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Study on Air Quality in School Located near the Former Landfill Site and its Influences on Student's Respiratory Health

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Abstract: Former landfill site although no longer in use, may produce landfill gas (LFG), which can be harmful to human health. The aim of this study was to determine the effects of air quality on student (respiratory) health at SK Taman Dato Harun 1 (SKTDH1), located near the former landfill site compared to the SK Wangsa Maju Seksyen 1 (SKWMS1) as a control. Respondents were 289 students in SKTDH1 and 245 students in SKWMS1. Air sampling (PM_{10}, cadmium, lead) was done by using the High Volume Sampler (HVS) while the sampling of gases (CH_4, O_3, NO, H_2S, CO) was carried out by using Aeroqual and Multilog Gas Detector. Respondents' socio-demographic data were obtained through questionnaires, while the value of PEFR (L/min) the respondent was measured by using the Mini-Wright peak flow meter. The results showed that there is a significant difference (p=0.00) on the concentration of lead ($\mu g/m^3$) between the location of the case study ($1.127x10^{-4}\pm1.136x10^{-3}$) and control ($0.386x10^{-4}\pm3.452x10^{-3}$). Only a group of students aged 8 years differed significantly (p=0.00) on the reading of PEFR (L/min) between respondents in the study area (193.10±32.01) and control (236.54±31.61). Respiratory symptom scores showed significant differences (p=0.012) among students aged 9 years in the study area (14.55±2.83) and controls (13.15±2.49). Similarly, there was a significant difference (p=0.036) of respiratory symptom scores of respondents aged 12 years in the study area (13.58±2.03) and control (14.46±2.66). There was a significant relationship (p=0.01) between respiratory symptom score by the value of PEFR (L/min) among the students in the study area. In conclusion, in terms of respiratory symptoms, the difference only involved groups of students aged 9 and 12 years of the study and control schools. In terms of PEFR reading (L/min), only the group of students aged 8 years varied between study and control schools. The study also found that there is a relationship between respiratory symptom score with PEFR (L/min) reading among students in a school near the former landfill site.

Key words: Landfill · Peak Expiratory Flow Rate (PEFR) · Air Quality · Children · Respiratory

INTRODUCTION

The former landfill site even not being used is still providing an environmental hazard to humans. This is because the process of waste decomposition by bacteria still occurs even after being filled in a long time.

There are many studies that confirm that the level of indoor air quality affects health more than the level of outdoor air quality does [1]. Communities in developing countries spend as much as 54% of their time in the interior such as homes, schools and offices. Therefore, the air quality in this area gives much impact on the life [2]. School is an important environmental exposure associated with increased risk and can cause health effects upon students compared with adults [3]. According to the study carried out by Diapouli *et al*. [4], children who live in the city spent about 90% of their time either at home, schools or transport.

These parameters are directly or indirectly will lead to health problems, particularly human respiratory system like bronchitis, chronic obstructive pulmonary disease (COPD) and asthma [5]. There is also a respiratory effect

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due to long-term exposure to air pollution in schools which involves children aged between 8 and 12 years and shows a significant decline in lung function, especially for girls [6].

Peak expiratory flow rate (PEFR) is a simple and reliable way of monitoring patients with bronchial asthma and other obstructive airway diseases, response to a bronchodilator in the assessment of asthmatic subjects even in the specific forms such as occupational asthma. The peak flow meter is a useful instrument for monitoring PEFR in children and adults. An observed PEFR compared with the student's predicted value, which is taken as the mean PEFR attainable by normal people of the same ethnic origin, gender, age and body build [7]. Therefore, this study was conducted to determine the health effects due to exposure of school students to landfill gases.

MATERIALS AND METHODS

SK Taman Dato Harun 1 was selected as the study area because the location is near to the former landfill site which is about 150 meters. SK Taman Dato Harun 1 is located in Petaling Jaya, Selangor with high population density and traffic. SK Taman Dato Harun 1 has two blocks of classrooms, cafeteria and field and other basic infrastructure such as a library. The ventilation in the class is open type ventilation. All student tables and chairs are made from wood and the wall was painted using water based paint. To see the effects of air pollutants at SK Taman Dato Harun 1, the same study was carried out in SK Wangsa Maju Seksyen1 as control school based on the background of a similar environment.

The air quality parameters studied was particulate matter (PM_{10}), heavy metals (cadmium and lead) and landfill gases (CH_4, O_3, NO, H_2S, CO) as well as biological agents (bacteria and fungi). PM_{10}, lead and cadmium were collected by high volume sampler for 24 hours sampling duration with flow rate 1.13m^3/minute and the prior extraction procedure was done by using USEPA 3050B modification method for air quality [8]. There are 4 selected sampling points to represent the whole air in the studied area. Direct reading of gases was done by using Aeroqual and Multilog Gas Detector. Microbiological sampling was done by using 15 minutes passive air sampling method based on USEPA Monitoring of Laboratories for Airborne Contaminants, Standard Operating Procedures (SOPs) number QC-02-04.

In obtaining student's respiratory health status, a total of 289 respondents from SK Taman Dato Harun 1 and 245 respondents of SK Wangsa Maju Seksyen 1 were selected to answer the questionnaires and the peak flow meter was used to measure the value of PEFR by using Mini-Wright peak flow meter and height respectively.

The collected data were analyzed using the Statistical Package for Social Science (SPSS) version 18. The analytical tests used were independent t-test, ANOVA, chi-square and Pearson correlation test.

RESULTS

Table 1 shows the mean concentration of PM_{10}, heavy metals cadmium and lead. In the case study, the average concentration of PM_{10} was higher than in the control area which were 67.76 and 47.21μg/m^3, respectively. However, a non-significant difference ($P>0.05$) was shown by the statistical test, non-paired T-Test. For the parameters of lead, there was a significant difference ($P<0.05$) in the two study areas in which the mean concentration of lead in the study area was higher than in the control area. No significant difference ($P>0.05$) could be shown for the concentration of ozone and nitric oxide gas. While other gases weren't detected. There were no significant differences ($P>0.05$) between the mean concentration of fungal and bacterial total counts.

Table 1: Comparison of the concentrations of the parameters studied in both case and control study areas.

	Concentration (μg/m^3)			
Parameter	SKTDH 1 mean±SD	SKWMS1 mean±SD	t	p value
PM_{10}	67.76±9.46	47.21±17.43	2.072	0.084
Lead	$1.127x10^{-3}$±$1.136x10^{-4}$	$0.386x10^{-3}$±$3.452x10^{-4}$	5.769	0.000*
Cadmium	$1.133x10^{-4}$±$6.284x10^{-5}$	$0.563x10^{-4}$±$4.76x10^{-5}$	2.045	0.060
O_3	0.014±0.002	0.018±0.006	-1.180	0.283
NO	0.450±0.1291	0.400±0.141	0.522	0.620
CO	ND	ND	-	-
CH_4	ND	ND	-	-
H_2S	ND	ND	-	-
Fungus	4.50±1.000	5.75±0.957	-1.806	0.121
Bacteria	5.00±0.816	5.75±1.708	-0.792	0.458

Table 2: Comparison of mean PEFR of the respondents according to height

	PEFR (L/min)					
Height	n	SKTDH 1 Mean±SD	n	SKWMS 1 Mean±SD	t	p value
<120	47	194.27±26.285	14	183.57±24.685	1.127	0.269
121-130	74	213.34±38.38	77	225.32±29.091	-2.168	0.032*
131-140	95	255.32±41.984	82	250.00±39.875	0.86	0.391
141-150	58	267.76±45.722	61	284.75±47.91	-1.978	0.05*
>150	15	296.33±34.25	11	300.00±43.589	-0.024	0.812

Table 3: Comparison of the mean PEFR respondents by age

	PEFR (L/min)					
Age	n	SKTDH 1 Mean±SD	n	SKWMS 1 Mean±SD	t	p value
8	39	193.10±32.011	26	236.54±31.615	-5.386	0.000*
9	38	213.42±32.322	60	222.00±31.932	-1.289	0.200
10	66	240.00±38.869	60	245.17±47.210	-0.673	0.502
11	71	265.07±46.824	45	260.00±49.497	0.556	0.579
12	75	278.07±44.788	54	281.67±49.783	-0.423	0.668

Table 4: Comparison of the mean scores of respiratory symptoms experienced by respondents according to age.

	PEFR (L/min)					
Height	n	SKTDH 1 Mean±SD	n	SKWMS 1 Mean±SD	t	p value
<120	47	194.27±26.285	14	183.57±24.685	1.127	0.269
121-130	74	213.34±38.38	77	225.32±29.091	-2.168	0.032*
131-140	95	255.32±41.984	82	250.00±39.875	0.86	0.391
141-150	58	267.76±45.722	61	284.75±47.91	-1.978	0.05*
>150	15	296.33±34.25	11	300.00±43.589	-0.024	0.812

Table 5: The relationship between respiratory symptoms score factor with the PEFR (L/min) value obtained.

		Respiratory symptoms score	
Location		r value	p value
PEFR (L/min)	SKTDH1	-0.152	0.010*
	SKWMS1	0.070	0.275

Table 2 shows the comparison of the mean value of PEFR according to the physical height of the respondents in both study locations. Height factor plays an important role in the production of PEFR readings among the respondents. The mean reading of PEFR (L/min) in students' height (cm) showed significant differences (P<0.05) between case and control respondents in the height range 121-130 cm (213.34±38.38) and the height range 141-150 cm (267.76 ±45. 7).

Table 3 shows a comparison of the mean PEFR according to age for both the case and control. In terms of age, there were significant differences (p <0.05) of the average reading of PEFR (L/min) among students aged 8 years in the case study (193.10±32.01) and control (236.54 ±31. 61).

Table 4 shows the mean scores and comparison of respiratory symptoms experienced by respondents in both study areas according to the age of the respondents. There were significant differences in respiratory symptoms scores respondents aged 9 years, with SKTDH1 (14.55±2.83) and SKWMS1 (13.15±2.49) and at the age of 12 years, with SKTDH1 (13.58±2.03) and SKWMS1 (14.46±2.66).

There was a significant difference (p <0.05) between respiratory symptom score by reading PEFR (L/min) among the students in case studies as shown in Table 5. Nevertheless, there was no significant relationship (p >0.05) between respiratory symptom scores with reading PEFR (L / min) in the control area.

DISCUSSION

Based on a non-paired t test, there were significant mean differences (p <0.01) detected between SKTDH1 and SKWMS1. The average lead concentration in SKTDH1 was $1.127x10^{-3}$ ± $1.136x10^{-4}$ µg/m3 compared to $0.386x10^{-3}$± $3.452x10^{-4}$µg/m^3 in SKWMS1. High lead concentration from the former waste disposal site showed that it may contain the old paint, metal, pesticides, pewter

and alloy [9]. In addition, internal resource classroom such as paint walls and stationery also contributed to the high concentration of lead. The study conducted by Shen *et al*. [10] and Norlen *et al*. [11] said that the writing, paint, dressing table and colored book equipment are the sources of lead in the indoor air classroom. Other factors that affect the concentration of lead are the flow of traffic both located near the study area [12].

According to height, there were significant differences ($p < 0.05$) between the average value of respondents PEFR between 141 to 150cm tall and 121 to 130 cm when compared between case and control study sites. This could be attributed to the presence of high PM_{10} at SKTDH1. In the study of asthma, levels of higher PM_{10} concentration are inversely proportional to the change in peak expiratory flow rate (PEFR) [13].

There was a significant correlation ($p < 0.05$) in PEFR readings by the factors studied on respiratory symptom scores. This is supported by Emad [14] which stated that some researchers have demonstrated a significant correlation of respiratory symptoms and PEFR values.

As a conclusion, the difference only involved groups of students aged 9 and 12 years of the study and control school in terms of respiratory symptoms. While in PEFR readings (L/min), only the group of students aged 8 years varied between study and control school. The study also found that there is a relationship between respiratory symptom score with a PEFR (L/min) among students in a school near the former landfill site. These findings showed that the presence of air pollutants from the former landfill site studied in SK Taman Dato Harun 1 does not influence the respiratory health of students in the school.

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