary impairment, supporting research by (Chen et al., 2022), which suggests that strenuous activities increase oxygen demand and respiratory rates, leading to greater inhalation of airborne pollutants. High-intensity labor in polluted environments exacerbates lung damage, emphasizing the necessity for ergonomic interventions, structured rest periods, and enhanced ventilation systems to mitigate respiratory distress. A study by (Collaud et al., 2024) demonstrated that physical activity can improve various physiological parameters, including lung function, suggesting that the relationship between physical workload and impaired lung function may be influenced by other factors, such as the type of activity and work environment.

Inadequate PPE usage was another critical determinant of pulmonary impairment, corroborating findings by (Dwijaningtyas et al., 2023) and (Beyene Gebrezgiabher et al., 2019) which highlight the effectiveness of respiratory protective equipment in reducing inhalation of hazardous substances. Workers who did not consistently use PPE were at significantly higher risk, emphasizing the need for stricter PPE regulations, mandatory training, and continuous assessments of compliance to ensure occupational safety. Regular

use of masks affects lung function capacity by minimizing inhaled dust particles and reducing the impact of workplace dust exposure, thereby lowering the risk of impaired lung function capacity (Pramesti & Sutiari, 2021).

Other variables, including age, BMI, work location, dust exposure, exercise habits, and smoking habits, did not exhibit statistically significant associations with pulmonary impairment. While aging naturally affects lung function, this study suggests that occupational exposures play a more dominant role than age-related physiological changes. Similarly, BMI was not a significant factor, contradicting (Tang et al., 2024), which associates obesity and malnutrition with impaired respiratory function. Although dust exposure and smoking are well-established risk factors for pulmonary diseases, their lack of significance in this study suggests that occupational coal dust exposure may have overshadowed the impact of lifestyle-related risks. Studies by (Nurul Fatmasari Gaffar, 2021) and (Emilia Sentosa, 2022) indicate that workers with shifts exceeding eight hours per day in environments with dust particle exposure are more susceptible to respiratory organ stress. Additionally, while extended working hours showed a higher likelihood of impairment, the association was not statistically significant, aligning with (Utomo et al., 2021), which suggests that other factors such as ventilation quality, exposure duration, and PPE usage may have a more direct impact on respiratory health.

To mitigate the risk of pulmonary function impairment among coal workers, several preventive measures should be implemented. Routine health monitoring through pulmonary function tests and medical screenings should be prioritized, particularly for workers with pre-existing conditions, to enable early detection and intervention. (Erana & Kebede, 2019), workers exposed to higher levels of dust experience increased respiratory symptoms. Additionally, long-term dust exposure, particularly in the manufacturing and mining industries, poses a higher risk of reduced lung capacity. Workplace exposure control measures such as improved ventilation systems, dust suppression strategies, and enclosed workspaces should be enforced to minimize airborne pollutant exposure. Ensuring compliance with PPE regulations through mandatory training, provision of high-quality protective equipment, and strict enforcement policies is essential in reducing respiratory risks (Putri, 2020). Additionally, ergonomic workload management, including task rotation, structured rest periods, and adjustments to physically demanding jobs, can help alleviate excessive strain on workers' respiratory systems. Finally, educational programs should be developed to enhance worker awareness of occupational health risks, promote proper PPE usage, and encourage healthy lifestyle behaviors, such as smoking cessation and regular exercise, to improve overall pulmonary function.

These findings have broader implications for occupational health policies beyond the coal mining industry. Other high-risk sectors, such as construction, manufacturing, and agriculture, face similar occupational hazards that contribute to respiratory impairment. Implementing stricter safety regulations, improving PPE compliance, and conducting regular pulmonary health screenings are critical measures to protect workers from long-term respiratory complications. Future research should adopt a longitudinal approach with larger sample sizes to further investigate causal relationships between occupational exposures and pulmonary function decline. Additionally, intervention-based studies evaluating the effectiveness of PPE enforcement, workplace ventilation improvements, and respiratory health programs will provide valuable insights for developing evidence-based policies to enhance worker health and safety.

CONCLUSION

Occupational exposures and individual health conditions play a critical role in pulmonary

function impairment among coal workers. A history of other diseases, long work tenure, heavy physical workload, and inadequate PPE usage were identified as key contributing factors, highlighting the cumulative effects of workplace hazards on respiratory health. While factors such as age, BMI, work location, dust exposure, exercise habits, and smoking did not show significant associations, long-term exposure to occupational pollutants remains a major concern. Strengthening workplace safety measures, enforcing PPE compliance, and implementing regular health screenings are essential steps in reducing respiratory risks. By integrating preventive strategies and improving awareness of occupational health risks, this study contributes to the development of evidence-based policies aimed at protecting workers from long-term pulmonary complications. Ensuring a safer work environment not only improves individual health outcomes but also enhances productivity and overall workplace well-being, emphasizing the need for sustained efforts in occupational health interventions.

REFERENCES

- Adiratna dkk. (2022). *Profil Keselamatan dan Kesehatan Kerja Nasional Indonesia Tahun 2022*. Kementerian Ketenagakerjaan Republik Indonesia .
- Akbar, K. A., & Kallawicha, K. (2024). Black Lung Disease Among Coal Miners in Asia: A Systematic Review. In *Safety and Health at Work* (Vol. 15, Issue 2, pp. 123–128). Elsevier B.V. <https://doi.org/10.1016/j.shaw.2024.01.005>
- Arum Sari, J., Astuti, R., & Bima Prasetio, D. (2020). *Kapasitas Vital Paru pada Pekerja Tambal Ban Pinggir Jalan* Info Artikel. <https://doi.org/10.15294/higeia/v4i2/32604>
- Azafilmi Hakiim. (2018). Analisis Beban Kerja Fisik dan Mental Menggunakan CVL dan NASA-TLX Pada Divisi Produksi PT X. *Jurnal Ilmu Dan Teknik:Barometer*, 2. <https://doi.org/https://doi.org/10.35261/barometer.v3i2.1396>
- Beyene Gebrezgiabher, B., Tetemke, D., & Yetum, T. (2019). Awareness of Occupational Hazards and Utilization of Safety Measures among Welders in Aksum and Adwa Towns, Tigray Region, Ethiopia, 2013. *Journal of Environmental and Public Health*, 2019. <https://doi.org/10.1155/2019/4174085>
- Bratandhary, V. P., & Azizah, R. (2022). LITERATURE REVIEW : FAKTOR YANG BERHUBUNGAN DENGAN GANGGUAN FUNGSI PARU PEKERJA INDUSTRI MEBEL. *IKESMA*, 18(1), 36. <https://doi.org/10.19184/ikesma.v18i1.25100>
- Chen, L., Li, H., Zhao, L., Tian, F., Tian, S., & Shao, J. (2022). The effect of job satisfaction regulating workload on miners' unsafe state. *Scientific Reports*, 12(1). <https://doi.org/10.1038/s41598-022-20673-y>
- Collaud, S., Touilloux, B., von Garnier, C., Marques-Vidal, P., & Kraege, V. (2024). Physical activity and lung function association in a healthy community-dwelling European population. *BMC Pulmonary Medicine*, 24(1), 169. <https://doi.org/10.1186/s12890-024-02979-x>
- Dwijaningtyas, S., Widowati, E., Pranoto, Saputra, J., & Wintara, J. A. (2023). Analysis of the Obedience of Personal Protective Equipment Usage to Prevent Occupational Disease among Cosmetic Workers. *Kemas*, 19(2), 278–286. <https://doi.org/10.15294/kemas.v19i2.43861>
- Emilia Sentosa. (2022). Analisis Risiko Gangguan Fungsi Paru Akibat Paparan Debu PM10 Pada Pekerja Mebel Kayu. *Jurnal Sanitasi Lingkungan*, 2(1).
- Erana, F. G., & Kebede, Z. (2019). Dust exposure associations with lung function among ethiopian steel workers. *Annals of Global Health*, 85(1). <https://doi.org/10.5334/aogh.2422>
- Geddes, D. (2023). *The history of respiratory disease management*.
- Helmalia. (2024). *Pengaruh Paparan Debu Dan Karakteristik Individu Terhadap Kapasitas Paru Pada Tenaga Kerja Di Unit Produksi Di Pt. Industri Kapal Indonesia (Persero)*. Tesis Magister Keselamatan dan Kesehatan Kerja Fakultas Kesehatan Masyarakat.

- Kamanzi, C., Becker, M., Jacobs, M., Konečný, P., Von Holdt, J., & Broadhurst, J. (2023). The impact of coal mine dust characteristics on pathways to respiratory harm: investigating the pneumoconiotic potency of coals. In *Environmental Geochemistry and Health* (Vol. 45, Issue 10, pp. 7363–7388). Springer Science and Business Media B.V. <https://doi.org/10.1007/s10653-023-01583-y>
- Mayang, Ancah, & Hadi. (2020). Pengaruh masa kerja, lama paparan terhadap gejala fungsi paru pada pekerja garment UD. Surabaya Kabupaten Jember. *Multidisciplinary Journal*, 3, 1–15. <https://doi.org/http://dx.doi.org/10.19184/multijournal.v3i1.23681>
- Nurul Fatmasari Gaffar. (2021). GAMBARAN KADAR DEBU DI LINGKUNGAN PABRIK KAPUR ANTANG KOTA MAKASSAR. *Window of Public Health Journal*, 2(3), 503–511. <http://jurnal.fkm.umi.ac.id/index.php/woph/article/view/woph2115>
- Pramesti, & Sutiari. (2021). Determinan Gangguan Kapasitas Fungsi Paru-Paru Pada Perajin Batu Bata Merah di Kabupaten Badung. *Arc. Com. Health*, 8, 16–28.
- Putri, N. S. (2020). LITERATURE REVIEW: COAL DUST EXPOSURE AND PULMONARY PHYSIOLOGY STATUS. In *Jurnal Kesehatan Lingkungan* (Vol. 12, Issue 4, pp. 292–301). Airlangga University Faculty of Public Health. <https://doi.org/10.20473/jkl.v12i4.2020.292-301>
- Rathod, M. B., Budensab, A., Bhalla, S., Mahesh, N. K., Alex, E., & Jesudas, M. (2024). Spirometric Assessment of Pulmonary Function Tests in Asthma Patients. *Cureus*. <https://doi.org/10.7759/cureus.54979>
- Shi, R., Meacham, S., Davis, G. C., You, W., Sun, Y., & Goessl, C. (2019). Factors influencing high respiratory mortality in coal-mining counties: A repeated cross-sectional study. *BMC Public Health*, 19(1). <https://doi.org/10.1186/s12889-019-7858-y>
- Surya, Indi Esha, Faisal Yubus, Adrianison, Azizman Saad, & Ridha Restilla. (2021). Faktor Risiko yang Mempengaruhi Keluhan Respirasi dan Gangguan Fungsi Paru Pekerja Pabrik Kelapa Sawit PT. X di Kecamatan Kandis. *J Respir Indo*, 41(3)(1), 180–186.
- Suryadinata, R. V., & Lorensa, A. (2023). Studi Risiko Gangguan Fungsi Paru Terhadap Perokok Di Kalangan Remaja. *Indonesian Journal of Professional Nursing*, 4(1), 1. <https://doi.org/10.30587/ijpn.v4i1.5489>
- Tang, Y., Zhang, L., Zhu, S., Shen, M., Cheng, M., & Peng, F. (2024). Associations between different body mass index and lung function impairment in Chinese people aged over 40 years: a multicenter cross-sectional study. *BMC Pulmonary Medicine*, 24(1). <https://doi.org/10.1186/s12890-024-02844-x>
- Tomášková, H., Horáček, J., Šlachtová, H., Šplíchalová, A., Riedlová, P., Dalecká, A., Jirák, Z., & Mad'ar, R. (2022). Analysis of Histopathological Findings of Lung Carcinoma in Czech Black Coal Miners in Association with Coal Workers' Pneumoconiosis. *International Journal of Environmental Research and Public Health*, 19(2). <https://doi.org/10.3390/ijerph19020710>
- Utomo, S. W., Ni'mah, Z., & Asyary, A. (2021). The correlation of limestone dust exposure to lung function impairment in limestone mining's workers, centre Java, Indonesia. *Open Access Macedonian Journal of Medical Sciences*, 9, 265–272. <https://doi.org/10.3889/oamjms.2021.5796>
- Widiyaristi, D., Sunarsih, E., Flora, R., Windusari, Y., Zulkarnain, M., & Kesehatan Masyarakat, F. (2023). *RISK FACTORS AFFECTING PULMONARY DISORDERS OF WORKERS IN INDONESIA: LITERATURE REVIEW 2017-2022*. <https://doi.org/10.26553/jikm.2023.14.3.263>