Iran J Public Health, Vol. 45, Suppl. Issue No. 1, Feb 2016, pp.77-84

Original Article

Respiratory Health Symptoms and Lung Function among Roadside Hawkers in Serdang and Its Association with Traffic-Related Exposures

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(Received 20 Nov 2015; accepted 13 Jan 2016)

Abstract

Background: The main objective of this study was to determine the respiratory health symptoms and lung function among roadside hawkers in Serdang, Malaysia and its association with traffic-related exposures.

Methods: This cross-sectional comparative study was conducted among 60 roadside hawkers while 60 restaurant workers were included as the comparative group in 2015. A questionnaire was used to collect background information and symptoms of respiratory health. All participants performed lung function tests. Personal exposure to traffic-related fine particulate matter ($PM_{2.5}$) and carbon dioxide (CO) were performed among a representative group of workers. All statistical analysis was performed using SPSS version 22.

Results: The mean (standard deviation) $PM_{2.5}$ exposure among the roadside hawkers was 31.05 (1.62) μg/m³ while the exposure among the comparative group was 19.41 (1.51) μg/m³ (P<0.05). The mean exposure level of CO among the roadside hawkers was 2.42 (0.29) ppm compared to 1.51 (0.14) ppm among comparative group. FEV1 (litres) (z=-1.96, P=0.04) of the exposed group was significantly lower than the comparative group. Respiratory symptoms such as wheezing, chest tightness, coughing and phlegm were significantly higher among exposed group (P<0.05). There were significant associations between the reporting of wheezing with $PM_{2.5}$ (Odds Ratio, OR=10.39, 95% Confidence Interval, CI=2.67-40.41), working duration (OR=13.36, 95%CI=3.13- 57.03) and current smoking status (OR=3.34, 95%CI=1.04-10.67).

Conclusion: Roadside hawkers are exposed to high traffic-related pollutants, had reduced lung function, and are at risk for increased respiratory health symptoms. The study suggested the importance of preventive management for this specific group of workers.

Keywords: Fine Particulate Matter ($PM_{2.5}$), Carbon Monoxide (CO), Respiratory health symptoms, Lung function, Roadside hawkers

Introduction

Occupational exposure to respiratory pollutants is a serious problem as health impacts are greater for the group of workers whose occupation requires them to work near roads or close to traffic lights where vehicles are required to stop and leave their engines running (1). In Bangkok, roadside hawkers are exposed to particulate matter with aerodynamic diameter of less than 2.5 μm ($PM_{2.5}$) of 70.94 μg/m³, exceeding the 24-h threshold limit WHO Air Quality Guideline (AQG) of 25 μg/m³ (2, 3). The hawkers had increased risk of coughing (Odds Ratio, OR=3.63, 95% Confidence Interval, CI=2.53-5.20) phlegm (OR=7.07, 95%CI=5.61-8.91) and upper respiratory diseases (OR=3.45, 95%CI=2.71-4.40). Another study conducted among roadside vendors reported high percentage of coughing (45.2%) and shortness of breath (54.6%) compared to the percentages reported among the control group (4).

In Malaysia, motor vehicles emission has been recognized as one of the major sources of air pollution especially in highly urbanized area (5). These activities will emit pollutants such as particulate matter (PM), carbon monoxide (CO), nitrogen oxide (NOx), hydrocarbon and sulfur oxides from the combustion of fossil fuels. The average 24-h levels of $PM_{2.5}$ in the urban area of Malaysia are approximately 20.3 $\mu g/m^3$ and are within the reported threshold by the WHO (5). However, there are excursions where PM levels spiked higher than the threshold limit especially during heavy traffic congestion period. It is common that marked temporal variations in air pollution were observed during selected times in the mornings and afternoons.

Roadside hawkers are a common sight in Selangor, attracting a lot of interest and businesses from the general population either during the day or even at night. As such, roadside hawkers in Malaysia are an occupational group at risk for continuous exposure to these traffic pollutants in addition to the PM exposures arising from their cooking activities and from the burning of fossil fuels. Although the place of employment of street vendors is not within a pre-determined indoor space, roadside hawkers are still covered under the Malaysian Occupational Safety and Health Act (6). According to Section 15 of the act, it is stated that *"the duty of every employer and every self-employed person includes, the provision and maintenance of plant and systems of work that are, so far as is practicable, safe and without risks to health"*. Thus, such study is important because in determining the levels of exposure to $PM_{2.5}$ and CO, provisions for further protection measures can be suggested to protect the occupational group of roadside hawkers should they be at risk for deleterious health effects.

From the review of available literature, there are currently limited numbers of studies related to the impact of air pollution exposures on respiratory health of roadside hawkers in this country. The limited information on this group of worker population made it difficult to estimate the health effects associated with occupational exposure due to air pollution. As such, a study of exposure to air pollution among roadside hawkers will close the existing gap of knowledge in the scientific field, thus robust suggestions to protect this specific group of workers can be made.

The main objective of this study was to assess respiratory health symptoms and determine lung functions among roadside hawkers in Serdang, Malaysia and its association with traffic-related exposures.

Materials and Methods

Study Location

This was a cross-sectional comparative study conducted among roadside hawkers at Serdang, Malaysia (2°59'35°N 101°47'20°E) in 2015. A stretch of road adjacent to a local university was chosen as a location for this study because of its proximity to a federal road. Convenience sampling was used and 60 roadside hawkers were chosen to participate in this study. The comparative group were 60 workers who worked in air- conditioned restaurants, which are less exposed to the traffic air pollution.

Ethical approval for this study was obtained from the Ethical Committee for Research involving Human Subjects of Universiti Putra Malaysia. Approval to conduct the study was given by the Sepang City Council. Confidentiality of the respondents' information in this study was observed.

Study Instrumentation

Questionnaires were constructed and modified based on the International Union against Tuberculosis and Lung Diseases (IUATLD) Bronchial Symptoms Questionnaire 1984 (7). Questionnaires were administered to the respondents by the researchers. The questionnaire consists of several sections on background socio-demographics, smoking habit, health status and family history of health. The questionnaire was back-to-back translated from English to Malay. Pre-test was conducted among 20 hawkers who were not involved in this study in order to ensure the questionnaires were easily comprehensible. The data from the completed questionnaires were entered into SPSS software (Chicago, USA) (Version 22).

$PM_{2.5}$ and carbon dioxide (CO) was selected to represent traffic-related pollution. Sampling for $PM_{2.5}$ was performed using Personal Air Sampling Pump (Air Sampling Pumps-Aircheck 52, SKC USA, 2010). The air-sampling filter used to collect air samples was Mixed Cellulose Enter membranes (MCE) filter with 5.0 µm pore size. Before inserting the filter paper into the cassettes, the filters were weighed in an environmentally controlled area. Before each weighing, the balance was zeroed (Analytical Micro Balance, Germany, 2012) and the filters were handled with forceps. The filter paper were weighed as W1 (mg) and the values were recorded. Field blanks were also prepared before taking any measurement. Each air-sampling pump was calibrated to measure 1.7 L/min. During the measurement, the cyclone was placed at the breathing zone of the selected respondents as a representative of every stall for a total of 8 hours exposure time. To obtain the final mass of $PM_{2.5}$, the weight of the filter after each measurement was then subtracted with W1, in addition to subtracting the average weight of the field blanks. Q-Trak (TSI, USA) was used for measuring CO concentration and the equipment was placed on the table of the stall hawker, which is 0.5 m above the ground floor level. CO was measured for duration of 3 hours.

Lung function assessment was performed using TRANSLAB spirometer. The respondents were guided by the researcher throughout the process of the spirometer test. Height (Seca Bodymeter 208, USA) and weight (Tanita Digital Body Fat Scales, USA) of the respondents were measured and recorded.

Results

The response rate for this study is 100%. This study involved 120 respondents who had agreed to participate in this study. Table 1 presents the distribution of gender, age, ethnicity, marital status, level of education, working duration income, weight and height.

Table 1: Distribution of socio-demographic distribution of the respondents

Variables	**Study Group** **Frequency (%)/Mean (standard deviation)**			
	Exposed Group (n = 60)	**Comparative Group (n=60)**	**χ^2**	***P* value**
Gender				
Male	41 (68.3)	33 (55)	2.25	0.13
Female	19 (31.7)	27 (45)		
Ethnicity				
Malay	60 (100)	54 (90.0)	6.31	**0.012***
Others	-	6 (10.0)		
Marital status				
Single	29 (48.3)	46 (76.7)	10.27	**0.001***
Married	31 (51.7)	14 (23.3)		
Education Level				
Primary	4 (6.7)	7 (11.7)	16.23	**0.001***
Lower secondary	6 (10.0)	19 (31.7)		
Upper secondary	48 (80.0)	27 (45.0)		
Tertiary	2 (3.3)	7 (11.7)		
Working duration (yr)				
< 2 yr	13 (21.7)	20 (33.3)	2.26	0.32
3 – 5 yr	35 (58.3)	28 (46.7)		
>5 yr	12 (20.0)	12 (20.0)		
Age (yr)	27.30 (8.80)	25.20 (5.60)	- 0.58 [a]	0.56
Daily income (USD)	39.76 (19.32)	20.91 (7.59)	- 6.36 [a]	**< 0.001***
Height (cm)	163.11 (6.72)	161.69 (11.01)	- 1.14 [a]	0.26
Weight (kg)	60.68 (12.35)	61.95 (13.21)	- 0.69 [a]	0.49

Pearson's Chi-square statistics *Significant at $P < 0.05$ [a] Z value

The results showed that among roadside hawkers, there were a higher percentage of males compared to females. All of the hawkers were of Malay ethnicity and half of them married. More respondents had upper secondary school level of education and more than 50% of respondents had working duration of 3 to 5 yr. Socio-demographic characteristics such as ethnic group, marital status, level of education and daily income were significantly different between both groups of study population. The distribution of age, height and weight were similar across both groups.

$PM_{2.5}$ and CO Distribution

Table 2 presents averages of $PM_{2.5}$ and CO distribution. The results showed that there were significant differences of $PM_{2.5}$ and CO distribution between the exposed and comparative group.

Table 2: Fine particles ($PM_{2.5}$) concentration and Carbon Monoxide (CO) exposure among respondents

Variables	Mean (SD) Exposed Group (n = 60)	Mean (SD) Comparative Group (n=60)	Median (Inter Quartile Range) Exposed Group (n = 60)	Median (Inter Quartile Range) Comparative Group (n=60)	Z value	*P* value
$PM_{2.5}$ (µg/m³)	31.05 (1.62)	19.41 (1.51)	31.0 (2.0)	20.0 (2.0)	-9.53	**<0.001***
CO (ppm)	2.42 (0.29)	1.51 (0.14)	2.4 (0.5)	1.5 (0.20)	-9.50	**<0.001***

Statistic Mann-Whitney test *Significant at $P \leq 0.05$ SD: standard deviation

Respiratory Symptoms Distribution

Based on the Table 3, coughing (χ^2=12.05, *P*=0.001), phlegm (χ^2=33.41, *P*<0.01), chest tightness (χ^2=24.64, *P*<0.01) and wheezing (χ^2=14.70, *P*<0.01) were significantly higher among exposed group and comparative group.

Table 3: Comparison of respiratory symptoms among respondents

Variables	Study Group Frequencies (%) Exposed Group (n = 60)	Study Group Frequencies (%) Comparative Group (n=60)	χ^2	*P* value
Cough				
Yes	38 (63.3)	19 (31.7)	12.05	**0.001***
No	22 (36.7)	41 (68.3)		
Phlegm				
Yes	30 (50.0)	2 (3.3)	33.41	**<0.001***
No	30 (50.0)	58 (96.7)		
Chest tightness				
Yes	40 (66.7)	13 (21.7)	24.64	**<0.001***
No	20 (33.3)	47 (78.3)		
Wheezing				
Yes	41 (68.3)	20 (33.3)	14.70	**<0.001***
No	19 (31.7)	40 (66.7)		

Pearson's Chi-square statistics *Significant at $P < 0.05$

Lung Function Parameters

Table 4 presents averages for FVC (litres) and FEV_1 (litres) of the respondents. FEV_1 (litres) was significantly lower among the exposed than the comparative group (Z=-1.96, P=0.049).

Table 4: Distribution of lung function across the exposed and comparative groups

Variables	Study Group: Mean (SD) Exposed Group (n=60)	Study Group: Mean (SD) Comparative Group (n=60)	Study Group: Median (Inter Quartile Range) Exposed Group (n=60)	Study Group: Median (Inter Quartile Range) Comparative Group (n=60)	Z value	*P* value
FVC (liter)	2.94 (0.50)	2.90 (0.79)	3.04 (0.70)	2.88 (1.41)	- 0.43	0.66
FEV_1 (liter)	2.82 (0.47)	2.65 (0.77)	2.86 (0.66)	2.51 (1.15)	- 1.96	**0.04***
FVC%[a] Predicted	83.0 (9.54)	83.7 (14.5)	81.9 (12.11)	83.5 (17.7)	- 0.46	0.64
FEV_1%[b] Predicted	84.8 (11.5)	87.4 (15.5)	82.9 (52.69)	84.5 (24.4)	- 0.57	0.56
FEV1/FVC Predicted	102.8 (11.5)	105.4 (14.5)	103.4 (22.2)	107.1 (16.8)	- 1.03	0.30

Statistic Mann-Whitney test   *Significant at P< 0.05

Multivariate Analysis of Respiratory Symptoms and Its Risk Factors

For the multivariate analysis, $PM_{2.5}$ and CO concentrations were recategorised into two groups. Table 5 indicates that $PM_{2.5}$ contributed significantly to the reporting of all respiratory health symptoms: wheeze (Odds Ratio, OR=10.39, 95% Confidence Interval, CI=2.67-40.41), chest tightness (OR=3.02, 95%CI=2.30-13.10), coughing (OR=2.78, 95%CI=1.88-8.77), phlegm (OR=7.5, 95%CI=6.97-17.78).

Table 5: Multivariate analysis (logistic regression) of respiratory symptoms and its risk factors

Variables (reference group)	Wheezing OR (95%CI)	Chest tightness OR (95%CI)	Coughing OR (95%CI)	Phlegm OR (95%CI)
$PM_{2.5}$ *(< 25 µg/m³)*				
≥ 25 µg/m³	**10.39 (2.67-40.41)***	**3.02(2.3-13.1)***	**2.78 (1.88-8.77)***	**7.50 (6.97-17.78)***
CO *(< 2 ppm)*				
≥ 2 ppm	0.21 (0.09-0.47)	0.03 (0.007-0.12)	0.35 (0.11-1.12)	0.74 (0.14-3.67)
Gender *(Male)*				
Female	0.26 (0.08-0.86)	0.72 (0.22-2.31)	1.00 (0.31-3.14)	0.74 (0.14-3.67)
Ethnicity *(Others)*				
Malay	0.77 (0.08-7.13)	1.38 (0.43-4.45)	1.16 (0.09-15.06)	-
Marital status *(Single)*				
Married	0.96 (0.31-2.92)	0.40 (0.13-1.21)	2.74 (0.39-6.43)	8.37 (0.50-46.79)
Education level *(Tertiary)*				
Primary level	6.70 (0.51-87.84)	0.30 (0.03-2.98)	0.21 (0.01-2.42)	-
Lower Secondary level	8.69 (0.86-87.73)	0.84 (0.11-6.05)	1.49 (0.21-10.3)	0.94 (0.06-14.64)
Upper Secondary level	0.71 (0.09-5.53)	0.15 (0.02-1.10)	0.59 (0.10-3.50)	0.37 (0.03-4.42)
Working duration *(≤ 2 years)*				
3- 5 years	**11.44 (1.83-71.21)***	0.49 (0.15-1.60)	0.67 (0.22-2.09)	0.66 (0.14-3.05)
≥ 5 years	**13.36 (3.13-57.03)***	2.02 (0.62-6.57)	0.37 (0.08-1.63)	1.58 (0.25-10.06)
Smoking *(No)*				
Yes	**3.34 (1.04-10.67)***	0.78 (0.25-2.48)	**2.93 (1.01-8.53)***	4.14 (0.68-25.05)

Nagelkerke R^2 wheeze: 0.49, tight chest: 0.39, cough: 0.42, phlegm: 0.57 *Significant at P < 0.05   Reference variable in bracket

Discussion

All respondents from the exposed and comparative groups had different background levels such as marital status, level of education and working experiences. The hawkers were engaged in selling food, fruits, sweets and drinks. The comparative group worked in air-conditioned shops and had similar work activity such as selling food items but were not directly exposed to the pollutants from traffic exhaust.

There are no local occupational standard to be used as a reference to compare the results of this study. When compared to the threshold limit value (TLV) for fine particulate matter (size of PM_4 or less) by the American Conference of Governmental Industrial Hygienists (ACGIH) the levels found in this study is less than the 3 mg/m^3 limit (8). However, when based on the existing WHO AQG, the hawkers in this study were exposed to levels exceeding the limits. Owing to the differences in averaging time, it is not possible to make a direct comparison with WHO guidelines value for $PM_{2.5}$. Nevertheless, the levels of $PM_{2.5}$ concentration at the roadside in this study are likely to exceed the WHO guidelines value of 25 μg/m^3 (3). Compared to studies reported elsewhere the levels of exposure in this study were much lower. For example, in Istanbul, the background concentration of daily average (standard deviation) $PM_{2.5}$ in the roadside environment was 55.4 (29.5) μg/m^3 (9). In India, the average level of $PM_{2.5}$ at the roadside was 91 μg/m^3 (10). Outdoor emissions of $PM_{2.5}$ are affected by heavy traffic, busy intersection and meteorological factors (11). As such, high levels of PM were most likely reflective of traffic congestion and the resuspension of dust due to traffic movement (10). Although the levels measured in this study were much lower than reported elsewhere in Europe and India, the results still shows that this select group of occupation is continuously exposed to high level of traffic-related pollution while they are at work. The evidence from this study showed that CO concentration was significantly higher among the exposed group. In Peru, the average (standard deviation) occupational exposure of traffic policeman and newspaper vendor to CO was 3.76 (1.86) ppm compared to office workers which were exposed to 2.05 (1.75) ppm of CO (12). Despite its presence in levels below the accepted limits, exposure to CO remains dangerous even in low concentrations (13).

There were higher reported respiratory symptoms among the roadside hawkers in this study. The exposures to $PM_{2.5}$ and CO were significantly associated with respiratory symptoms. In Thailand, exposure to CO from traffic-vehicle emissions contributed to the reporting of sore throat, cold and coughs (1). In Hong Kong, roadside vendors reported 45% higher respiratory symptoms compared to university personnels (4). Even as the comparative group in this study has similar job tasks, the results supported the evidence that the nature of job for roadside vendor is more physically demanding due to its environmental risk factors.

FEV_1 were significantly different between the exposed and comparative group. This is expected because the hawkers have been directly involved with tasks that exposes them to increased levels of $PM_{2.5}$ and CO. A previous study has shown that decreases in FEV_1 indicates development of obstruction in the respiratory tract of the lung while decreases in FVC indicates reduced lung capacity, which is a sign of susceptibility to future infection (14). Similar finding by Inge et al. (15) shows a fall in FVC and FEV_1 observed among shopkeepers who work in places near highways and were exposed to high levels of air pollution compared to the control group. FEV_1 and FVC value in this study was lower compared to a study in Bogota (16), in which FEV_1 and FVC among traffic policemen exposed to air pollution was 3.9 ± 0.7 and 4.8 ± 0.8 respectively. There was significant impairment in FEV_1 and FVC value among shopkeepers working in highly polluted areas of Ahmadabad (17). Reiterating an earlier point, the authors emphasised that reduced FVC is an early indicator of obstruction in the smaller airways, in which inhaled pollutants are primarily deposited.

The present study showed that higher $PM_{2.5}$ level exceeding 25 μg/m^3 was linked to the increased odds of reporting respiratory symptoms. The results are contradicted by (1) where $PM_{2.5}$ was not linked with coughing and phlegm. Working duration of more than 5 years were linked to 10-fold higher risk to report wheeze, similar to a study conducted in 1999 in India involving 665 traffic police (18). The study reported that respiratory symptoms were correlated with working duration of more than 5 years.

Some limitation needs to be considered in this study. This study did not measure the real-time variations of $PM_{2.5}$ in which temporal excursions of PM at selected times can be determined. These temporal excursions of PM have been shown to affect respiratory health more severely compared to average PM levels (19). Temporal excursions may have been the reason why epidemiological studies continue to report links with respiratory symptoms even at PM exposures occurring below the existing standards.

Lastly, several studies on respiratory health symptoms among roadside hawkers have been conducted in other developing countries but the relevant data for roadside hawkers in Malaysia are limited. Thus, the data obtained from this study have been able to identify the significant links of PM and CO on the respiratory health of roadside hawkers. As a future recommendation, a longitudinal study to identify the disease trend and further sampling inclusive of other pollutants should be conducted combined with integrated sampling among a larger number of respondents.

Conclusion

Roadside hawkers in this study were exposed to high traffic-related pollutants; had reduced lung function and were at risk for increased respiratory health symptoms. The finding emphasised the importance of preventive management for this specific group of workers as required by law to protect them from the risks of respiratory symptoms and diseases.

Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

Acknowledgments

We would like to thank all respondents who volunteered to participate in this study. The authors declare that there is no conflict of interest.

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