Determinant Factors Causing Symptoms of Respiratory Disorders with Exposure to Nitrogen Dioxide in Adults Around The Steel Industry

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Abstract

Air pollution is a health problem that causes many deaths. Respiratory disorder is one of the causes of death due to increased air pollution in the environment. One of the gases that damage the environment is Nitrogen dioxide (NO_2). NO_2 concentration can be produced from the combustion process, one of which is the result of combustion in the steel industry. The steel industry that is around the community will increase the risk of exposure to NO_2. This study was conducted to determine the relationship of factors that influence the respiratory disorders that occur in adults around the steel industry. Variable respiratory disorders, the concentration of NO_2, length of stay, BMI and a history of respiratory disease were tested using the chi-square test with p value <0.05 means that these variables have a relationship. Respiratory disorders have a significant relationship with a history of respiratory disorders OR 3.69 95% CI (1.548 - 8.799). Although it turns out it is known that the NO_2 concentration variable does not have a significant relationship with respiratory disorders with OR 0.765 95% CI (0.329 - 1.779), other than that the unrelated variable is the variable length of stay OR 1.179 95% CI (0.523 - 2.655), BMI OR 1,739 95% CI (0.754 - 4.01). In this study it was found that a factor that can cause respiratory disorder is a history of respiratory disorders in adults.

Keywords : Respiratory disorder, Nitrogen dioxide, Adult population, Steel industry, Determinant factor.

1. Introduction

According to a World Health Organization (WHO) report, more than 6 million premature deaths each year can be attributed to indoor and outdoor air pollution[1]. It is estimated that in Austria, France, and Switzerland air pollution causes 40,000 premature deaths[2]. In the Russian Federation, about 4% of total deaths are caused by air pollution[3]. A study in Italy tested exposure to NOemissions$_2$ in workers significantly related to lung function abnormalities as assessed by spirometry[4]. Nitrogen dioxide in high levels of exposure can damage the respiratory tract, otherwise contact with the skin or eyes can cause burns[5]. In Isfahan, Iran, 109 cases occurred due to the short-term health effects of NO_2 which were presented as the total number of deaths from cardiovascular and respiratory diseases, inpatients due to COPD (*chronic obstructive pulmonary disease*) and acute myocardial infarction[6].

The main sources of NO_2 emissions outside space include transportation, combustion processes and industrial activities. Emissions are generally the highest in urban areas[7 8 9 10]. One industry that has the potential to emit NOx emissions is the iron and steel industry. The use of fuel in the iron and metal (steel) industry will increase greenhouse gas emissions. Production activities in the iron and steel industry tend to go through processes with high temperatures with huge fuel consumption, consequently most of these processes are sources of NOx emissions, especially those

produced from equipment technology such as *boilers* and *furnaces* [11 12]. Based on this, it is possible that exposure to NO_2 in the environment and other determinant factors will have an impact on the health of surrounding communities in the steel industry. The purpose of this study is to determine the relationship of factors that can affect respiratory disorders in the community around the steel industry.

2. Materials And Methods

2.1. Subjects

Ninety-four adults aged 22 to 69 years were obtained by the proportion estimation formula. The criteria in this study are adults who have lived and been active around the steel industry for at least 1 year. Their dwellings are categorized based on the distance of residence from the steel industry: short distances (<500 meters, n = 6), medium distances (500-100 meters, n = 22), long distances (> 100 meters, n = 68) with samples each radius uses *proportional stratified random sampling*. Before data collection and measurement are carried out, all adults must complete informed consent that determines their willingness to become a respondent. Data from interviews using a questionnaire adapted from the *American Thorachic Society* to see symptoms of respiratory disorders experienced.

2.2. Anthropometric Data

Obtained from measurements of body weight and height in adults. Weight is regulated in kilograms. Height is calculated in centimeters. The weight was measured using a floor weight scale and height was measured using a microtoise mounted on the wall. To find out the Body Mass Index (BMI) can be generated based on the calculation of body weight (kilograms) / height^2 (meters).

2.3. NO_2 Measurement

Based on the Indonesian National Standard (SNI) the method of measurement is carried out by the Gries Saltsman method. The tool used for this method is spectrophotometry. The principle works is to absorb NO_2 gas into the Griess Saltzman solution to form pink azo dye compounds. The concentration of the solution is determined by a spectrophotometer at a wavelength of 550 nm. Measurements were made at a radius of <500 m, 500-1000 m and> 1000 m taking into account the existence of community settlements.

2.4. Statistical Analyzes

We analyzed data on health problems, NO_2 concentration, length of stay, nutritional status and history of disease. A chi-Square test was used to analyze the relationship between variables. Significance value is determined if p-value <0.05.

3. Result

3.1. Individual Characteristics

It is known that the majority of respondents were 71 women (75.5%) with the majority being housewives. Most of the respondents are permanent residents who are older than 32 years as many as 49 people (52.1%). Distribution of the education level of respondents mostly had higher education of 67 people (71.3%) while having low education as many as 27 people (28.7%). In Tabel 2 it can be seen the demographic characteristics of adults that the average value of BMI is 26.7 ± 4.81 which indicates that BMI is more in the abnormal category.

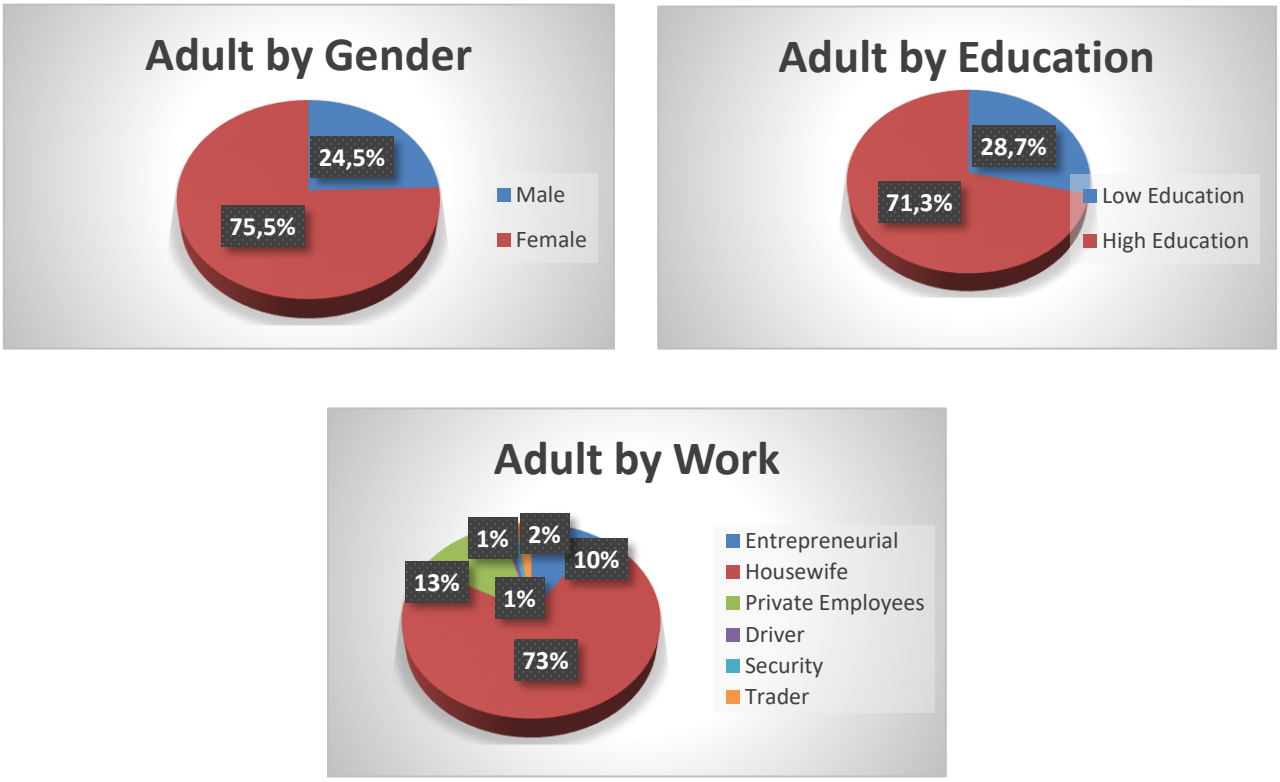

Figure 1 Overview of adult by Socio-Demographic Characteristics

Tabel 1 Demographic Characteristics of Study Sample (Mean ± SD)

Dimention	Min	Max	Total Adult (N = 94)
			Mean ± SD
Age (year)	22	69	32 ± 10.213
Wheight (kg)	41	100	66.3 ± 13.2
Height (cm)	144	175	157 ± 7.54
Length of Stay (year)	1	65	23 ± 15.47
BMI	17.1	38.0	26.7 ± 4.81

3.2. Health Disorders

Based on the *American Thorachic Society* (ATS) there are symptoms of respiratory disorders that can be used as a reference in the form of coughing, phlegm, shortness and wheezing. Each symptom is found in respondents not independently but in one respondent there is more than one respiratory disorder. Respondents are said to have respiratory problems if there is at least one of the symptoms of respiratory disorders experienced. Then it was found that the majority of respondents experienced respiratory distress that is as much as 54.3%.

3.3. The Relationship of Determinant Factors to Respiratory Disorders

Bivariate analysis between the independent variables and the dependent variables was carried out using thetest *Chi Square.* test was *Chi Square* performed on independent variables with categorical data and respiratory disorders as the dependent variable.

Table 2 Results of Analysis *Chi Square* Distribution The concentration of NO_2 in air, Day Stay (days/year), Length Of Stay (Year), Nutritional Status and History Respiratory in Desa with Respiratory Disorders

No	Variable	Respiratory Disorders				Total		OR (95% CI)	*p* Value
		Yes		No					
		N	%	N	%	N	%		
1	**Concentration of NO_2**								
	≥ 0,026 mg/m^3	17	50,0	17	50,0	34	100	0,765 (0,329 – 1,779)	0,683
	< 0,026 mg/m^3	34	56,7	26	43,3	60	100		
	Total	51	54,3	43	45,7	94	100		
2	**Length of Stay (Years)**								
	≥ 23 tahun	27	56,2	21	43,8	48	100	1,179 (0,523 – 2,655)	0,850
	< 23 tahun	24	52,2	22	47,8	46	100		
	Total	51	54,3	43	45,7	94	100		
3	**Nutritional Status (BMI)**								
	Abnormal	34	59,6	23	40,4	57	100	1,739 (0,754 – 4,01)	0,275
	Normal	17	45,9	20	54,1	37	100		
	Total	51	54,3	43	45,7	94	100		
4	**History of Respiratory Disease**								
	Yes	30	71,4	12	28,6	42	100	3,69 (1,548 – 8,799)	0,005
	No	21	40,4	31	59,6	52	100		
	Total	51	54,3	43	45,7	94	100		

3.4. Relationship of NO_2 Concentration with Respiratory Disorders

Result of *Chi Square* test as shown in table 2 showed that there were 17 respondents out of 34 respondents (50%) who were exposed to NO_2 above the average NO_2 concentration in Sukadanau Village experiencing respiratory problems. While among 34 respondents (56.7%) of the 60 respondents who were exposed to NO_2 below the average NO_2 concentration in Sukadanau Village also experienced respiratory problems. Results of *Chi Square* test obtained *p value* = 0.683, it can be concluded that there is no difference in the proportion of respiratory disorders between respondents exposed to NO_2 concentrations below the average or above the average $NOconcentration_2$ in Sukadanau Village.

3.5. Relationship of Length of Stay (years) with Respiratory Disorders

Results of the analysis of the relationship between length of stay (years) with respiratory disorders obtained that there were 27 (56.2%) of adult respondents who lived ≥ 23 years in Sukadanau Village had respiratory disorders. While among adult respondents who lived <23 years, there were 24 (52.2%) who experienced respiratory problems. Results of *Chi Square* test obtained *p value* = 0.850, it can be concluded there is no difference in the proportion of respiratory disorders between respondents who lived ≥ 23 years or <23 years.

3.6. Relationship of Nutritional Status with Respiratory Disorders

The results of the analysis of the relationship between nutritional status and respiratory disorders found that there were 34 (59.6%) of 57 adult respondents who had abnormal nutritional status experiencing respiratory disorders. Of the 37 respondents who had normal nutritional status, only 17 (45.9%) respondents had respiratory problems. Results of *Chi Square test* obtained *p value* = 0.275, it can be concluded that there is no difference in the proportion of respiratory disorders between respondents who have normal nutritional status and abnormal nutritional status.

3.7. Relationship of Disease History with Respiratory Disorders

Results of the analysis of the relationship between the history of illness and respiratory disorders obtained that there were 30 (71.4%) of 42 adult respondents who had a history of illness experiencing respiratory disorders. While 21 (40.4%) of 52 respondents who did not have a history of the disease had respiratory problems. Results of *Chi Square* test obtained p value = 0.005, it can be concluded that there is a difference in the proportion of respiratory disorders between respondents who have a history of illness and do not have a history of disease. From the results also obtained OR value = 3,690, meaning that adult respondents who have a history of disease have a 3,690 times higher chance of experiencing respiratory disorders compared with respondents who do not have a history of the disease.

4. DISCUSSION

4.1. Relationship of NO_2 concentration with Respiratory Disorder

NO_2 concentrations can damage the epithelial cells due to oxidants, reducing the ability of cilia to prevent infecting organism, suppress alveolar macrophages and release of proinflammatory mediators[13]. Exposure to gas over several years can cause more respiratory complaints than short-term exposure (3 months)[14]. However, we did not find a significant relationship between NO_2 concentrations and symptoms of respiratory disorder in adults around the steel industry. This result is in line with research conducted by Sakti (2012) in Bekasi City, Indonesia, that there is no significant relationship between NO_2 concentration and respiratory disorders where the results of the analysis show a value of $p > 0.05$[15]. In other studies also found no significant association of NO_2 concentrations of respiratory disorders symptoms[16 17 18 19]. However, in several studies it was found that there is a relationship between exposure to NO_2 concentrations with respiratory disorders. As research conducted by Zhang (2011) shows a significant relationship, that NO_2 has the greatest influence on deaths due to respiratory disorders[20]. This is possible because the concentration of NO_2 is much lower at a distance of more than 500 meters from the steel industry, and the concentration of NO_2 yet that exceed the quality standards set by WHO, so that significant effect of NO_2 concentrations has been seen on the health problems. Besides respiratory disorders

can also be caused by many factors and disease agents. Therefore, further research with other factors is needed to determine the effect of NO_2 exposure with respiratory disorders.

4.2. Relationship of Length of Stay with Respiratory Disorders

In this study the length of stay variable is a dichotomy variable consisting of two categories, namely more than 23 years and less than 23 years. Statistically, the variable length of stay showed no relationship with respiratory disorders in adults. In line with research from Trigunarso (2018) on the community around PT Semen Baturaja which states that there is no meaningful relationship between length of stay with potential respiratory disorders[21]. In contrast to the study of Zuskin (1995) who found a statistically significant relationship between long exposure to respiratory function disorders such as chronic cough, sputum, shortness of breath and chest pain[22].

The results of this study are not in accordance with the theory that the longer a person is exposed to a risk agent, the greater the risk of respiratory problems. The length of stay of respondents who are more than 21 years in areas where the air is polluted will increase morbidity, especially respiratory diseases[14]. The absence of a relationship between length of stay and respiratory disorders is possible because the length of stay is not accompanied by a large number of risk agents. The findings in the field show that although respondents have the same length of stay, one of the others has a different dose of risk agent exposure. The body's response to toxic chemicals besides depending on the length of stay can also be influenced by the amount of exposure[23]. In addition, length of stay is not a variable that can stand alone to influence the dependent variable, so there is the possibility of other variables such as a person's vulnerability, intensity of activities and others can contribute to increasing the risk of respiratory disorders in someone.

4.3. Relationship of Nutritional Status with Respiratory Disorders

Nutritional status in this study is based on the Body Mass Index (BMI) indicator of the ratio between body weight in kilograms and height in meters squared. Categorization of BMI based on the classification of the Ministry of Health of the Republic of Indonesia with BMI <18.5 and ≥ 25 is categorized as abnormal and 18.5 - 24.9 is categorized as normal. Mungreiphy (2012) found that normal BMI impacts better respiratory health compared to people who have lower or higher BMI[24]. In another study it was also found that nutritional deficiencies cause respiratory muscle strength to be reduced and nutritional intervention can restore muscle ventilation function to normal levels[25].

However, in this study no relationship was found between nutritional status and respiratory disorders as investigated by Tolanggi (2014) who did not find an association between nutritional status and respiratory disorders in limestone mining workers[26]. Then in Liu's study (2017) also found no relationship between nutritional status and respiratory disorders in male and female students[27]. This is possible in this study the data on nutritional status variables are homogeneous or with low variations. Seen from the data of respondents with abnormal nutritional status with respiratory disorders have a difference that is not too much different from respondents who have normal nutritional status and do not have respiratory disorders.

4.4. Relationship of Disease History and Respiratory Disorders

The results showed a history of illness in respondents who had respiratory disorders as much as 71.4%. The results of statistical analysis found a relationship between the history of respiratory

diseases with respiratory disorders (*p value* = 0.005). This research is in line with research conducted by Esha (2017) which shows that a history of respiratory disorders have a significant relationship to respiratory disorders that occur (p = 0.001)[28]. However the results of this study are not in line with the research of Clarissa (2010) which found no relationship between history of illness and respiratory disorders in gas station workers in Palembang[29].

The results of this study are in accordance with the theory that a history of disease that has been experienced can facilitate the supporting factors to bring back the previous disease. If the condition of the immune system is down and the presence of risk agents that affect the body it is possible to potentially re-create the risk of respiratory disorders that have suffered. This is because the history of respiratory disease is a possible factor in respiratory disorders[30]. The existence of someone who has a history of respiratory illness can worsen the presence of respiratory disorders that arise. History of this disease includes ARI, bronchitis, pneumonia, tuberculosis ever experienced by adult respondents. This is because members of the body that have previously been stricken with disease will cause resistance to the disease will decrease, in contrast to limbs that have never been stricken with the disease[31].

5. CONCLUSION

We found that the factors that influence the presence of respiratory disorders in adults are history of respiratory disorders. Apart from not exceeding the established quality standards, there is no relationship between the concentration of NO_2 and respiratory disorders, it is possible for many other factors and other disease risk agents in the industrial area. Similarly, nutritional status and length of stay were found to be unrelated to respiratory disorders. Maintaining a normal nutritional status and living a healthy lifestyle may help prevent respiratory disorders.

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References

1. Miri M, Derakhshan Z, Allahabadi A, Ahmadi E, Oliveri Conti G, Ferrante M, et al. Mortality and morbidity due to exposure to outdoor air pollution in Mashhad metropolis, Iran. The AirQ model approach. Environ Res [Internet]. 2016;151:451–7. Available from: http://dx.doi.org/10.1016/j.envres.2016.07.039
2. Pope CA. Epidemiology of fine particulate air pollution and human health: Biologic mechanisms and who's at risk? Environ Health Perspect [Internet]. 2000;108(SUPPL. 4):713–23. Available from: https://ehp.niehs.nih.gov/doi/abs/10.1289/ehp.108-1637679
3. Golub A, Strukova E. Evaluation and identification of priority air pollutants for environmental management on the basis of risk analysis in Russia. J Toxicol Environ Heal - Part A Curr Issues [Internet]. 2008;71(1):86–91. Available from: https://www.ncbi.nlm.nih.gov/pubmed/18080899

4. Carbone U, Montuori P, Novi C, Triassi M. Respiratory function in power plant workers exposed to nitrogen dioxide. Occup Med (Chic Ill) [Internet]. 2014;64(8):644–6. Available from: https://www.ncbi.nlm.nih.gov/pubmed/25183701
5. ATSDR. NITROGEN OXIDES (nitric oxide , nitrogen dioxide , etc .). Div Toxicol [Internet]. 2002;9:43–4. Available from: http://www.atsdr.cdc.gov/substances/toxsubstance.asp?toxid=69
6. Abdolahnejad A, Jafari N, Amir M, Miri M, Hajizadeh Y. Mortality and Morbidity Due to Exposure to Ambient NO2 , SO2 , and O3 Isfahan in 2013–2014. Int J Prev Med [Internet]. 2017;8(2):1–6. Available from: https://www.ncbi.nlm.nih.gov/pubmed/29541426
7. Chao CYH. Comparison Between Indoor and Outdoor Air Contaminant Levels in Residential Buildings from Passive Sampler Study. Build Environ [Internet]. 2001;36(9):999–1007. Available from: https://www.sciencedirect.com/science/article/abs/pii/S0360132300000573
8. Poupard O, Blondeau P, Iordache V, Allard F. Statistical Analysis of Parameters Influencing the Relationship Between Outdoor and Iindoor Aair Quality in Schools. Atmos Environ [Internet]. 2005;39(11):2071–80. Available from: https://www.sciencedirect.com/science/article/abs/pii/S1352231005000166
9. Demirel G, Özden Ö, Döğeroğlu T, Gaga EO. Personal Exposure of Primary School Children to BTEX, NO2 and Ozone in Eskişehir, Turkey: Relationship with Indoor/Outdoor Concentrations and Risk Assessment. Sci Total Environ [Internet]. 2014;473–474(2):537–48. Available from: https://www.sciencedirect.com/science/article/pii/S0048969713014885
10. Peng L, Zeng X, Wang Y, Hong GB. Analysis of Energy Efficiency and Carbon Dioxide Reduction in The Chinese Pulp and Paper Industry. Energy Policy [Internet]. 2015;80:65–75. Available from: http://dx.doi.org/10.1016/j.enpol.2015.01.028
11. Siregar E. Industri Besi dan Logam Merupakan Sumber Emisi Gas Co2. MPI. 2007;1(3):82–91.
12. US. EPA. Alternative Control Techniques Document -- NOx Emissions from Iron and Steel Mills. North Carolina Contract No EPA-453/R-94-065. 1994;
13. American Thoracic Society. Health effects of outdoor air pollution. Committee of the Environmental and Occupational Health Assembly of the American Thoracic Society. Am J Respir Crit Care Med [Internet]. 1996;153(1):3–50. Available from: https://www.ncbi.nlm.nih.gov/pubmed/8542133
14. Mukono J. Pencemaran udara dan pengaruhnya terhadap gangguan saluran pernapasan [Internet]. Surabaya: Airlangga University Press; 2008. 150 p. Available from: https://books.google.co.id/books?id=TmhuAQAACAAJ&dq=Pencemaran+Udara+dan+Pengaruhnya+Terhadap+Gangguan+Pernapasan&hl=en&sa=X&ved=0ahUKEwjNusa1t8PnAhUbb30KHTV6AKkQ6AEIKTAA
15. Sakti ES. Tinjauan Tentang Kualitas Udara Ambien (NO2, SO2, Total Suspended Particulate) Terhadap Kejadian ISPA di Kota Bekasi Tahun 2001-2011 [Internet]. Universitas Indonesia; 2012. Available from: http://lib.ui.ac.id/file?file=digital/20319917-S-PDF-Eka Satriani Sakti.pdf
16. Brunekreef B, Holgate ST. Air pollution and health. Lancet [Internet]. 2002;360(9341):1233–42. Available from: https://www.ncbi.nlm.nih.gov/pubmed/12401268
17. Levy JI, Lee K, Spengler JD, Yanagisawa Y. Impact of residential nitrogen dioxide

exposure on personal exposure: An international study. J Air Waste Manag Assoc [Internet]. 1998;48(6):553–60. Available from: https://www.ncbi.nlm.nih.gov/pubmed/9949739

18. Sunyer J, Puig C, Torrent M, Garcia-Algar O, Calicó I, Muñoz-Ortiz L, et al. Nitrogen dioxide is not associated with respiratory infection during the first year of life. Int J Epidemiol [Internet]. 2004;33(1):116–20. Available from: https://www.ncbi.nlm.nih.gov/pubmed/15075156
19. Gillespie-Bennett J, Pierse N, Wickens K, Crane J, Howden-Chapman P, Shields H, et al. The respiratory health effects of nitrogen dioxide in children with asthma. Eur Respir J [Internet]. 2011;38(2):303–9. Available from: https://erj.ersjournals.com/content/38/2/303
20. Zhang F, Li L, Krafft T, Lv J, Wang W, Pei D. Study on The Association Between Ambient Air Pollution and Daily Cardiovascular and Respiratory Mortality in an Urban District of Beijing. Int J Environ Res Public Health [Internet]. 2011;8(6):2109–23. Available from: https://www.ncbi.nlm.nih.gov/pubmed/21776219
21. Trigunarso SI, Yushananta P, Ainin FK. Dust Levels to Vital Lung Capacity in The Community around PT Semen Baturaja. J Kesehat [Internet]. 2018;9(3):396. Available from: https://www.researchgate.net/publication/334741348_Kadar_Debu_terhadap_Kapasitas_Vital_Paru_pada_Masyarakat_di_Sekitar_PT_Semen_Baturaja
22. Zuskin E, Mustajbegovic J, Neil Schachter E, Doko-Jelinic J, Bradic V. Respiratory Function in Shoe Manufacturing Workers. Am J Ind Med [Internet]. 1997;31(1):50–5. Available from: https://www.ncbi.nlm.nih.gov/pubmed/8986254
23. Prihartini N. Analisis Risiko Kesehatan Pajanan Toluen Pada Pekerja Bengkel Sepatu 'X' di Kawasan Perkampungan Industri Kecil (PIK) Pulogadung Jakarta Timur Tahun 2010 [Thesis]. Universitas Indonesia; 2010.
24. Mungreiphy NK, Kapoor S, Sinha R. Relationship between nutritional status, respiratory performance and age: Study among Tangkhul Naga females of Northeast India. Acta Biol Szeged [Internet]. 2012;56(1):31–6. Available from: http://abs.bibl.u-szeged.hu/index.php/abs/article/view/2766
25. Baliviera F, Pierdominici S, L S. Effects of Nutritional Status on The Respiratory System. Minerva Anestesiol [Internet]. 1989;55(11):443–50. Available from: https://www.ncbi.nlm.nih.gov/pubmed/2699012
26. Tolinggi S, Nakoe MR, Gobel A, Sengke J, Keman S, Sudiana K, et al. Effect Inhaling of Limestone Dust Exposure on Increased Level of IL-8 Serum and Pulmonary Function Decline to Workers of Limestone Mining Industry. Int Ref J Eng Sci [Internet]. 2014;3(8):66–72. Available from: www.irjes.com
27. Liu P, Ye Z, Lu H, Lu J, Huang L, Gong J, et al. Association between body mass index (BMI) and vital capacity of college students of Zhuang nationality in China: A crosssection study. Oncotarget [Internet]. 2017;8(46):80923–33. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5655250/
28. Indi Esha, Dedi Afandi VA. Analysis of Carbon Monoxide Exposure and Its Effect to Lung Function of Parking Officer in Basement Mal X Pekanbaru A. J Ilmu Lingkung [Internet]. 2017;11(1):25–34. Available from: https://jil.ejournal.unri.ac.id/index.php/JIL/article/view/4473
29. Clarissa AS, Aulia P, Hasyim H, Purba IG. Factors Related to Lung Vital Capacity of 24.301.118 Gas Station Operators in Palembang 2010. J Ilmu Kesehat Masy [Internet]. 2010;1(3):217–24. Available from:

https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=FACTORS+RELATED+TO+LUNG+VITAL+CAPACITY+OF+24.301.118+GAS+STATION+OPERATORS+IN+PALEMBANG+2010&btnG=

30. World Health Organisation (WHO). Global Surveillance, Prevention and Control of Crhonic Respiratory Diseases. Geneva; 2007.
31. Bagus H. Analysis of NH3 Content, Individual Characteristics and Respiratory Scavenger Complaint in Landfills Benowo Rubbish and Not Scavenger Around Landfills Benowo Surabaya. J Kesehat Lingkung [Internet]. 2017;Volume 9:135–44. Available from: https://e-journal.unair.ac.id/JKL/article/download/9183/5171