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Abstract: Outdoor air pollution is a leading cause of death and premature death globally. Motorcycle-taxi drivers were most at risk associated with occupational exposure to ambient air pollution in urban areas. Therefore, a cross-sectional study was conducted to determine the influencing factors and prediction of lung function impairment in 308 motorcycle-taxi drivers living in Bangkok and adjacent provinces between February and June 2022. The study design included: data collection using questionnaires applied from the Thai version of ATS-DLD-78A: American Thoracic Society Division of Lung Diseases and Department of Disease Control, Ministry of Public Health, Thailand; a collection of respirable dust, and ambient air pollution parameters measured by personal air sampling pump and real-time air quality index (AQI) station, and lung function determined by the spirometer. The results showed that 14 factors were significantly associated with lung function impairment ($p<0.05$). Apparently, seven influencing factors showing the most association were included: gender, the height of the subjects, history of allergies, exposure to respirable dust, mask types, helmet types, and family history of lung disease. The lung function impairment of motorcycle-taxi drivers was significantly predicted in 28.1% by regression analysis of these seven variables ($R^2=0.281$). Therefore, this is the first report on influencing factors and prediction of lung function impairment among motorcycle-taxi drivers. These findings would be very useful for preventing and controlling measure ambient air pollution, setting policies and strategies to mitigate the risks for motorcycle-taxi drivers and the other exposed population.

Keywords: respirable dust; lung function impairment; motorcycle taxi driver

1. Introduction

Ambient air pollution is a leading cause of death and premature death worldwide, with more than the estimated number of approximately 3 million premature deaths per year globally (Thurston et al., 2017). The World Health Organization estimates that more than 91% of the world's population lives in areas where air quality exceeds the recommended values (World health organization, 2016). The significant air pollution that can affect health is particulate matter (PM). Particulate matter (PM) refers to inhalable particles, composed of carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), polycyclic aromatic hydrocarbons (PAHs), mineral dust, or water. PM can be of different sizes and is generally defined by their aerodynamics. PM is separated into three main groupings: coarse particles (PM_{10}), fine particles ($PM_{2.5}$), and ultrafine particles ($PM_{0.1}$), with $PM_{2.5}$ and PM_{10} being the most common in the regulatory framework and relevant for health (Zaharia, 2014). PM_{10} and $PM_{2.5}$ can enter the respiratory tract through blood flow and infiltrate the processes of various organs. The health effects related to PM exposure include acute upper and lower respiratory diseases, asthma, chronic obstructive pulmonary disease, pneumonia, bronchiolitis, lung cancer, stroke, dermatitis and allergy, neurodegenerative disease, hypertension in cardiovascular disease, premature birth, premature mortality, decreased birth weight, child height and body mass index (Chuang et al., 2020; Cordova et al., 2020; Jiang et al., 2020). The early detection of adverse respiratory exposure to air pollution has been determined by a lung function test, the principle of measuring the

volume and flow rate of exhaled breath or breathing in the patient (American Thoracic Society, 2000; Summacheeva Foundation, 2018). Several studies reveal that lung function impairment was associated with exposure to PM_{10}, $PM_{2.5}$, PM_1, PAHs, NO, and NO_2 (Daleck et al., 2021; Yang et al., 2020).

In Thailand, the average concentration of PM_{10} and $PM_{2.5}$ has tended to exceed the standard from 2010 to 2020, which averages high to a level that affects people's health. Especially, Bangkok and adjacent urban provinces with terrible traffic had an average annual concentration of $PM_{2.5}$ equal to 25 µg/m³ (range 6-40 µg/m³). Most of the yearly average exceeds Thailand's and WHO standards (15 µg/m³ and 5 µg/m³) (Pollution Control Department, 2022). Motorcycle-taxi drivers are the groups of informal workers at high risk of exposure to ambient air pollution. Around 76.0% of them work in the central region of Thailand (Bureau of Highway Safety, 2021). They must drive to pick up or drop off passengers outside the building throughout their working hours, on average 10 hours per day, ranging from 4-19 hours per day (Pannipa Suebsuk et al., 2014). Therefore, there is a chance of exposure to ambient air pollution than in other occupations. In addition, a few previous studies have focused on health risk levels to benzene, toluene, ethylbenzene, and xylenes (BTEX) and carbonyl compounds (CCs) inhalation exposure of traffic policemen working in the inner city of Bangkok, commuters, exposure to BTEX in public transportation modes in Bangkok, assessing the risk and BTEX exposure among car park workers and occupational exposure of gasoline station workers to BTEX compounds in Bangkok (Kanjanasiranont et al., 2017; Loonsamrong et al., 2017; Ongwandee & Chavalparit, 2010; Tunsaringkarn et al., 2012).

Nowadays, the problems of the heavy traffic around Bangkok and adjacent provinces, motorcycle-taxi services are more popular used than cars or public buses for daily paratransit to provide more convenient, faster trips, and save time in areas, i.e., high traffic congestion, high density residential, and narrow dead-end street, etc. (Raphiphan et al., 2014). At present, the increasing number of registered motorcycles in Thailand amounted to approximately 21.7 million units (Traffic, 2022). However, up to date, motorcycle-taxi drivers exposed to respiratory dust or ambient air pollution causing lung function disorders have been rarely documented. It still requires more evidence to assess the effect of ambient PM on lung function among motorcycle-taxi drivers. Therefore, this study determined the assessment of the associations between exposure to respiratory dust in the working environment and lung function decline including predictions of lung function impairment among motorcycle-taxi drivers in Bangkok and adjacent provinces in Thailand. This finding provided the crucial information on the prediction of influencing factors associated with lung function impairment to assist in proper preventing actions and controlling strategies.

2. Materials and Methods

2.1. Study Area

The motorcycle taxi drivers were selected from the central region of Thailand. Those areas included Bangkok, Nonthaburi, Pathum Thani, Samut Prakan, Samut Sakhon, and Nakhon Pathom. Bangkok and adjacent provinces occupying 7,762 square kilometers (Department of Provincial Administration, 2020) with a population of 10,899,786 people and 5.6 million inhabitants (National Statistical Office, 2021). The data collection was grouped into six areas, as shown in Figure 1.
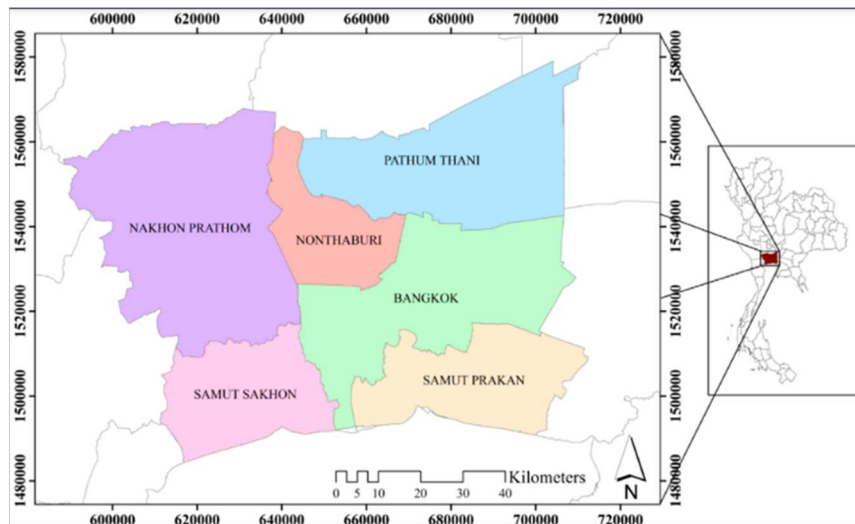
Figure 1. Six studied location of Bangkok and adjacent provinces in Thailand.

2.2. Study Design and Participants

A cross-sectional study was conducted among motorcycle taxi drivers who worked in ambient outdoor air between February and June 2022. The motorcycle taxi drivers aged over 20 years were randomly chosen. The total number of motorcycle taxi drivers were estimated 135,231 people in the studied areas (Department of Land Transport, 2021). A total of 308 studied subjects were determined using proportionate stratified sampling and distributed in each province by purposive sampling. Determining the sample size in cases where the questionnaire required a proportional conclusion and the sample size to have a confidence interval (1-α) was based on Equation (1). The calculated number of motorcycle taxi drivers in each province is shown in Table 1. The recruitment process was based on the inclusion and exclusion criteria. These inclusion and exclusion criteria for the study are shown in Table 2.

$$n = \frac{p(1-p)}{\frac{e^2}{z^2} + \frac{p(1-p)}{N}} \tag{1}$$

where; n= sample size, N = population, p = the portion of the population to have reasonable access (p = 0.5), e = tolerance interval or a specified proportion of the population for a given confidence level (e = 0.05, Z=1.96) (Yamane, 1973).

Table 1. The studied number of motorcycle-taxi drivers in each province (n=308).

Province	Number of Motorcycle Taxi Drivers [1]	Sample Size
Bangkok	84,889	152
Nonthaburi	10,346	33
Pathum Thani	11,543	32
Samut Prakan	17,218	44
Samut Sakhon	4,949	35
Nakhon Pathom	6,286	12
Total	135,231	308

[1] source: Department of Land Transport, Thailand (2020).

Table 2. Inclusion and exclusion criteria for a cross-sectional study of motorcycle taxi drivers.

Inclusion Criteria	Exclusion Criteria
O Over 20 years of age	O Diagnosis of chronic respiratory disease or any other chronic respiratory disease.
O Motorcycle taxi drivers who worked in ambient outdoor more than one year in Bangkok and adjacent provinces.	O Any acute or chronic condition that would limit the ability of the subject to participate in the study.
O Thai nationality and able to speak Thai language.	O Having an intermittent period working outdoor such as a stopping to work for other jobs outdoor and moving to indoor for doing work.
	(Refusal to give informed consent.

According to the number calculated to represent each motorcycle taxi driver group, all samples must have a negative result for COVID-19 with a screening antigen test kit prior to interview. The staff and the sample group strictly followed the procedures to prevent the spread of COVID-19 by the Ministry of Public Health (Ministry of Public Health, 2021; Simaporn Promsarn & Lertritwimarnman., 2020).

2.3. Data Collection

2.3.1. Data of Participants

All participants were face-to-face interviewed completely by questionnaires before examining their lung function test. Data collection in the questionnaires included: personal characteristics, respiratory symptoms (cough, phlegm, wheeze, and chest tightness), and work characteristics. The participant's identification was also measured their height and weight (checking obese participants, if the participant was unable to stand to have their height measured, arm span was used instead). Their age, sex, and race were also recorded. Subsequently, the participants who were recruited in this study did not become sick with the following symptoms or diseases: non-specific respiratory disease (NSRD): chronic respiratory symptoms (persistent cough, and phlegm: PCP), NSRD; chronic bronchitis, or bronchial asthma: (Uma Sawetskulanont, 1997), thoracic, abdominal or cerebral aneurysms, recent eye   hemoptysis of unknown origin, pneumothorax, unstable cardiovascular status, recent myocardial infarction or pulmonary embolism surgery, acute disorders affecting test performance, such as nausea or vomiting, recent thoracic or abdominal surgical procedures. These symptoms were the exclusion criteria for recruiting the studied participants in this study.

2.3.2. Ambient Air Pollution Parameters

Data of ambient air pollution parameters were retrieved from the database of the Pollution Control Department. The questionnaires were applied from Thai version of ATS-DLD-78A: American Thoracic Society Division of Lung Diseases and Department of Disease Control, Ministry of Public Health, Thailand (Doungrutai Boudoung, 1999). Additionally, the exposure to respirable dust parameter of participants were measured using the personal air sampling pumps with an aluminum cyclone and PVC membrane filter of 5.0 µm pore size (UNIVERSAL PCXR8, SKC, Inc., USA). Personal air sampling pumps were calibrated and set up at 2.5 litre/minute; NIOSH Method 0600 using the technique of gravimetric (filter weight), gravimetric for analyzing the mass of respirable dust in the air (National Institute for Occupational Safety and Health, 1998).

Lung function test were measured using a calibrated portable spirometer (UNIVERSAL PCXR8, SKC, Inc., USA). Participants performed the lung function test in a standing position (Milanese et al., 2021; Redlich et al., 2014; Simaporn promsarn & lertritwimanman, 2020). The forced vital capacity (%FVC), % forced expiratory volume in 1 sec (%FEV1), forced expiratory volume in 1 sec/forced vital capacity (FEV1/FVC), and forced expiratory flow between 25% and 75% expired volumes (FEF25-75%) were measured. The predicted values were calculated in accordance with the National Health

and Nutrition Survey III equations (Hankinson et al., 1999), adjusted for Asian ethnicity (Hankinson et al., 2010). %FEV1 and %FVC greater than 80% predicted and FEV1/FVC ratio greater than 70% predicted were used as the criteria for normal lung function.

2.4. Ethical Approval

Ethical approval to conduct this study was received from the Human Research Ethics Committee of Thammasat University, No.3. Ethical approval number 031/2565, and the approval date was 29 April 2022.

2.5. Data Analysis

The data were analyzed using Statistical Package for Social Sciences (SPSS version 23). Descriptive statistics such as frequency and percentage were used for analyzing the socio-demographic, work characteristics, respiratory symptoms of participants, exposure to respirable dust concentration, the 24-hour average concentration of $PM_{2.5}$ and PM_{10}, and lung function test. Pearson's correlation coefficient was used to determine the association between those variables and percentages for FVC. Furthermore, regression analysis was used to identify the factors significantly associated with predicted percentages for FVC and predict its possible occurrence. The regression analysis was also run to predict lung function impairment.

Before using regression analysis, several key assumptions were considered: the linear correlation was confirmed between percentages for FVC and the independent variables. The use of scatter plots showed whether there was a linear correlation. There were no multivariate normality and multicollinearity. Variance Inflation Factor (VIF) values and homoscedasticity were tested as assumption. A plot of standardized residuals versus predicted values showed whether points were equally distributed across all values of the independent variables. All key assumptions were passed for testing as shown in Figure 2.
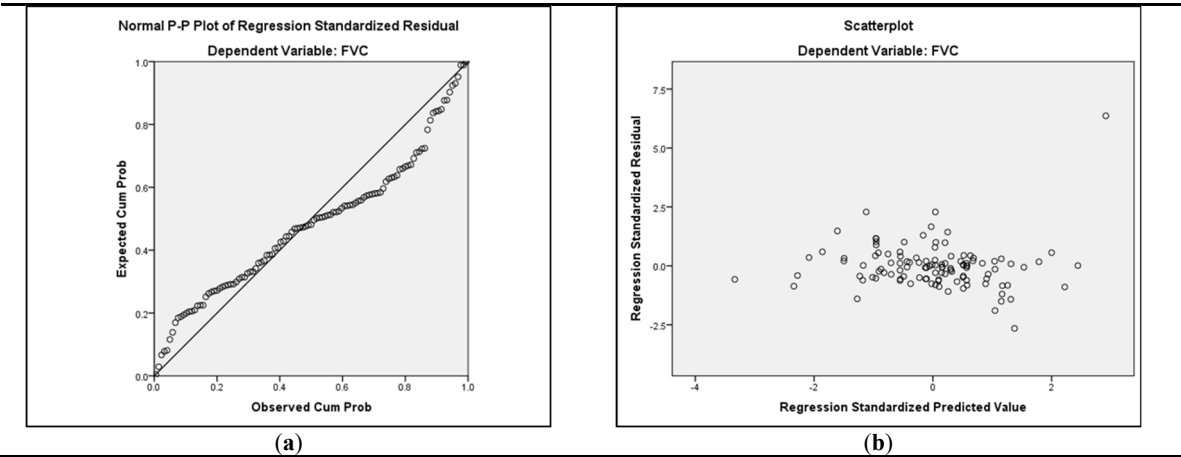

(a)   (b)

Figure 2. (**a**) Normal P-P plot of regression standardized residual; (**b**) Scatterplot regression standardized residual and regression standardized predicted value.

3. Results

3.1. Demographic, Work Characteristics, and Respiratory Symptoms of Participants

Table 3 demonstrated the general profile, work characteristics, and respiratory symptoms of the sample population. There were 308 respondents, including 33 females and 275 males. The results showed that 89.3% of the male participants were between 40-59 years old, the education level was primary education (48.8%), most of them were married (62.7%), 45.1% of the participants have never smoked before, there was no the history of the COVID-19 patient (70.1%), most of the participants did not exercise (54.2%), which may result in the body mass index exceeding the Asia-Pacific guidelines: BMI>23.0 kg/m² standard (64.9%). About 85.4% and 75.3% of the participants had no

diabetes and hypertension, respectively. Most of the participants (42.6%) had more than 10 years of experience in this occupation and took 11 hours a day to perform tasks. Their resting places while waiting for passengers were near the road (85.4%). Types of equipment they wore while performing the task was a surgical mask (94.5%). Cotton and N95 respirator masks were rarely used. In addition, they wore an open-face helmets while working. However, while waiting for passengers in the resting place, they did not wear masks. Based on the data, the participants had only mild respiratory system symptoms.

Table 3. Lung function testing criteria.

Activity	Length of Time to Stop before Lung Function Testing
Drinking alcohol	4 hours
Eating a large meal	2 hours
Vigorous exercise	30 minutes
Smoking	>1 hour
For reversibility testing	
Taking short-acting bronchodilators	6 hours
Taking long-acting bronchodilators (including combination inhalers) or twice-daily preparations	24 hours
Taking tiotropium or once-daily preparations	48 hours

Table 4. Demographic, work characteristics, and respiratory symptoms of participants (n=308).

Characteristics	N	Percent (%)
Gender		
Male	275	89.3
female	33	10.7
Age		
20-39	59	19.2
40-59	201	65.3
≥60	48	15.5
Mean$\pm$SD(min.-max.)= 49$\pm$11.1 (20-79)		
Education		
Primary education	150	48.8
Secondary education	127	41.2
College or higher	31	10.0
Marital status		
Single	87	28.2
Married	193	62.7
Widowed/divorced	28	9.1
Smoking history		
Never-smoker	139	45.1
Current smoker	121	39.3
Former smoker	48	15.6
History of the COVID-19 patient		
No	216	70.1
Yes	92	29.9
Physical activity		
No	167	54.2
Yes	141	45.8
Body Mass Index; BMI		
Underweight (<18.5kg/m2)	30	9.7

Normal (18.5-22.9 kg/m2)	78	25.3
Overweight (23.0-24.9kg/m2)	50	16.3
Obese (>25.0kg/m2)	150	48.7
Mean+SD(min.-max.)= 25.42+5.53 (13.17-60.55)		
Diabetes		
No	263	85.4
Yes	45	14.6
Hypotension		
No	232	75.3
Yes	76	24.7
Resting places while waiting for passengers near the road		
No	45	14.6
Yes	263	85.4
Work experience		
<5 years	101	32.8
5-10 years	85	24.6
>10 years	122	42.6
Mean+SD(min.-max.)= 11.76+9.08 (1-40)		
Work hour		
<8 hours per day	48	15.6
>8 hours per day	260	84.4
Mean + SD(min-max)=11.10+3.28(3 – 19)		
Surgical mask		
No	17	5.5
Yes	291	94.5
Wearing a cotton mask		
No	286	92.9
Yes	22	7.1
N95 respirator masks		
No	302	98.1
Yes	6	1.9
Types of helmets worn while riding		
Full face	94	30.5
Open face	126	40.9
Half face	88	28.6
Chronic bronchitis		
No	273	88.6
Yes	35	11.4
Acute bronchitis		
No	285	92.5
Yes	23	7.5
History of allergies		
No	306	99.4
Yes	2	0.6
Chronic Obstructive Pulmonary Disease: COPD		
No	308	100.0
Yes	0	0

3.2. The 24 Hours Average Concentration of PM$_{2.5}$ and PM$_{10}$ in Bangkok and Adjacent Provinces

The 24 hours average concentration of PM$_{2.5}$ ranged from 5-33 µg/m³, with the highest PM$_{2.5}$ concentration level at the Bangkok monitoring site and the lowest PM$_{2.5}$ concentration at Nonthaburi and Samut Prakan province. These data from all real-time air quality index (AQI) stations were lower than Thailand's standard. However, the maximum 24-hour average for all stations were higher than the air quality of WHO standard. The 24 hours average concentration of PM$_{10}$ varied from 11-70 µg/m³. The highest PM$_{10}$ concentration level was detected in Bangkok, while the lowest PM$_{2.5}$ concentration level was at Samut Prakan province. The average PM$_{10}$ concentration in all the locations were lower than Thailand's standard. However, Bangkok and Pathum Thani province had PM$_{10}$ concentrations level higher than the air quality of WHO standard (world Health Organization, 2021). All details can be considered in Table 5.

Table 5. The 24 hours average concentration level of PM$_{2.5}$ and PM$_{10}$ in Bangkok and adjacent provinces.

Province	Station	PM$_{2.5}$ (µg/m³)			PM$_{10}$ (µg/m³)		
		range[a]	mean[b]	>std[c]	range[a]	mean[b]	>std[c]
Bangkok	Din Daeng Community Housing	17-33	23	0/30	38-70	51	0/30
Pathum Thani	Bangkok University	5-21	12	0/28	17-53	31	0/28
Nonthaburi	Sukhothai Thammathirat Open University	5-20	10	0/30	-	-	-
Samut Prakan	Disabled and Handicapped Vocational Rehabilitation Center Station	5-22	11	0/30	11-34	20	0/30
Samut Sakhon	Samut Sakhon Highway District	12-30	17	0/30	-	-	-
Nakhon Prathom	Water supply reservoir	6-21	10	0/30	13-40	21	0/30

The source of data was retrieved from the Pollution Control Department of Thailand. (Pollution Control Department, 2022). [a] minimum-maximum; [b] PM$_{10}$ and PM$_{2.5}$ concentration level average; [c] frequency of exceeding Thailand standard (The National Environment Board, 2022).

3.3. Exposure to Respirable Dust Concentration while Performing Tasks

Similar Exposure Groups (SEGs) were used to identify groups performing tasks experiencing the same general exposure to risks. The motorcycle taxi drivers from all six provinces were classified into six groups (SEG 1-6) depending on the level of PM$_{10}$ and PM$_{2.5}$ concentration level from real-time air quality index (AQI) stations. The information on respirable dust concentration from air personal sampling was presented in Table 6.

Table 6. The concentration of respirable dust from air personal sampling each SEG (n=153).

SEG	Work Performing Area	Number of Workers	Personal Air Samplings (Psoint)	Respirable Dust Concentration (mg/m³)		
				Max.	Min.	Mean
SEG1	Bangkok- Din Daeng District	152	57	0.365	Not detected	0.029
SEG2	Pathum Thani- Khlong Nueng Subdistrict, Khlong Luang District	32	21	0.094	0.003	0.024
SEG3	Nonthaburi- Sukhothai Thammathirat Open University	33	15	0.018	0.002	0.006
SEG4	Samut Prakan- Song Khanong Subdistrict, Phra Pradaeng District	44	34	0.025	Not detected	0.009

SEG5	Samut Sakhon- Om Noi Subdistrict, Krathum Baen District	35	16	0.027	0.001	0.008
SEG6	Nakhon Prathom- Nakhon Pathom Subdistrict, Mueang District	12	10	0.018	Not detected	0.008

3.4. Lung Function Tests (LFTs)

Approximately 28.9% of the participants had a lung function impairment, with 24.7% of lung function impairment being restrictive lung disorder based on the criterion of the American Thoracic Society. All details can be considered in Table 7.

Table 7. Lung function test of the participants (n=308).

Results	N	Percent (%)
Normal	219	71.1
Abnormal	89	28.9
- Restrictive	76	24.7
- Obstructive	10	3.2
- Combination	3	1.0
FVC (% of predicted) Mean +SD (Min.-Max.) = 91.76+21.43 (32.67-272.88)		
FEV1 (% of predicted) Mean +SD (Min.-Max.) = 93.05+18.94 (18.12-160.33)		
FEV1/FVC Mean +SD (Min.-Max.) = 99.34+13.85 (43.21-128.21)		
FEF25%-75% Mean +SD (Min.-Max.) = 84.53+31.97 (5.31-182.00)		

3.5. Association between Independent Variables and Lung Function Impairment

The association between the 14 independent variables and lung function impairment were analyzed using Pearson's correlation coefficient, as shown in Table 8.   The lung function impairment in this study was described in terms of predicted percentages for forced vital capacity (FVC).

The results showed that the correlation between the province, gender, family history of lung disease, height, hypertension, types of helmet, wearing a cotton mask, exposure to respirable dust concentration, wind direction and lung function impairment was low negative. On the other hand, there was a low positive correlation between distance from resting places while waiting for passengers with real-time air quality index (AQI) station, history of allergies, $PM_{2.5}$, SO_2, temperature and lung function impairment.

Table 8. Association between independent variables and lung function impairment(n=308).

Independent Variables	Pearson's Correlation	P-Value *
Province	-0.18	0.002
Gender	-0.13	0.028
Distance from resting places while waiting for passengers with real-time air quality index (AQI) station	0.20	0.001
Family history of lung disease	-0.15	0.011
Height	-0.13	0.028
Hypertension	-0.13	0.021
Types of helmet	-0.12	0.035
Wearing a cotton mask	-0.15	0.009
History of allergies	0.15	0.007
Exposure to respirable dust concentration	-0.11	0.047
$PM_{2.5}$	0.14	0.017
SO_2	0.17	0.003

Wind direction	-0.14	0.015
Temperature	0.02	<0.001

[*] p-value < 0.05.

All significant variables were included in the model for their correlation with lung function impairment. Regression analysis covers fourteen affected variables from those analyses. Only seven influencing variables were tested using regression analysis as shown in Table 9. The regression analysis model formula was shown in Equation (2). A regression analysis model was run to predict the lung function impairment of motorcycle taxi drivers from seven influencing factors fairly total of 28.1% (R^2=0.281), which was a moderate fit for the data.

$$Y = 350.939 - 20.204X_1 - 144.465X_2 + 20.867X_3 - 6.370X_4 - 25.269X_5 - 3.563X_6 + 15.721X_7 \quad (2)$$

where; Y= Lung function impairment was described in terms of predicted percentages for forced vital capacity (FVC), X_1 = Gender (1 = Male, 2 = Female), X_2 = Height (meter), X_3 = History of allergies (1 = Yes, 2 = No), X_4 = Exposure to respirable dust concentration (mg/m^3), X_5 = Wearing a cotton mask (1 = No, 2 = Yes), X_6 = Types of helmet (1= Full, 2 = Open, 3 = Half), X_7 = Family history of lung disease (1 = Yes, 2 = No).

Table 9. Regression analysis model for predicting the lung function impairment (n=308).

Independent Variables	Unstandardized Coefficients		t	P-Value [*]
	B	Std.Error		
Constant	350.94	81.18	4.32	0.000
Gender (X_1)	-20.20	8.73	-2.31	0.023
Height (X_2)	-144.47	41.27	-3.50	0.001
History of allergies (X_3)	20.87	9.59	2.18	0.032
Exposure to respirable dust concentration (X_4)	-6.37	2.84	-2.24	0.027
Wearing a cotton mask (X_5)	-25.27	7.48	-3.38	0.001
Types of helmets (X_6)	-3.56	1.49	-2.39	0.019
Family history of lung disease (X_7)	15.72	7.75	2.03	0.045

[*] P-Value <0.05, R=0.530, R^2=0.281, Std.Error=22.373, F=5.862.

4. Discussion

The motorcycle taxi drivers of Bangkok and adjacent provinces in Thailand have been heavily exposed to high concentrations of ambient air pollution and the impact of this on their lungs has been neither documented nor studied. The exposure to respirable dust concentration was negatively associated with %FVC (p<0.05) among motorcycle taxi drivers. These findings were consistent with the previous study (Aretz et al., 2021; Dauchet et al., 2018; Guo et al., 2019; Hou et al., 2020; Johannson et al., 2018; Ma et al., 2021; Syahira et al., 2020; Yang et al., 2021). Our study collected respirable dust exposure by air personal sampling. Those previous studies collected air pollution by using real-time air quality index (AQI) station. However, both of two methods sampling showed exactly correlation with lung function impairment. The advantage of air personal sampling showed the participants were actually exposed to respirable dust when compared to ambient air pollution sampling. Therefore, air personal sampling study had a more clearly relationship to the respiratory system among outdoor workers than an area sampling. It was evident from this study that demographic factors used to predict lung function impairments were gender(p=0.023) and height(p=0.001). Most participants were males (89.3%) with a mean height of 165.75±6.99 ranged from 149–185 centimeters because qualifications of this occupation require physical fitness and using driving skills (Ben Saad et al., 2014; China et al., 2020; Kan et al., 2007; Thanapon Lertchittasakul et al., 2019; Wang et al., 2020). In addition, The Global Lung Function Initiative has defined height as one of the other prediction equations for spirometry (Quanjer et al., 2012). Our study showed the positive correlation with lung

function impairment as history of allergies(p=0.032), a family history of lung disease (p=0.045) that reversibility to inhaled bronchodilators is a marker of bronchial involvement in patients with allergic rhinitis, even in the absence of overt chest symptoms. Also reported that the duration of allergic rhinitis was related to the deterioration of nasal airflow limitation, indicating a close relation between nasal and bronchial airflow (Ciprandi & Cirillo, 2006). Furthermore, the genetic composition of an individual may be considered for monitoring and identifying people at risk of respiratory illnesses, as the results of studies in India and Canada (Okeleji et al., 2021; T.Warkentin et al., 2019; Thayyezhuth et al., 2021). There was a significant relationship between safety equipment and lung function impairment; wearing a cotton mask (p=0.001) and types of helmets (p=0.019)due to the theory that the self-protection against small particles entering the respiratory tract has to wear dust masks (Barry S. Levy et al., 2011), but in this study, we found that participants who wore a cotton mask during work of 7.1% had a negative relationship to the lung function impairment. Cotton masks were ineffective enough in filtering small particles that make their way into the respiratory tract; several studies found that personal masks were associated with respiratory diseases, especially must at least N95 to be effective against fine particulate matter enough (Chaaban et al., 2022; Paranthaman et al., 2022; Tanawat Rakkamon et al., 2015). Types of helmet help prevent traffic accidents, especially the head (Jenson & Unnikrishnan, 2015; Li et al., 2020). In addition, we also found association between a full face of helmets and lung function impairment because those devices had a face shield to protect against particulate matter while riding a motorcycle.

A regression analysis model was run to predict the lung function impairment of motorcycle taxi drivers from seven influencing factors fairly total of 28.1% (R^2=0.281), which was a moderate fit for the data. Based on previous literature, there were demographics, health status, safety equipment, and air pollution exposure factors associated with lung function impairment which could predict lung function impairment by multiple logistic regression analysis. Nevertheless, those studies conducted in different occupations, ages, and the number of samples (Siriorn Sindhu et al., 2011; Tanawat Rakkamon et al., 2015; Ueyama et al., 2021).

5. Conclusions

Seven significantly influenced variables that could predict motorcycle taxi drivers' lung function impairment was 28.1%. The successful instrument used to understand individual impairment of lung function of motorcycle taxi drivers, including similar outdoor workers. The development of model in order to promote the preventive measures of respirable dust exposure of outdoor workers and ambient air pollution to be effective and lead to sustainable practices. The main limitation of this study was the lack of some data about personal air sampling in the working area due to budget constraints. Therefore, SEGs were used to represent the respirable dust concentration exposure of the sample group. Consequently, future research could improve the reliability of the data by collecting all personal air sampling and should be evaluated model to predict lung function impairment based on significant variables. Our findings may help policymakers develop effective policies and communication strategies to mitigate the hazards of respiratory systems among motorcycle taxi drivers.

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