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Statistical Analysis of Air Pollutants Concentration and Health Information Related to Respiratory Disease Patients in Bangkok, Thailand

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Abstract. Air pollution can lead to exposure to foreign particles, air that can be inhaled deep into the lungs and cardiovascular system, causing diseases such as stroke, heart disease, lung cancer, chronic obstructive pulmonary diseases, and respiratory infections. The Pearson's product moment correlation coefficient (r) was used to determine the strength of association between a pair of variables, to test the relationship between these variables and to test whether the association is greater than could be expected by chance. The linear regression between respiratory disease patients, PM10, and other air pollutants were used in this study. Among PM10 together with CO, O3, and NOx was statistically significant with P-value of <0.01 (r = .031, .307, .561; 95% CI = -.570-1.437, .275-.445, and .223-.289 respectively).

Keywords. Data analysis, Air pollutants, PM_{10}, Respiratory disease

1. Introduction

Air pollution is a major cause of death and disease in the world. The combined effects of outdoor and indoor air pollution cause about 7 million premature deaths every year, largely as a result of increased mortality from stroke, heart disease, chronic obstructive pulmonary disease, lung cancer, and acute respiratory infections [1]. Particulate matter (PM) can be inhaled and cause serious health problems. Some particles less than 10 micrometers in diameter (PM10) can be inhale deep into lungs and some may even get into bloodstream. People that are most likely to be affected by particle pollution exposure are elderly people and children with lung or heart diseases [2].

Traffic-related air pollution (TRAP) is a major problem in many cities in Asia, including Bangkok. Long-term exposure to the TRAP may lead to metabolism maladaptation and possible development of cardiovascular disease and diabetes mellitus [3]. An objective of this study is to analyze concentrations of conventional air pollutants and PM10 obtained from the Air Monitoring Stations in Bangkok metropolitan area.

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2. Methods

This present research is a longitudinal study of concentrations of conventional air pollutants and PM_{10} collected from January 2013 to December 2018. The air monitoring data used in this study were from January 2013 to December 2018. Conventional air pollutants and PM_{10} were collected at 3 air monitoring stations in Bangkok metropolitan area – Nonsiwitthaya School, Huai Khwang, and Thonburi Metropolitan Electricity Authority (MEA) by the Pollution Control Department (PCD). Health information on respiratory diseases (bronchitis, emphysema, chronic obstructive pulmonary disease, and asthma) as diagnosed by physicians based on the International Classification of Diseases (ICD-10) were collected from 3 hospitals in regions of the air monitoring stations (Klang, Rajavithi, and Taksin Hospitals). The monitored air pollutants were carbon monoxide (CO), nitric oxide (NO), nitrogen dioxide (NO_2), nitrogen oxides (NO_x), and ozone (O_3). The sum of NO and NO_2 was used to describe NO_x. The treatment of data was carried out by the interpolation technique. The correlation coefficient and linear regression analysis were used to determine a potential correlation between number of respiratory disease patients, PM_{10}, and other criteria pollutants and creating an equation to predict PM_{10} concentration in Bangkok by the Statistical Package for Social Science (SPSS).

3. Results

The variation of PM_{10} concentration and respiratory disease patients was observed in Figures 1, 2, and 3. In Figure 1, the concentration of PM_{10} showed a decrease from May to September an increase from October to April of next year. The number of respiratory disease patient's tendencies decrease from January 2013 to April 2017 after that increase to December 2018.

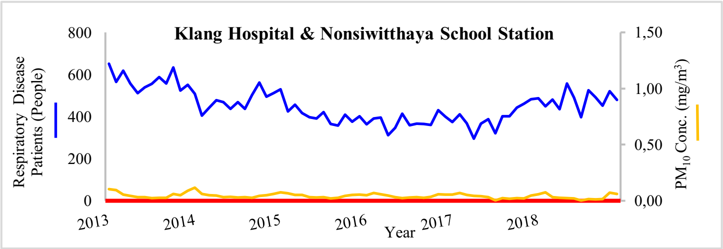

Figure 1. The data of PM_{10} concentration and number of respiratory disease patients at station 1.

In Figure 2, the concentration of PM_{10} showed a similar type of variation as a decrease from May to September an increase from October to April of next year. The number of respiratory disease patient's tendencies increased from January 2013 to December 2018. In Figure 3, the concentration of PM_{10} showed a similar type of variation as a decrease from May to September an increased from October to April of next year. The number of respiratory disease patients slightly varied from January 2013 to December 2018.

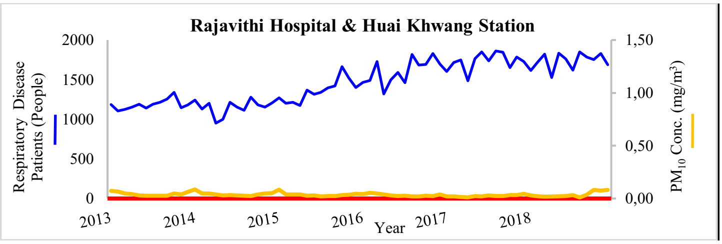

Figure 2. The data of PM_{10} concentration and number of respiratory disease patients at station 2.

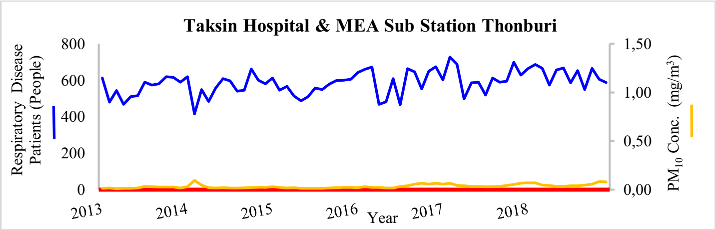

Figure 3. The data of PM_{10} concentration and number of respiratory disease patients at station 3.

The linear regression between PM_{10} and other criteria pollutants presented in Table 1. From this table, an equation for predicting PM_{10} concentration can be written as;

$$PM_{10} = 11.857+0.433CO+0.36O_3+0.256NO_x$$

Among PM_{10} together with CO, O_3, and NO_x was statistically significant with P-value of <0.01 (r = .031, .307, .561; 95% CI = -.570-1.437, .275-.445, and .223-.289 respectively).

Table 1. Linear regression analysis of respiratory disease patients, PM_{10} and other criteria pollutants

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
	B	Std. Error	Beta			Lower Bound	Upper Bound
1 (Constant)	11.857	1.941		6.108	.000	8.042	15.671
CO	.433	.511	.031	.849	.396	-.507	1.437
O_3	.360	.043	.307	8.358	.000	.275	.445
NO_x	.256	.017	.561	15.143	.000	.223	.289

a. Dependant variable: PM_{10}

Adjusted R Square = 0.348, Durbin-Watson = 1.984, F = 90.594, and P-value = 0.000)

4. Discussions

The concentration of PM_{10} decreased during rainy season and increased during cold season. The effect of PM_{10} can have many variations from season to season. PM_{10} can be introduced from diverse sources. The mixing height becomes lower in cold season and higher in hot season and PM_{10} gets trapped adjacent to the ground level appearing in inversion conditions, which could lead to atmospheric stable or non-dispersion of the air pollutants [4], [5]. After the government of Thailand has taken various roles to mobilize their resources for haze management in the second stage from 2011 to 2019. The highest PM_{10} value which adverse health effects for sensitive groups was found in February and had been decreasing in March [6]. The Pearson's product moment correlation coefficient (r) and linear regression between respiratory disease patients, PM_{10}, and other air pollutants were used to define the strength of association between a pair of variables, to test the relationship between these variables and to test whether the association is greater than could be anticipated by chance [7].

5. Conclusions

Results from this study provides a body of evidence that respiratory diseases are consequences of air pollution produced in Bangkok metropolitan areas. In addition, an equation for predicting PM_{10} concentration might be useful for further public health interventions.

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