KEMAS 19 (1) (2023) 129-137

Jurnal Kesehatan Masyarakat

http://journal.unnes.ac.id/nju/index.php/kemas

Impact of PM_{10} Exposure and Socio-Demographic Aspect With Lung Function Disorders

Siti Rachmawati[1], Iwan Suryadi[2]✉, Juherah[2], Abdur Rivai[2], Nurlaila Fitriani[3], Fathoni Firmansyah[4], Rina Zum Ratun[5]

[1]1Environmental Science Departement, Universitas Sebelas Maret, Indonesia
[2]Enviromental Health Departement, Poltekkes Kemenkes Makassar, Indonesia
[3]Faculty of Nursing, Universitas Hasanuddin, Surakarta, Central Java, Indonesia
[4]Student of Diploma 4 Occupational Health And Safety, Universitas Sebelas Maret, Indonesia
[5]Occupational Health and Safety Departement, Stikes Mitra Husada, Indonesia

Article Info

Article History:
Submitted Feruary 2023
Accepted May 2023
Published July 2023

Keywords:
PM_{10}, lung function, Socio-Demography

DOI
https://doi.org/10.15294/kemas.v19i1.42953

Abstract

The concentration of $PM_{2.5}$ and PM_{10} particles is a major problem and the primary environmental health risk that causes premature death. This study aims to examine the effect of PM_{10} exposure and socio-demographic aspects on lung function disorders of bus Terminal workers exposed to traffic emissions. This research used a cross-sectional approach. The population is 96 people, and 50 became samples according to the purposive sampling criteria. The measurement of lung vital capacity is by spirometry. The high-volume air sampler was applied to measure dust concentration, and the questionnaire was used to assess individual characteristics. The independent variables of this research are PM_{10} concentration, age, smoking behavior, working period, type of work, education, use of masks, and body weight. The dependent variable is impaired lung function. The bivariate analysis showed that exposure to PM_{10}, smoking behavior, years of service, and use of masks were significant for impaired lung function. The result of multivariate analysis of dust is the most relevant to the lung vital capacity. In conclusion, dust concentrations are classified above the Threshold Limit Value (TLV), so government should control the source of dust exposure.

Introduction

Air pollution due to the massive use of fossil fuels has received significant attention recently (Zhang et al., 2010; Anenberg et al., 2012; Rao et al., 2013). The World Health Organization (WHO) estimates that around one million premature deaths are caused by outdoor air pollution worldwide each year. Delicate particulate matter with a diameter smaller than 2.5 (PM2.5) is one of the main contributors (Lelieveld et al., 2015; Zhang et al., 2016). Based on the global disease burden database found that PM2.5-related deaths in 2010 were 3.15 million people per year worldwide, 1.61–4.81 million deaths per year at a 95% confidence interval, with cerebrovascular disease (CEV), accounted for 42% (1.31 million) of total premature deaths and 34% (1.08 million) due to ischemic heart disease (IHD). The study also found that outdoor air pollution's contribution to sudden death will double (6.6 million) by 2050.

Air pollution is a significant risk factor for global public health well into the 21st century. Many research studies have revealed the relationship between disease risk and air pollution. There is a strong correlation between morbidity and mortality in various risk groups (Bowe et al, 2017). Air pollution is responsible for the deaths of seven million people worldwide each year. Among air pollutants, particulate matter (PM) is considered the most harmful

✉ Correspondence Address:
Environmental Science Departement, Universitas Sebelas Maret, Surakarta, Central Java, Indonesia
Email : iwansuryadi@poltekkes-mks.ac.id

pISSN 1858-1196
eISSN 2355-3596

substance released from various biogenic and anthropogenic sources or generated by secondary reactions occurring in the atmosphere. (Khaefi et al., 2017; Omidi et al., 2018; Ghasemi et al., 2019). PM2.5 and PM10 Have different physicochemical properties, the ratio between delicate particulate matter and coarse particulate matter between PM2.5 and PM10 can provide more details about particulate sources, origination processes, and human health impacts (Camilo, Becerra and Rojas, 2015; Johnston et al., 2019; Tahery et al., 2021). Coarse particulate matter (PM10) can enter deep into the respiratory tract, causing severe respiratory illness. However, PM2.5, because of its smaller size, can pass through the respiratory tract and accumulate in the lungs, causing various respiratory diseases and lung cancer (Lu et al., 2015; Geravandi et al., 2017; Park et al., 2018).

According to the literature, increased concentrations of PM are associated with increased morbidity and mortality in the EU population, as a result of which PM2.5 reduces the average life span by up to 8.6 months. (Orru, Maasikmets and Lai, 2010). Furthermore, according to the different studies, a decrease in the concentration level of PM2.5 by 10 $\mu g\ m^{-3}$ can increase the lifetime by 0.61 years (Apte et al., 2018; Qi et al., 2020). PM2.5 is more toxic than PM10 because it induces inflammation and oxidative stress. These tiny PM2.5 particles are of particular concern because when inhaled, they can penetrate deep into the alveoli, where they can be stored and absorbed. These excellent particles are believed to have some more aggressive health implications than larger particles (Valavanidis and Fiotakis, 2014). Several studies have established particulate matter exposure as the source of various health problems, including premature death in people with heart or lung disease, nonfatal heart attacks, irregular heartbeats, severe asthma, decreased lung function, and increased respiratory symptoms such as respiratory tract irritation. Air, cough, or difficulty breathing (Cadelis, Tourres and Molinie, 2014).

According to the Environmental Protection Agency (EPA), particles are categorized based on their penetration capacity into coarse particles (PM10) with an aerodynamic diameter of 10 μm and fine particles (PM2.5) with an aerodynamic diameter of 2.5 μm. PM mainly comes from many sources, including road dust, agricultural dust, riverbeds, construction sites, mining operations, and similar activities (Reizer and Juda-rezler, 2016; Katarzyna et al., 2021). Traffic is the main source of PM, mainly from wear and tear of vehicle components such as brakes and tires as well as road dust suspension (Mbelambela et al., 2017; Shelly et al., 2019). Tirtonadi Bus Terminal is one of the places with a high emission load from the vehicle bus Terminal that exits the bus Terminal every day. Passenger activities, vehicle exhausts, bus repairs, and bus engines that are not turned off during reception at Tirtonadi Bus Terminal will produce particulate dust emissions.

Methods

The study used an analytic observational design with a cross- sectional research approach to explain the differences between the dependent and independent variables, in this study measuring research variables at the same time. The sample selection was by simple random sampling technique from a total population of 54 respondents who had previously been subjected to inclusion and exclusion criteria to obtain a homogeneous sample. Inclusion criteria include productive workers aged 17-60 and cleaning, maintenance, security, and traffic control officers. From this sampling, the researcher obtained a sample of 50 respondents.

The independent variable in this study was the concentration of TSP dust, age, years of service, exercise habits, and smoking behavior, while the dependent variable was impaired lung function. Measurement of dust levels in the work environment was measured in 2 sectors, namely the western sector and the eastern sector, using the High Volume Air Sampler (HVAS) tool. The gravimetric method is used to get the dust concentration, by using a sample filter before and after. The procedure for measuring environmental dust refers to SNI 16-7058-2004. Other variables such as age, years of service, sports habits, and smoking behavior were assessed using a questionnaire. Pulmonary function tests were carried out on a total of 50 workers. Measurement using spirometry is a tool used to determine the percentage of Forced Vital Capacity (FVC) and Forced Expiratory Volume / Forced Expiratory Volume / Forced Expiratory Volume / Forced Expiratory Volume in the first second (FEV1).

Study participants were first introduced to the principles of the spirometer, surgery, and pulmonary function testing procedures. The spirometer recorded subjects such as age, test date, height, name, and weight. Ethical clearance is used to avoid possible contraindications before the start of spirometry. Spirometry is performed standing using a nose clip while the subject takes complete inspiration and a rapid, forceful expiration on the instrument's mouthpiece. Weak and invalid inspiratory and expiratory attempts were excluded. Pulmonary function measurement is carried out with three readings, choosing the best result from these measurements. Only one investigator recorded and conducted all of the subject interviews to minimize variability between investigators. FVC (forced vital capacity), FEV1 (forced expiratory volume in 1 second), PEFR (peak expiratory flow rate in liters/sec and FEV1/FVC recorded in an automated spirometer following all standard protocols (Kesavachandran et al., 2006; Adei et al. ., 2011). Spirogram in the printed form directly downloaded from the spirometer, and data recorded in an excel sheet. To assess and evaluate the respiratory health of workers, LFT readings were recorded from the spirogram and self-reported respiratory health symptoms from a comparison of categories of impaired lung function. The vital capacity of the lungs is classified into four: normal, obstructive, restrictive, and mixed. based on %FVC and %FEV1 Normal lung function if % FVC ≥ 80% and % FEV1 ≥ 70% and obstructive disorders if % FVC > 80% and % FEV1 <70%, restrictive disorders if % FVC <80% and % FEV1 ≥ 70 %, mixed disorder if % FVC <80% and % FEV1 <70%.

This analysis is used to see the description and characteristics of each independent and dependent variable. The research variables were analyzed using the characteristic frequency distribution of each research variable. Bivariate analysis is used on two variables suspected of having a relationship or mutual correlation. Bivariate analysis used Spearman's correlation test for work environment dust variables with impaired lung function and multivariate analysis to determine which variable had the most influence among variables with a P-value <0.25.

Results and Discussion

Tirtonadi Bus Terminal is one of the biggest stations in Central Java which is located in Surakarta City. The Tirtonadi Terminal has been operating since 1976. In 2009, theTirtonadi Bus Terminal underwent a major renovation. In 2016, the Minister of Transportation, Budi Karya Sumadi re-inaugurated the Tirtonadi Type A Passenger Terminal, equipped with main, supporting, and general facilities to guarantee security, safety, and comfort for its users.

Tirtonadi bus terminal serves public passenger vehicles for Rural Transportation (ADES), City Transportation (AK), Inter-City Within Provinces (AKDP), and Inter-City Inter-Provinces (AKAP). The Tirtonadi Terminal operates 24 hours because it is a connecting route for bus transportation from within and outside the province, including East Java, West Java, and Yogyakarta to Sumatra. Tirtonadi Terminal Bus also provides rest facilities that can accommodate 70 buses. The capacity of buses that transit every day reaches 1,500 units of bus fleets and increases up to three times during holidays or long holidays from both AKDP and AKAP transportation.

Arrival and departure zones have been separated at Tirtonadi Terminal Bus. The arrival of the bus, which includes AKDP and AKAP, in dropping passengers in one drop-off zone, after the bus drops off passengers, the bus goes straight to the departure zone. The existing condition of the Tirtonadi Terminal is currently designed and divided into two areas, namely the West and East Terminals. This division facilitates the arrangement of departures to the West and East. It is also the basis for orientation for prospective passengers to go to the departure waiting area according to the ticket.

The western terminal serves passengers to major cities located west of Surakarta City, such as Semarang, Yogyakarta, and West Java to

Lampung, with daily bus volume reaching 500 buses. The eastern terminal serves passengers to major cities in the east, such as Karanganyar and Sragen, to regencies and cities in East Java, with daily bus volume reaching 1,000 buses. The west area of Tirtonadi Terminal Bus has a semi-open ceiling design that allows emissions from buses to be wasted into the environment and not accumulate there. The east area has a ceiling design covered by concrete, so emissions from buses still accumulate in that area.

Generally, Tirtonadi Bus Terminal workers are 24-55 years with an average age of 44. Most of the education is at the High Education level. All these two variables did not show a significant effect on impaired lung function. The smoking behavior variable for most respondents was in the still smoking category with 62%, the average working period variable had been working for 19 years, the average body weight was 64 kg, and the type of work most worked in the traffic department. The results of the bivariate test showed that smoking behavior and length of service were significant for impaired lung function. However, the work is significant for the results of the FVC spirometry test, as shown in Table 1.

Table 1. Sociodemographic Aspects of Respondents with Lung Function Dissorders

Variables	Unit	Total (N= 50)	p-Value (%pred FVC)	P-value (%pred FEV1)	p-value (%pred FEV1/FVC)	Lung Function Dissorders Category
Age	Mean (SD)	44,02 (10,328)	0,204	0,715	0,091	0,418
Education	Lower Education (%)	7 (14%)	0,979	0,355	0,478	0,324
	Midle Education (%)	24 (48%)				
	High Education(%)	19 (38%)				
Smoking Status	Curent (%)	31 (62%)	0,001	0,001	0,049	0,000
	Former (%)	12 (24%)				
	Never (%)	7 (14%)				
Working Period	Mean (SD)	19,62 (9,17)	0,044	0,0317	0,047	0,043
Weight	Mean (SD)	64,26 (6,90)	0,295	0,818	0,848	0,736
Type of Work	Security (%)	12 (24%)	0,024	0,494	0,84	0,081
	Traffic (%)	25 (50%)				
	Safety (%)	13 (26%)				
Use mask	Yes	9 (18%)	0,148	0,004	0,645	0,002
	No	41 (82%)				

Source: Primary Data, 2022

Table 2. Frequency Distribution of Lung Function Disorders

Variables	Normal (%)	Restrictive (%)	Obstructive (%)	Mixed (%)
Lung Function Disorders	17 (34%)	19 (38%)	3 (6%)	11 (22%)

Source: Primary Data, 2022

Table 2 shows the frequency distribution of lung function where there are 19 (38%) respondents with restrictive disorders, 3 (6%) with obstructive disorders, 11 (22%) with mixed disorders, and 17 (34%) respondents who do not experience lung function disorders of 50 respondents. Table 3 shows the bivariate test between PM10 concentrations and impaired lung function where there is a significant effect with the FVC, FEV1 spirometry test, and impaired lung function, but not significant with the FEV1/FVC spirometry test.

Table 3. Effect of PM_{10} Concentration on Lung Function Disorders

Variables			p-Value (%pred FVC)	P-value (%pred FEV1)	p-value (%pred FEV1/ FVC)	Lung Function Disorders Category
PM_{10} Concentration	Max	302,00	0,003	0,001	0,168	0,003
	Min	89,74				
	Mean	196,22				
	SD	107,56				

Source: Primary Data, 2022

Table 4. Multivariate test of independent and dependent variables.

Model		Anova Test		Determination Coefficient Test		Regression Coefficient	Sig.
		F	Significant	R-Squar	Adjusted R-Square		
1	(Constant)	9,265	0,000	0,440	0,404		.470
	Working Period					.117	.342
	Smoking Status					-.340	.011
	Used Mask					.280	.044
	PM_{10} Concentration					.352	.005
2	(Constant)	12,068	0,000				.558
	Smoking Status					-.310	.017
	Used Mask					.333	.010
	PM_{10} Concentration					.381	.002

a. Dependent Variable : Lung Function Disorders

Source: Primary Data, 2022

Based on the table, smoking behavior, use of masks, PM10 concentrations, and years of service simultaneously influence lung function disorders (p-value <0.05). The proportion of the influence of the independent variable on the dependent variable is 40.4% (R-Square = 0.404), while the rest is influenced by other variables not included in the regression test. Based on the regression coefficient value, the PM10 concentration variable affects lung function disorders compared to the variables of years of service, male smoking behavior, and use of masks. It is because the PM10 concentration regression coefficient value is greater than the other regression coefficients. The calculation results of the multiple regression coefficients above show the value of the PM10 concentration coefficient of 0.381 so that it can predict 38.1% of lung function disorders.

Most PM sources in Southeast Asia come from vehicle emissions, industrial pollution, and secondary aerosols as the dominating sources (Singh et al., 2017). Vehicle activity, industrial by-products and re-suspension of crustal soil are the main factors contributed by anthropogenic activity of particulate pollutant emissions in the environment (Hazarika and Srivastava, 2016; Bodor and Bodor, 2022; Fadel, Afif and Courcot, 2022).. Tirtonadi Bus Terminal is one of the bus stations with high vehicle activity, so PM10 production is more significant. Urban air pollution has health effects on the public and workers, especially those working in dense traffic environments and small roadside industries. Vehicle exhaust is the worst type of exhaust because it is emitted on the ground near respiratory levels, and provides maximum exposure to humans, the health problems of which include decreased lung function due to exposure at work (Ahmad et al., 2016).

Particles that are toxic to magrofag can be stimulating the formation of new macrophages. Forming and destruction of macrophages continue to play a vital role in the forming of collagen connective tissue and the deposition of hyaline in the connective tissue that forms fibrosis. This fibrosis occurs in the lung parenchyma, which is the alveoli and wall intertestial connective tissue. As a result, pulmonary fibrosis will decrease lung tissue elasticity (shifting lung tissue) and rising impaired lung development, namely restriction. Obstruction disorder is a pulmonary disorder characterized by barriers to airflow in the respiratory tract that are irreversible. In this study, 3 respondents (6%) experienced obstruction. Narrowing of the airways and disruption in airflow therein will affect the work of breathing. FEV1 will always decrease in respondents who experience obstruction and can be a large amount, whereas FVC cannot be reduced. A mixture of restrictions and obstruction occurs due to pathological processes which reduce lung volume, capacity, and flow, and the presence narrowing of the respiratory tract and the presence of landfill breathing by particulates (Suryadi et al, 2021)

In recent years, high concentrations of PM10 can be caused by dust production and the development of transportation facilities and industrial processes. Based on the results of different studies, reducing PM10 concentrations reduces the number of COPD cases. Research by Khaefi shows an increase in COPD due to PM10 increase, climate change, and geographical aspects (Khaefi et al., 2017; Ryswyk et al., 2021). This study showed high concentrations of PM10 in the western sector due to the greater volume of vehicles and higher traffic activity because it is an inter-provincial transportation route.

This study found that impaired lung function in exposed occupations can be ascribed to exposure to smoke and high fuel and solvent vapors levels that can cause well-defined systemic pulmonary inflammation. Decreased lung function values may indicate underlying lung dysfunction due to inhalation of polluted air caused by car exhausts and fuel vapors. Emissions and movement of vehicles contribute to around 60–70% of total air pollution, which decreased lung function values in this study, our lifestyle, and smoking behavior. Many studies cite similar respiratory health symptoms as standard among exposed populations due to workplace exposures. (Ahmad et al., 2016; Wu et al., 2019; Wang et al., 2021).

Exposure to air pollution in the long term can cause continuous inflammatory reactions, leading to repeated tissue damage and repair processes, which will cause extensive tracheal structural damage and a more severe impact on lung function. It may be the reason why long-term exposure is more serious. The effects of long-term exposure should also be of concern to us, but the short-term effects of pollution cannot be ignored (Sah et al., 2019; Zhang et al., 2022). Our findings show that PM10 concentrations account for 40% of lung function impairment.

Given the demographic changes that have yet to be extensively researched, we must increase our understanding of the factors that influence health outcomes in older adults. Therefore, we attempted to determine the association of various sociodemographic factors with lung function, primarily in adults. The results of our study show that decreases in FVC, FEV1, FEV1/FVC, and the general category of impaired lung function are more likely to be associated with smoking behavior, use of masks, length of service, and type of work. Overall, the clear and well-known determinants of lung function, namely age, sex, height, weight, smoking, and respiratory disease, account for most of the variation in the lung function measures studied. It is by research by Mchugh et al., which shows sociodemographic factors are factors that influence lung function disorders (Johannessen et al., 2010; Mchugh et al., 2020).

Given the solid potential confounding by tobacco use in the association between lung function and subclinical atherosclerosis, adjustment for tobacco use was insufficient to control for this factor, and a substantial degree of residual confounding cannot be ignored. Therefore, a relationship tracing was carried out grouped by smoking status, including those who never (Gonzalez et al., 2022). Smoking can reduce lung function because the substances contained in cigarettes are addictive substances that can damage human organs, including the lungs. Smoking can cause changes in function and structure and lung tissue, and smoking habits can accelerate the decline in lung function. Cigarette smoke can stimulate mucus secretion, while nicotine paralyzes the respiratory tract's ciliary hairs, which filter air entering the breath.

PM10 exposure due to air pollution

from motor vehicle emissions has a significant relationship with a negative impact on vital lung capacity. An increase in PM10 pollution concentration causes respondents to be more at risk of experiencing disturbances in lung vital capacity (Thi et al., 2018; Gowda and Thenambigai, 2020). Other health risks, such as COHb, can also result from exposure to other pollutants, such as CO (Rachmawati et al, 2022). The effects of air pollution and lung function can vary by gender, genetics, smoking status, diet, medications, and obesity.

Conclusion

This study found that apart from exposure to PM10, other factors, such as sociodemography, affect pulmonary function disorders. The increase in PM10 concentrations is caused by motor vehicle exhaust because the research location is one of the centers of air pollution. Sociodemographic aspects also have significant contributions, such as the type of work that is directly related to direct exposure to pollutants, smoking habits, and years of service which are related to the length of exposure

References

Ahmad, I., Rehan, M., Balkhyour, M., & Abbas, M., 2016, Review of Environmental Pollution and Health Risks at Motor Vehicle Repair Workshops : Challenges and Perspectives for Saudi Arabia. *International Journal of Agricultural and Environmental Research,* 2(1).

Anenberg, S.C., Schwartz, J., Shindell, D., Amann, M., Faluvegi, G., Klimont, Z., Janssens-maenhout, G., Pozzoli, L., Dingenen, R. Van, Vignati, E., & Emberson, L., 2012. Global Air Quality and Health Co-benefits of Mitigating Near-Term Climate Change through Methane and Black Carbon Emission Controls. *Environmental Health Perspective*, 120(6).

Apte, J.S., Brauer, M., Cohen, A.J., Ezzati, M., & Pope, C.A., 2018. Ambient PM 2.5 Reduces Global and Regional Life Expectancy. *Environmental Science & Technology Letters*, 5.

Bodor, K., & Bodor, Z., 2022. The Human Health Risk Assessment of Particulate Air Pollution (PM 2.5 and PM 10 in Romania. *Toxycology Report*, 9.

Cadelis, G., Tourres, R., & Molinie, J., 2017. Associations of Ambient Coarse Particulate Matter, Nitrogen Dioxide, and Carbon Monoxide with the Risk of Kidney Disease: A Cohort Study. *The Lancet Planetary Health*, 1(7).

Cadelis, G., Tourres, R., & Molinie, J., 2014, Short-Term Effects of the Particulate Pollutants Contained in Saharan Dust on the Visits of Children to the Emergency Department due to Asthmatic Conditions in Guadeloupe (French Archipelago of the Caribbean). *Plos One* 9(3).

Camilo, L., Becerra, B., & Rojas, N., 2015, Influence of Precipitation Scavenging on the PM2.5PM10 Ratio at the Kennedy Locality of Bogotá, Colombia. *Revista Facultad de Ingeniería*, 7.

Fadel, M., Afif, C., & Courcot, D., 2022, Human Health Risk Assessment for PAHs, Phthalates , Elements, PCDD/ Fs , and DL-PCBs in PM 2.5 and for NMVOCs in two East-Mediterranean Urban Sites Under Industrial Influence. *Atmospheric Pollution Research*, 13.

Geravandi, S., Sicard, P., Khaniabadi, Y.O., Marco, A., De Ghomeishi, A., Goudarzi, G., & Mahboubi, M., 2017 , A Comparative Study of Hospital Admissions for Respiratory Diseases During Normal and Dusty Days in Iran. *Environ Sci Pollut Res,* 24(22).

Ghasemi, F.F., Dobaradaran, S., Saeedi, R., Nabipour, I., & Nazmara, S., 2019, Levels and Ecological and Health Risk Assessment of PM 2.5 -Bound Heavy Metals in the Northern Part of the Persian Gulf. *Environmental Science and Pollution Research*, 26(36).

Gonzalez, J., Gracia-lavedan, E., Silvia, G., Barril, S., Godoy, P., Berm, M., Betriu, A., Fern, E., Lecube, A., Pamplona, R., Purroy, F., Farr, C., Barb, F., & Torres, G., 2022, Lung Function Impairment is Related to Subclinical Atherosclerosis Only in Active Smokers. *Journal of Vascular Disease,* 1(1).

Gowda, G., & Thenambigai, R., 2020. A Study on Respiratory Morbidities and Pulmonary Functions among Traffic Policemen in Bengaluru City. *Indian Journal of Community Medicine*, 45(1).

Hazarika, N., & Srivastava, A., 2017. Estimation of Risk Factor of Elements and PAHs in Size-Differentiated Particles in the National Capital Region of India. *Air Quality, Atmosphere & Health*, 10(4).

Johannessen, A., Omenaas, E.R., Bakke, P.S., & Gulsvik, A., 2010. Socioeconomic Risk Factors for Lung Function Decline in a General Population. *Eur Respir J,* 36(3).

J Johnston, H.J., Mueller, W., Steinle, S., Vardoulakis, S., Tantrakarnapa, K., Loh, M., & Cherrie, J.W., 2019. How Harmful Is Particulate Matter Emitted from Biomass Burning ? A Thailand Perspective. *Current Pollution Reports*, 5(4).

Katarzyna, J., Magdalena, R., Jean-paul, O., Juda-rezler, K., Reizer, M., & Oudinet, J., 2021. Determination and Analysis of PM10 Source Apportionment Urban Areas: The Case of Wintertime 2006. *Atmospheric Environment*, 45(36).

Khaefi, M., Geravandi, S., Hassani, G., Yari, A.R., Soltani, F., Dobaradaran, S., Moogahi, S., & Mohammadi, M.J., 2017, Association of Particulate Matter Impact on Prevalence of Chronic Obstructive Pulmonary Disease in Ahvaz, Southwest Iran during 2009 – 2013. *Aerosol and Air Quality Research,* 17(1).

Lelieveld, J., Evans, J.S., Fnais, M., Giannadaki, D., & Pozzer, A., 2015. The Contribution of Outdoor Air Pollution Sources to Premature Mortality on a Global Scale. *Nature*, 25(1).

Lu, F., Xu, D., Cheng, Y., Dong, S., Guo, C., & Jiang, X., 2015. Systematic Review and Meta-Analysis of the Adverse Health Effects of Ambient PM 2.5 and PM 10 Pollution in the Chinese Population. *Environmental Research,* 136(1).

Mbelambela, E.P., Hirota, R., Eitoku, M., Muchanga, S.M.J., Kiyosawa, H., Yasumitsu-Lovell, K., Lawanga, O.L., & Suganuma, N., 2017. Occupation Exposed to Road-Traffic Emissions and Respiratory Health Among Congolese Transit Workers, Particularly Bus Conductors, in Kinshasa: A Cross-Sectional Study. *Environmental Health and Preventive Medicine*, 22(1).

Mchugh, J., Duong, M., Ma, J., Dales, R.E., Bassim, C.W., & Verschoor, C.P., 2020. Clinical Trial Paper A Comprehensive Analysis of Factors Related to Lung Function in Older Adults: Cross-sectional Findings from the Canadian Longitudinal Study on Aging. *Respiratory Medicine,* 173(1).

Omidi, Y., Sicard, P., Taiwo, A.M., & Marco, A.D., 2018. Modeling of Particulate Matter Dispersion from a Cement Plant: Upwind- downwind Case Study. *Journal of Environmental Chemical Engineering*, 6(2).

Orru, H., Maasikmets, M., & Lai, T., 2010. Health Impacts of Particulate Matter in Five Major Estonian Towns: Main Sources of Exposure and Local Differences. *Air Quality, Atmosphere & Health,* 4.

Park, M., Joo, H.S., Lee, K., Jang, M., Kim, S.D., Kim, I., Borlaza, L.J.S., Lim, H., Shin, H., Chung, K.H., Choi, Y., Park, S.G., Bae, M., Lee, J., Song, H., & Park, K., 2018. Differential Toxicities of Fine Particulate Matters from Various Sources. *Nature,* 8.

Qi, J., Id, Z.R., Qian, Z.M., Yin, P., Yang, Y., Id, K.A., Wang, L., & Id, H.L., 2020. Potential Gains in Life Expectancy by Attaining Daily Ambient Fine Particulate Matter Pollution Standards in Mainland China: A Modeling Study Based on Nationwide Data, *Plos Medicine*, 1(1).

Rachmawati, S., Iwan. S., Ferlin, A.S., & Fathoni. F.. 2022. Working Period and CO Exposure Relationship with Changes Levels COHb of Bus Terminal Officer. *Kemas,* 18(2).

Rao, S., Pachauri, S., Dentener, F., Kinney, P., Klimont, Z., Riahi, K., & Schoepp, W., 2013. Better Air for Better Health: Forging Synergies in Policies for Energy Access, Climate Change and Air Pollution. *Global Environmental Change*, 23(5).

Reizer, M., & Juda-Rezler, K., 2016. Explaining the High PM 10 Concentrations Observed in Polish Urban Areas. *Air Quality, Atmosphere & Health*, 1(1).

Ryswyk, K., Van Evans, G.J., Kulka, R., Sun, L., Sabaliauskas, K., Rouleau, M., Anastasopolos, A.T., Wallace, L., & Weichenthal, S., 2021. Personal Exposures to Traffic-Related Air Pollution in Three Canadian Bus Transit Systems: the Urban Transportation Exposure Study. *Journal of Exposure Science & Environmental Epidemiology*, 31.

Sah, D., Verma, P.K., Kandikonda, M.K., & Lakhani, A., 2019. Urban Climate Pollution Characteristics, Human Health Risk Through Multiple Exposure Pathways, and Source Apportionment of Heavy Metals in PM 10 at Indo-Gangetic Site. *Urban Climate,* 27.

Shelly, S.Y., Malik, H.J., Ali, Z., Manzoor, F., Nasir, Z.A. and Biosci, I.J., 2019. Lung Morbidity of Traffic Wardens Exposed to Chronic Vehicular Pollution in Lahore, Pakistan. *International Journal of Biosciences,* 14(5).

Singh, N., Murari, V., Kumar, M., Barman, S.C., & Banerjee, T., 2017. Fine Particulates Over South Asia: Review and meta-analysis of PM 2.5 Source Apportionment Through Receptor Model. *Environmental Pollution*, 223.

Suryadi, I., Aditama, P.N., Nurlaila, F., & Siti, R., 2021. The Determinant of Lung Function Disorders of The Textile Industry Spinning Section. *Kemas,* 17(4).

Tahery, N., Geravandi, S., Goudarzi, G., Shahriyari, H.A., & Jalali, S., 2021. Estimation of PM 10 Pollutant and Its Effect on Total

Mortality (TM), Hospitalizations Due to Cardiovascular Diseases (HACD), and Respiratory Disease. *Environmental Science and Pollution Research,* 28.

Thi, L., Ngoc, N., Kim, M., Khac, V., Bui, H., Park, D., & Lee, Y., 2018. Particulate Matter Exposure of Passengers at Bus Stations: A Review. *International Journal of Environmental Research And Public Health*, 15(12).

Valavanidis, A., & Fiotakis, K., 2008. Airborne Particulate Matter and Human Health: Toxicological Assessment and Importance of Size and Composition of Particles for Oxidative Damage and Carcinogenic Mechanisms. *J Environ Sci Health C Environ Carcinog Ecotoxicol Rev,* 26(8).

Wang, X., Xu, Z., Su, H., Chak, H., Song, Y., & Zheng, H., 2021. Science of the Total Environment Pneumonia: The Smaller Particle, the Greater Short-term Impact ?'. *Science of the Total Environment*, 772.

Wu, Q., Han, L., Xu, M., Zhang, H., Ding, B., & Zhu, B., 2019. Effects of Occupational Exposure to Dust on Chest Radiograph, Pulmonary Function, Blood Pressure and Electrocardiogram Among Coal Miners in an Eastern Province, China. *BMC Public Health*, 19(1).

Zhang, D., Aunan, K., Martin, H., Larssen, S., Liu, J., & Zhang, D., 2010. The Assessment of Health Damage Caused by Air Pollution and Its Implication for Policy Making in Taiyuan, Shanxi, China. *Energy Policy*, 38(1).

Zhang, S., Worrell, E., Crijns-graus, W., Krol, M., Bruine, M., De Geng, G., Wagner, F., & Cofala, J., 2016. Modeling Energy Efficiency to Improve Air Quality and Health Effects of China's Cement Industry. *Applied Energy*, 184.

Zhang, W., Ma, R., Wang, Y., Jiang, N., Zhang, Y., & Li, T., 2022. The Relationship Between Particulate Matter and Lung Function of Children: A Systematic Review and Meta-analysis.*Environmental Pollution*, 309(7).