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SPATIAL ANALYSIS OF ACUTE RESPIRATORY INFECTION (ARI) BASED ON THE AIR POLLUTION STANDARD INDEX (PSI) AT DKI JAKARTA REGION IN 2018-2019

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Abstract

Introduction: *Acute respiratory infection (ARI) is a health problem causing global morbidity and mortality in Indonesia, with 18.8 billion cases and more than six million deaths observed in 2016. Between 2013 and 2018, the diagnosis of ARI prevalence reportedly experienced a 10% decrease from 12.5-2.5%, within 10 provinces, including DKI Jakarta, Indonesia.* ***Methods:*** *This study aims to identify the spatial analysis of ARI events using an ecological method, based on the Air Pollution Standard Index (PSI) at DKI Jakarta between 2018 and 2019.* ***Results and Discussion:*** *Data analysis was performed by mapping case description through Quantum GIS, correlation assessment, as well as linear regression with SPSS scatter plot. Based on the bivariate analysis, the correlation assessment and linear regression of the ARI event with PM_{10} had positive regression in 2018 and 2019, at (R)0.649 and (R)0.0630, respectively.* ***Conclusion:*** *The highest PM_{10} values in Kelapa Gading and Cipayung districts increased the case of ARI fluctuations within two years. Therefore, the environmental health service office focused on the air quality evaluation and prevention control of ARI cases.*

INTRODUCTION

Acute respiratory infection (ARI) is a urinary tract disease responsible for the inflammation of the lungs (pneumonia), due to the prevention of normal breathing functions. Meanwhile, ARI is not an ear and throat disease caused by bacteria, viruses, fungi, or aspirates, including food, smoke, and other agents (1). This infection is a health problem capable of causing global morbidity and mortality, due to an incidence of 18.8 billion cases and approximately six million deaths, with 94% caused by lower ARI (2). Based on Marunda Public Flats North Jakarta, Indonesia was one of the five highest ranking countries with ARI incidence, subsequently indicating that indoor air quality was a factor, influencing the symptoms of the infection in infants. This air quality is often affected by several factors, such as indoor and outdoor environmental indicators, as well as occupant behavior (3). In addition, many developed countries in Europe, such as Italy and Germany, have lower values of this condition at 9.8 and 5.8%, respectively (4). According to the National Basic Health Research, the prevalence of ARI in Indonesia insignificantly decreased by 9.3% between 2013 and 2018. This indicated that DKI Jakarta was included in the 10 provinces with high ARI in Indonesia, where the diagnosis of the prevalence decreased by 10% from 12.5 to 2.5% between 2013 and 2018. Subsequently, the prevalence decreased by 15% from 25% to 10%, based on the symptoms. Based on the symptoms and diagnosis between 2013-2018, the ARI pneumonia prevalence also decreased by only 0.4% and 0.5% at 1.6% and 2.5-20%, respectively (5).

Based on the DKI Jakarta Health Profile, the province experienced an increase in the incidence of pneumonia ARI by 33.03% in 2017, with the lowest and highest percentages observed in North Jakarta with 25.27% and Thousand Island at 48.51%, respectively. Compared to 44,173 cases in 2017, the number of ARI pneumonia cases subsequently decreased to 14,629 in 2018 (6), indicating an insignificant reduction in the acute respiratory infection conditions. According to the Indonesian Health Profile, the Strategic Plan indicator used was the percentage of districts/cities, where 50% of

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the Public Medical Centers carried out standard checks and management of pneumonia through the Integrated Management of Sick Toddler (IMCI) and P2 ARI programs. This indicated that the results reached 14.62, 28.07, 42.6, and 43% of the standard 20, 30, 40, and 50% targets in 2015, 2016, 2017, and 2018, respectively. Additionally, the results obtained in 2018 did not meet the standard targets, although increased from the previous year (7). For instance, based on the data obtained from the Ministry of Environment and Forestry in the Air Pollutant Standard Index, Bekasi City was categorized very unhealthy and good air values of 30 and 15 times, respectively. Therefore, this study aims to determine the distribution and frequency of ARI occurrence, as well as the relationship of the Air Pollutant Standard Index (2018-2019) with a Spatial Analysis approach at DKI Jakarta, Indonesia.

METHODS

This study was conducted in the DKI Jakarta Region, including five administrative cities, namely South, North, West, East, and Central Jakarta. The sub-districts representing each city also included Cipayung, Jagakarsa, Gambir, Kebon Jeruk, and Kelapa Gading Districts, respectively. In this study, the secondary data were used as the information sources, based on the following, (1) incidence of ARI cases obtained from the DKI Jakarta Health Office in 2018-2019, and (2) the variables of Temperature, Humidity, and the DKI Jakarta Air Pollution Standard Index in 2018-2019. These were obtained from the Environmental Service of DKI Jakarta Province, as the data on the ARI cases per administrative city (2018-2019) were recorded in the annual report of the Provincial Health Office. The temperature, humidity, and Air Pollution Standard Index data were also obtained from the DKI Jakarta Provincial Environmental Service (2018-2019). The method used in this study was the spatial analysis, due to the variables being constant risk factors or characteristics within the community. These factors were analyzed against geographically restricted disease distributions, subsequently using statistical analysis for correlation tests, to determine the degree of closeness between the variables. Furthermore, the data analysis used two methods, namely univariate and bivariate spatial tests. The univariate analysis was used to describe the distribution of ARI based on the Temperature, Humidity, and Air Pollution Standard Index (SO_2, NO_2, CO, PM_{10}), with the results being presented as a diagram.

The distribution of this disease was then analyzed using spatial analysis, for the production of the ARI distribution based on the variables. This was subsequently compared regarding the geographical location, which was limited by each region and the disease trend within two years. In this study, the spatial analysis was carried out by combining (joining) the DKI Jakarta digital map database with the ARI cases in the administrative city areas, which were then colored according to the classification of each variable and disease conditions in the attribute table. Meanwhile, the bivariate analysis aims to determine the relationship between the independent and dependent variables, based on the relationship between SO_2, NO_2, CO, and PM_{10} with the ARI incidence in DKI Jakarta, through correlation and simple linear regression tests, using the SPSS software application.

RESULTS

The Spatial Distribution of ARI by the Districts in DKI Jakarta (2018-2019)

Based on Figure 1 and 2, the distribution of ARI was observed in five selected sub-districts, with the highest and lowest cases found in Cipayung with 39,419, as well as Kebon Jeruk and Gambir with 8,922 and 16,999, respectively. Subsequently, the Kebon Jeruk and Gambir Districts area is located in West and Central Jakarta, respectively. Based on the ARI distribution map, the sub-district previously having the highest number of cases experienced a decrease from 39,419 to 23,640, indicating that the Cipayung District encountered a 15,799 reduction in the number of acute respiratory infection conditions within one year. However, the sub-districts with previous moderate occurrences, such as Kelapa Gading District, increased to encounter the highest number of ARI conditions, from 21,786 to 29,700 cases. This showed that higher color contrast on the map led to more cases in each sub-district.

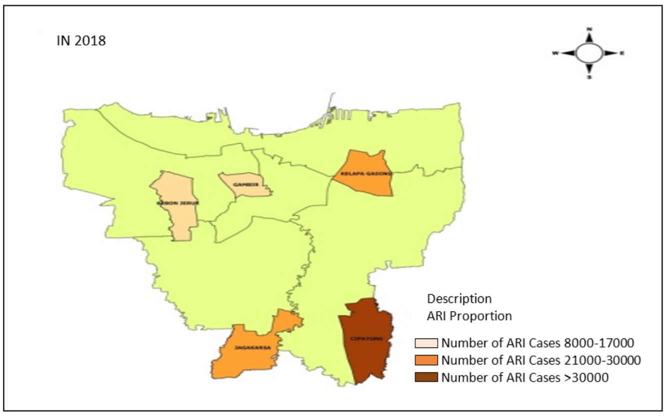

Figure 1. The Spatial Distribution of the ARI Diseases by District Area in DKI Jakarta Province 2018

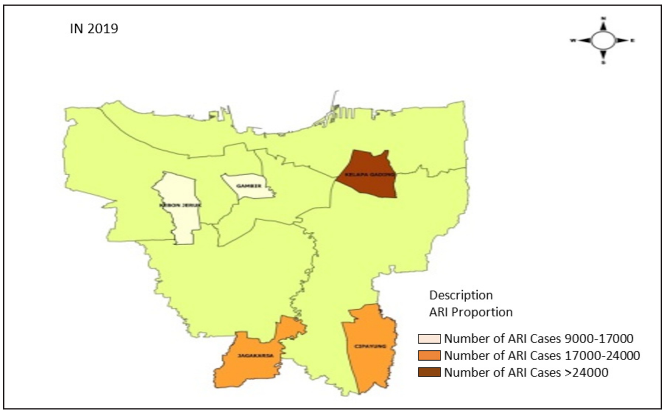

Figure 2. The Spatial Distribution of the ARI Diseases by District Area in DKI Jakarta Province 2019

The Distribution of ARI Frequency in DKI Jakarta (2018-2019)

Based on Table 1, the average, lowest, and highest number of ARI cases within each sub-district in 2018 were 23,315.60/24,000 (95% CI = 15,433.03-31,198.1), 8,922, and 39,419, respectively, after the performance of the statistical analysis. This indicated that the number of ARI cases in the DKI Jakarta sub-districts was between 15,433 and 31,198, according to the interval estimation results. Meanwhile, the average, lowest, and highest number of ARI cases in 2019 were 20,141.40/20,141 (95% CI = 14,878.22-5,404.58), 9,229, and 29,700, respectively, indicating that the conditions in the DKI Jakarta sub-districts were between 14,878 and 5,404, as regard the interval estimation results.

Table 1. The Distribution of the ARI Frequency in DKI Jakarta (2018-2019)

Variable	Mean	SD	Min - Max	95% CI
ARI 2018	23,315.60	11,019.072	8,922 – 39,419	15,433.03 – 31,198.10
ARI 2019	20,141.40	7,357.424	9,229 – 29,700	14,878.22 – 5,404.58

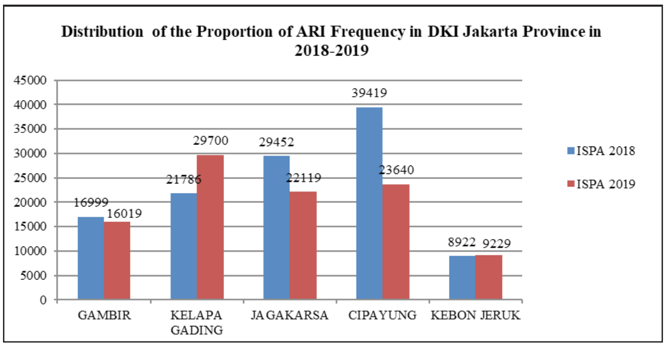

Figure 3. The Distribution of the ARI Frequency in DKI Jakarta Province (2018-2019)

The Distribution of ARI Frequency Based on Air PSI in DKI Jakarta (2018-2019)

According to Figure 4 and 5, the map showed the distribution of the ARI cases based on the Air PSI for two years. This indicated that the sub-districts in each administrative area had the incidence of ARI cases, from the fewest to the highest numbers. Based on the ARI proportion in 2018, Cipayung District had the highest number of cases at 39,419, compared to other sub-districts. However, the number of cases in this sub-district showed that the parameters of the Air PSI (SO_2, PM_{10}, CO, NO_2) were smaller when compared to the Kelapa Gading District. This was because the air quality monitoring station in Cipayung District was more than a 5 km radius, with the average values of the sub-districts PSI being 27.75 and 10.27 g/m^3 on the SO_2 and NO_2 parameters, respectively. For other sub-districts such as Jagakarsa, Gambir, Kebon Jeruk, and Kelapa Gading Districts, the number of ARI cases in 2018 was less than 30,000, with an air quality monitoring station distance of 5 km. Subsequently, the monitoring stations were located near settlements and area offices. In 2019, Kelapa Gading District had the highest ARI cases at 29,700, based on the Air PSI parameters dominated by the concentration of PM_{10}. The average value of the air psi parameter in this sub-district was also 12.79 and 10.65 g/m^3 for SO_2 and NO_2, respectively.

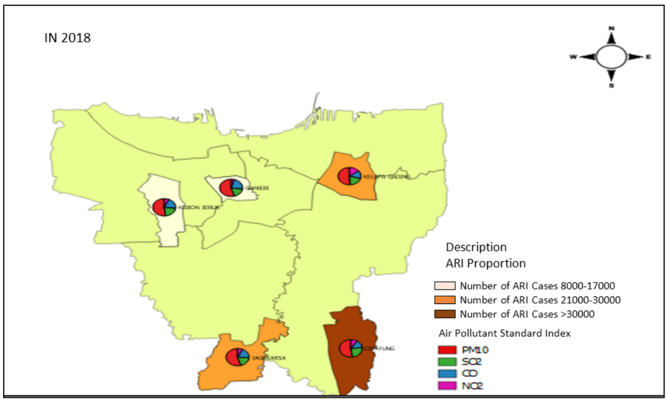

Figure 4. The Distribution of the ARI Disease Frequency Based on Air PSI in DKI Jakarta Region 2018

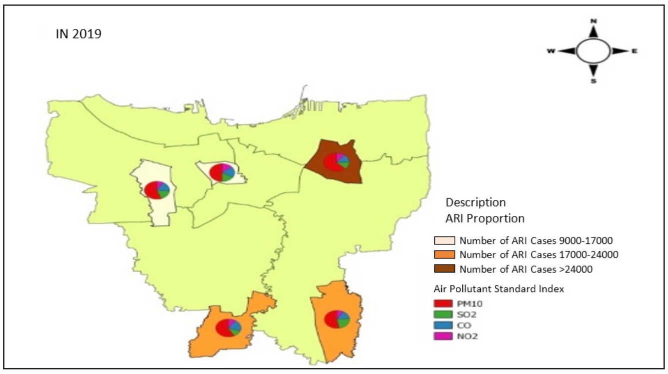

Figure 5. The Distribution of the ARI Disease Frequency Based on Air PSI in DKI Jakarta Region 2019

The Distribution of Air PSI Parameter Frequency in DKI Jakarta (2018-2019)

Based on Table 2, the average, lowest, and highest PM_{10} parameters within each district in 2018 were 52.30/52 (95% CI = 48.70-55.89), 45.85, and 60.11 μg/m³, respectively, after the performance of the statistical analysis. Meanwhile, the interval estimation in 2019 indicated that the average, lowest, and highest PM_{10} parameters were 57.14/57 (95% CI = 54.94-59.33), 52.45, and 61.05 μg/m³, respectively. This showed that the average PM_{10} parameters in the DKI Jakarta sub-district were between 54.94-59.33 μg/m³, according to the interval estimation. In 2018, the average, lowest, and highest SO_2 parameters within each sub-district were 20.61/21 (95% CI = 17.35-23.88), 15.18, and 27.25 μg/m³, respectively. Meanwhile, the interval estimation in 2019 indicated that the average, lowest, and highest parameters were 17.17/17 (95% CI = 13.10-21.24), 11.35, and 26.72 μg/m³, respectively. This showed that the average SO_2 parameters in the DKI Jakarta sub-districts were between 13.10-21.24 μg/m³, according to the interval estimation.

Table 2. The Distribution of Air PSI Parameter Frequency in DKI Jakarta (2018-2019)

Variable	Mean	SD	Min - Max	95% CI
PM_{10} 2018	52.30	5.02	45.85 - 60.11	48.70 - 55.89
PM_{10} 2019	57.14	3.07	52.45 - 61.05	54.94 - 59.33
SO_2 2018	20.61	4.56	15.18 - 27.25	17.35 - 23.88
SO_2 2019	17.17	5.69	11.35 - 26.72	13.10 - 21.24
CO 2018	17.47	1.64	15.45 - 20.03	16.29 - 18.65
CO 2019	18.84	3.14	13.75 - 21.53	16.59 - 21.09
NO_2 2018	8.41	4.32	3.63 - 15.64	5.31 - 11.50
NO_2 2019	10.41	2.20	8.61 - 14.35	8.33 - 11.99

According to the statistical analysis in 2018, the average, lowest, and highest CO parameters within each sub-district were 17.47/17 (95% CI = 16.29-18.65), 15.45, and 20.03 μg/m³, respectively. This indicated that the average number of CO parameters in the DKI Jakarta sub-districts were between 16.29-18.65 μg/m³, according to the interval estimation. Meanwhile, the average, lowest, and highest CO parameters within these districts in 2019 were 18.84/19 (95% CI = 16.59-21.09), 13.75, and 21.53 μg/m³, respectively. This showed that the average CO parameters in these sub-districts were between 16.59-21.09 μg/m³, as regard the interval estimation. From the statistical analysis in 2018, the average, lowest, and highest NO_2 parameters within each sub-district were 8.41/8 (95% CI = 5.31-11.50), 3.63, and 15.64 μg/m³, respectively. This indicated that the average number of these parameters in the DKI Jakarta Districts were between 5.31-11.50 μg/m³, based on the interval estimation. However, the average, lowest, and highest NO_2 parameters in 2019 were 10.41/10 (95% CI = 8.33-11.99), 8.61, and 14.35 μg/m³, respectively. This showed that the average number of these parameters in the sub-districts were between 8.33-11.99 g/m³, according to the interval estimation.

The Bivariate Analysis of the Correlation Between PM_{10} and the ARI Cases in DKI Jakarta (2018-2019)

Based on Table 3, the analytical values obtained in 2018 and 2019 had a positive pattern (R = 0.649 and 0.630), indicating that more PM_{10} significance led to the higher number of ARI cases yearly. The coefficient values with a determination of 0.421 and 0.396 also indicated that the regression-line-equation was highly sufficient to explain the PM_{10} variable. Therefore, the statistical test showed a significantly strong relationship between PM_{10} and ARI cases (P = 0.042).

Table 3. The Bivariate Analysis of the Correlation Between PM_{10} and the Incidence of ARI in 2018-2019

Variable	R	R^2	Line Equation	P-Value
ARI 2018	0.649	0.421	ARI 18 = (-51,135.615 + 1,423.433) *PM_{10} 2018	0.042
ARI 2019	0.630	0.396	ARI 19 = (-66,006.713 +1,507.667) *PM_{10} 2019	0.051

Table 4. The Correlation and Linear Regression Analysis of the SO_2 with the Incidence of ARI in DKI Jakarta (2018-2019)

Variable	R	R^2	Line Equation	P-Value
ARI 2018	0.517	0.267	ARI 18 = (-2,414.246 + 1,248.052) *SO_2 2018	0.0126
ARI 2019	-0.161	0.026	ARI 19 = (2,376.192 + (-209.292)) * SO_2 2019	0.0655

According to Table 4, the analytical values obtained in 2018 (R = 0.517) and 2019 (R = -0.161) had positive and negative patterns, respectively. These positive and negative patterns indicated that the greater and lesser SO_2 values led to higher ARI cases yearly. The coefficient values with a determination of 0.267 and 0.026 also showed that the regression-line-equation was highly sufficient to explain the 26.7 and 2.6% SO_2 variation. Therefore, the statistical test indicated a significantly strong relationship between SO_2 and ARI (P = 0.0126). Meanwhile, the coefficient (R = -0.161) having P = 0.0655 had a negative pattern, indicating that smaller SO_2 values led to higher ARI cases yearly, with no significant relationship observed.

The Bivariate Analysis of the Correlation Between CO and the ARI Cases in DKI Jakarta (2018-2019)

Based on Table 5, the values obtained in 2018 and 2019 (R = -0.684 and -0.883) had a negative pattern, indicating that a smaller CO value led to higher ARI cases yearly. The coefficient values with a determination of 0.468 and 0.781 also indicated that the regression-line-equation was highly sufficient to explain the 46.8 and 78.1% CO variation. Therefore, the statistical tests found a significantly strong relationship between CO and ARI incidence (P = 0.029 and 0.001), with a negative pattern direction.

Table 5. The Bivariate Analysis of the Correlation Between CO and the Incidence of ARI in DKI Jakarta (2018-2019)

Variable	R	R^2	Line Equation	P-Value
ARI 2018	-0.684	0.468	ARI 18 = (103,289.959 + (-4,576.7630)) *CO 2018	0.029
ARI 2019	-0.883	0.781	ARI 19 = (59,060.108 + (-2,065.530)) *CO 2019	0.001

The Correlation and Linear Regression Analysis of the NO_2 with ARI in DKI Jakarta (2018-2019)

According to Table 6, the values obtained in 2018 and 2019 (R = 0.311 and -0.059) had a positive and negative pattern, indicating that the greater and lesser values of NO_2 led to higher ARI cases per year, respectively. The coefficient values with a determination of 0.097 and 0.003 also showed the regression-line-equation was highly sufficient to explain 9.7 and 3% of the NO_2 variation. Therefore, the statistical test exhibits significantly and insignificantly strong relationships between the NO_2 and ARI in 2018 and 2019 (P = 0.0382 and 0.0872), respectively.

Table 6. The Correlation and Linear Regression Analysis of NO_2 with ARI in 2018-2019

Variable	R	R^2	Line Equation	P-Value
ARI 2018	0.311	0.097	ARI 18 = (16,654.664 + 792.026) *NO_2 2018	0.0382
ARI 2019	-0.059	0.003	ARI 19 = (22,182.941 + (-196.076)) *NO_2 2019	0.0872

DISCUSSION

The Spatial Description of the ARI Cases in DKI Jakarta (2018-2019)

The ARI cases that occurred within the DKI Jakarta sub-districts were observed from health services. Based on the comparative classification obtained in 2018, ARI increased within certain sub-districts in 2019, such as the Kelapa Gading with a total of 29,700 cases. The districts initially within the proportion of incidence were also experiencing an increase in the number of cases, while the areas previously having the highest values indicated a decrease. This increase was due to the occurrence of challenges in implementing the management standards of ARI cases (6).

The Distribution of the ARI Frequency based on the Air Pollutant Standard Index in DKI Jakarta (2018-2019)

The air pollutant standard index parameter is one of the factors causing ARI disease in DKI Jakarta. This indicated that several factors affected the incidence of ARI, such as air pollution, season and temperature, availability of health services, and preventive measures (8). According to the air quality monitoring, IQ Air DKI Jakarta was the third-ranked city in Indonesia with unhealthy status, due to the large volume of vehicle emissions. The ambient air qualities within DKI Jakarta in 2018 and 2019 were also categorized as 11/2, 139/136, 188/84, and 27/3 good, moderate, unhealthy, and very unhygienic days, respectively, based on the PSI measurements of the Provincial Environment Agency. Moreover, the dominant critical parameter observed during these periods was PM_{10}. This indicated that the pollution was harmful to human health when it exceeded the standard quality value set in PP No. 41 of 1999, which is 150 μg/m^3. The Environmental Service of DKI Jakarta also had air quality monitoring stations located at 5 points of the administrative area, with a radius of 5 km. Map 5.3 represents the distribution of ARI cases based on the air pollutant standard index, where the highest incidences were observed in the Cipayung and Kelapa Gading sub-districts.

The Correlation and Linear Regression Analysis of the ARI Incidence with PM_{10} in DKI Jakarta (2018-2019)

According to PM_{10}, the incidence of ARI had a muscular relationship strength in 2018 and 2019, subsequently indicating a positive pattern. This showed that a greater PM_{10} value led to higher ARI cases yearly. These results were not in line with a previous study, where the relationship between PM_{10} concentrations and the ARI incidence was significant although very weak at R = 0.219. Based on the direct effect of the PM_{10} particulates on the ARI cases, the impact was insignificant at 0.01% (9). These study inconsistencies were due to the incomplete secondary data from air monitoring and the yearly increase of the total PM_{10} values. This condition was caused by several factors, including the particulate concentration data obtained from a fixed station. These data only represented the spot due to the inability to cover a wide area, with another study showing that the binary logistic regression test indicated the effect of PM_{10} on chest pain and shortness of breath (P = 0.039) (10).

This corresponded to a previous study in Tabriz City, Iran, where the proportion attributed to the long-term exposure to PM_{10} was between 7.9/28.7% and 20.7/61.5% for post-neonatal infant mortality and adult chronic bronchitis, respectively (11). According to a study on the Settlement Surrounding the Industrial Environment of Tumapel Village, Mojokerto Regency, a significant relationship was observed between the PM_{10} and ARI incidence, at a p-value = 0.021 (12). This was subsequently in line with a study conducted on Construction Project Worker X at Depok, where a relationship was observed between the PM_{10} and ARI cases, with the average parameter measurement being 159.43 μg/m^3 at seven points within and outside the building (13). Additionally, a study was conducted within the Rawa Ternate Health Center, Cakung District, in 2017, with the results indicating that PM_{10} concentrations were significantly related to the ARI complaints in toddlers (p-value < 0.05) (14). This was not in accordance with the aforementioned reports, as a study conducted within Kebonsari, Surabaya, and other surrounding areas showed that PM_{10} was insignificantly different to the number of ARI pneumonia cases (15).

The Correlation and Linear Regression Analysis of the ARI Incidence with SO_2 in DKI Jakarta (2018-2019)

Based on the correlation analysis in 2018-2019, a strong relationship strength (R = 0.517) was obtained at P = 0.0126. This showed a positive pattern in 2018, indicating that higher SO_2 significance led to more ARI cases yearly. However, a feeble relationship strength (R = -0.161) at P = 0.0655 was obtained in 2019, as the negative pattern produced indicated that lesser SO_2 significance led to more ARI cases yearly, with an insignificant correlation. In this study, the correlation with multiple linear regression test also explained a significant effect between air pollution parameter, SO_2 (P = 0.001), and the incidence of infant pneumonia in Cipayung District, East Jakarta City, Indonesia (16). This was in accordance to previous several studies, where a relationship between SO_2 and ARI showed a significant value and correlation coefficient of 0.036 and 0.421 in Rungkut District, Surabaya, respectively. These correlations were due to the increased levels of SO_2 in one of the cities. This was subsequently caused by the increased amount of transportation modes providing high SO_2 levels in ambient air, which had harmful impacts on human health such as respiratory problems (17).

The air monitoring analysis was also found to be incomplete in this study, due to the yearly increase of the PM_{10} levels. This was caused by several factors, including the particulate concentration data obtained from a fixed station, which only represented the spot due to being unable to cover a wide area. Another study showed that the binary logistic regression test also indicated the effect of PM_{10} on chest pain and shortness of breath (P = 0.039) (10). According to a study in Shenyang, China, the burden of air pollution on the morbidity of lower ARI emphasized the control and prevention of air pollution and respiratory diseases (18). Furthermore, a study on the College Residence Halls in College Park, Maryland, showed that residents had an average of 6.6 and 2.3 L/s outdoor air in HVB and LVB, respectively. This indicated that the LVB rooms located on the leeward side of the building had lower average ventilation and slightly higher ARI incidence rates, as well as moderate CO_2 concentrations, compared to the values with locations on the windward position. The average ventilation rate in the twenty LVB dormitory rooms also increased from 2.3-7.5, 3.6, and 8.8 L/s, by opening the windows, door, and both, respectively. Therefore, opening the windows and doors in the LVB dormitory rooms increased ventilation rates to comparable HVB levels. It also harmed thermal comfort due to the low outdoor temperature (19).

The Correlation and Linear Regression Analysis of the ARI Incidence with CO in DKI Jakarta (2018-2019)

According to the correlation analysis in 2018-2019, a feeble relationship strength with a negative pattern was obtained. This indicated that R = -0.684 and -0.883 were obtained with P = 0.029 and 0.001 in 2018 and 2019, subsequently showing that lesser CO significance led to greater ARI cases yearly. These results supported a previous study conducted in Home Industri Area, South Pandansari, Sukoharjo District, in 2018. This showed the effect of chimneys on ARI incidence at a p-value of 0.033/2.682, indicating that the respondents having tile burning chimneys at 2,682 times experienced acute respiratory infections. The results also showed that the chimney emitted smoke from the combustion of industrial particulate processes and exhaust gases, which contained elements or pollutants such as SO_2, CO, NO_2, CO_2, etc. Moreover, CO is a gas with the ability to kill living things, including humans, due to its interference with blood oxygen. This is because the blood is found to bind more easily to CO than oxygen and other gases (20). These results reinforced a previous study conducted in Juntinyuat Health Center, Indramayu, in 2020 (21). However, these studies were not in line with the results obtained by a research conducted in Semarang, which showed that the correlation coefficient (R) of the CO concentration was 0.245 (positive correlation direction), subsequently indicating that the number of ARI occurrences increased with higher Carbon Monoxide values (22). Based on the statistical test, the significance p-value was 0.029, indicating a significant relationship between ARI incidence and CO concentrations in Semarang City (2013-2017). The dissimilarity of this study was however due to the secondary data from the air monitoring results being incomplete, and also the yearly increase of the total CO values.

There was no relationship between CO and breathing, as carbon monoxide was insufficiently strong to irritate the respiratory tract (23). This was because the main effect of CO on health was to shift the oxygen bound to hemoglobin (Hb), then bind Hb to COHb, leading to the observation of no relationship between carbon monoxide and the ARI incidence. These results were in line with a study on the School Children of Quito, Ecuador, in 2018, where there was no significant difference between the COHb concentration above the safe limit of 2.5% and ARI incidence ($p = 0.736$). Due to vehicle emission controls, reduced air pollution was associated with a lower incidence of respiratory illness in school children (24).

The Correlation and Linear Regression Analysis of the ARI Incidence with NO_2 in DKI Jakarta (2018-2019)

Based on the correlation analysis in 2018, a strong relationship ($R = 0.311$) was observed with a positive pattern at $P = 0.0382$, indicating that a greater NO_2 value led to higher ARI cases yearly. This was in line with a research conducted in Semarang in 2019, where the correlation coefficient (R) of the NO_2 concentration was found in the positive direction ($R = 0.222$), indicating that the ARI occurrences increased with greater AIR PSI (NO_2) values (22). Since the p-value = 0.048 ($p<0.05$), a significant relationship was observed between the NO_2 concentrations and the ARI incidence (2013-2017). These results were in line with the determination of 0.0001 ($p < 0.05$) and $R = 0.4972$ (23), as the occurrence of a significant relationship, was consistent in this study. This was because the increased levels of NO_2 in the city were caused by higher modes of transport vehicles, diesel-powered equipment, and process local industrial processes, which were harmful to human health, such as respiratory problems.

According to a study conducted within Mexico City in 2021, a positive association of index values with daily respiratory ED occurrences was observed among children (ages 2-17) and adults (ages 18+). This indicated that the use of previously unavailable daily health records enabled the short-term assessment of ambient air pollution concentrations on respiratory morbidity. It also created a health-based air quality index, which is being presently utilized in Mexico (25). Based on a study within Kebonsari, Surabaya, and other Surrounding Areas in 2021, the statistical test showed a correlation between NO_2 and ARI Pneumonia, indicating that the gas had a greater t-count value (2.290) than the t-table (1.680), with a significance level of 0.027 ($p < 0.05$) (15). This was in line with a previous study in Central Surabaya City in 2021, where NO_2 had a positive pattern and was significant with ARI Pneumonia (Sig = 0.041; $r = 0.343$) (26).

Meanwhile, the results were not related to a study conducted within Depok City in 2017, where the air quality of NO_2 was insignificant with the ARI cases (p-value = 0.641). This indicated that the relationship between NO_2 and ARI cases positively correlated with a very weak pattern ($r = 0.132$) (27).

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CONCLUSION

Based on this study, the following conclusions were obtained, the distribution of the ARI cases in the last two years (2018-2019) showed a fluctuating increase, where the sub-districts with the highest values were distributed and close to each other. This indicated that the area with the highest number of acute respiratory infection cases was the Cipayung District.

According to the air pollutant standard index for the last two years (2018-2019), the frequency distribution of ARI showed that the areas with the highest values were close to each other and located in the northern region. This indicated that the Kelapa Gading sub-district had a high-frequency distribution yearly for the last two years, which was dominated by the PM_{10} parameter.

The correlation and linear regression analysis between the air psi and the ARI incidence on SO_2 and NO_2 parameters also had positive and negative directions in 2018 and 2019, at p = 0.0126/0.0382 and 0.0655/0.0872 (R = 0.517/0.311 and -0.161/-0.059), respectively. In this study, the influence of the PM_{10} on the incidence of acute respiratory infection had a positive regression direction in 2018 and 2019, at p = 0.042 and 0.051 (R = 0.649 and 0.630), respectively. Meanwhile, the effects of the CO on ARI incidence had a negative regression direction in 2018 and 2019, at p = 0.029 and 0.001 (R = -0.684 and -0.883), respectively.

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