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COMMUNITY RESPIRATORY SYMPTOMS SURVEY AMONG RESIDENTS IN CLOSE PROXIMITY TO A LANDFILL IN A TROPICAL RURAL AREA

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Abstract: Controlled dumpsite without any liner, leachate treatment and engineered measures can emit landfill gases and hazardous air pollutants to the surrounding environment. This study was conducted to investigate self-reported respiratory symptoms among residents living within 2 km radius of Beris Lalang Landfill, Bachok, Kelantan. A total of 218 respondents aged between 18 and 65 years old were involved in this cross-sectional study from January to March 2019. The questionnaires were adopted from the St George's Respiratory Questionnaire and opted for the symptom score approach. Majority of the respondents were females (64.7 percent), non-smokers (85.3 percent), Malay (94.0 percent) and received tertiary education (43.6 percent). Respondents were reported to have higher proportions of sneezing, runny or blocked noses (35.8 percent) and coughing attack (36.7 percent) compared to the other respiratory symptoms. Associations were reported between respiratory symptoms with gender and exposure to tobacco smoke. Weak significant correlations were found between symptoms score with age of respondents and duration of living in the current home ($p<0.05$). This finding implied that proximity to dumpsites did not affect the respiratory symptoms of the communities living within 2 km radius of the dumpsite. This study provides initial evidence about reported symptoms in populations living near to a landfill as a baseline for future epidemiologic assessments towards sustainable health management.

Keywords: Landfill, respiratory symptoms, waste dumpsite, environmental health, sustainable solid waste management.

Introduction

Sustainable solid waste management requires consideration of social, health, environmental and economic aspects (Al-Khatib *et al.,* 2015). A holistic approach integrating all of these factors should be in place to achieve the sustainable development goals by ensuring access for all to adequate, safe and affordable solid waste collection services, to stop uncontrolled dumping and open burning and to achieve sustainable and environmentally sound management of all wastes by 2030 (Ferronato & Torreta, 2019). Among these factors, pollution and related health effects have the highest concern of the public on the existence of landfill (Al-Khatib *et al.,* 2015).

Landfill or open dumping are piled with unattended wastes exposed to physical, chemical and biological processes simultaneously accelerating the waste decomposition together with the generation of leachate and landfill gases (Oketola & Akpotu, 2015). Methane, hydrogen sulphide and ammonia are major air pollutants generated from a landfill which can be exposed to the public via inhalation of airborne emissions, dust or windblown particles from uncontrolled municipal solid waste (MSW) and open dumping (Vrijheid *et al.,* 2002). Emissions of volatile organic compounds mainly, benzene, toluene, ethylbenzene and xylenes (BTEX) from municipal solid waste dumpsites (Klett *et al.,* 2005) may also affect the respiratory system

via inhalation. These BTEX are associated with serious health implications in particular benzene due to its carcinogenic compounds (USEPA, 2014).

Communities near landfills and open dumps are susceptible to health effects associated with exposure to landfill gases. There have been several epidemiological studies which have investigated whether there is a higher than usual incidence of adverse health events such as cancer, asthma, and eczema in populations living near landfill sites (Mataloni *et al.,* 2016; Rusaik, 2016; Khan *et al.,* 2017; Esphylin *et al.,* 2018). A study conducted by Mataloni *et al.* (2016) reported that the public who live within 5 km of a landfill site are exposed to the health risk as they tend to get lung cancer, as well as deaths and hospitalizations for respiratory diseases.

Khan *et al.* (2016) reported that a higher proportion of households in St. Louis County residents in the Bridgeton Landfill, Missouri, United States area have other respiratory symptoms in the past 12 months than in the comparison area households, including: wheezing (38.5 percent vs. 32.6 percent), gasping for air (13.7 percent vs. 7.6 percent), heaviness in breathing (20.3 percent vs. 14.1 percent), an increased effort to breathe (22.6 percent vs. 12.5 percent), and sore throats (56.6 percent vs. 54.0 percent). Another study was conducted by Rusaik (2016) from households of Blumendhal and Madampitiya sites and Pothuwilkumbura-Kolonnawa sites around the Colombo dumpsite, in Sri Lanka. Identified prominent diseases close to the dumpsite are wheezing (56.3 percent), irritation (57.5 percent), lack of sleep (62.2 percent), asthma (73.6 percent), nausea (56.40 percent), burn patches of skin (dark skin) (56.6 percent), dengue (57.6 percent) and viral warts (70.8 percent).

A study by Esphylin *et al.* (2018) reported the respiratory symptoms in children together with the metals in particulate matter and fingernails of the children residing near landfills in Malacca, Negeri Sembilan, Selangor and Pahang, Malaysia.

In their study, increasing levels of certain metal accumulations in the fingernails were the risk factors that had caused numerous reports of reported respiratory symptoms. Human health risk is also faced by the waste collector workers who are constantly exposed to various types of diseases from sharp objects and unknown waste disposed in bulk by the public (Aminuddin & Rahman, 2015).

Beris Lalang landfill is the largest active waste dumpsite for the district of Kota Baru in Kelantan, on the East Coast of Malaysia. It receives approximately 350 tonnes of waste daily (Kamaruddin *et al.,* 2016; Fadhullah *et al.,* 2019). Beris Lalang is a typical mukim (sector) of the Telong sub-district of Bachok, Malaysia. This agriculture-based area is situated near the coastline of the South-China Sea in Kelantan, a north-eastern state of Peninsular Malaysia (Huat *et al.,* 2012). The landfill is a peat swamp area surrounded by palm oil plantations and consists of a small stream leading to the Gali River, which eventually flows to Kandis Beachin Bachok (Fadhullah *et al.,* 2019).

Previous studies were conducted to determine the effects of the Beris Lalang Landfill on the environment and health (Huat *et al.,* 2012; Kamaruddin *et al.,* 2016; Khan *et al.,* 2017; Fadhullah *et al.,* 2019). The study by Huat *et al.* (2012) showed that the rate of helminth infection was 37 percent among children in Beris Lalang, with *Trichuris trichiura* being the predominantly helminth isolated. One of the independent risk factors for helminth infection was consumption of raw salads and vegetables from the area. The waste was predominantly kitchen and food waste (Periathamby *et al.,* 2009). In 2016, Kamaruddin and his team had revealed the components and proportion of the waste dumped in Beris Lalang landfill and showed that the waste was predominantly organic (33.13 percent), followed by paper (22.01 percent), tetra-paks (12.6 percent), plastic film (8.49 percent) and rigid plastic (8.4 percent). The high amount of organic waste is due to high consumption of dairy products, processed and unprocessed foods (Kamaruddin *et al.,* 2016).

Khan *et al.* (2017) reported that few groundwater samples have high concentrations of manganese (Mn), lead (Pb), Iron (Fe) and chromium (Cr) as per World Health Organisation (WHO) standards for potable water. The high concentration of metal ions in groundwater is likely due to untreated effluents from landfill site, municipal wastewater, fertilizers and other activities. Arsenic (As) and lead in groundwater samples collected from the surface of two dug grounds within the vicinity of the Beris Lalang landfill exceeded the standard of Ministry of Health. chromium, Cu and Lead in leachates exceeded Environmental Quality Act (EQA, 1974)'s standard, whereas Ni, Lead and Zn in surface water of Gali River exceeded the limit of class III National Water Quality Standard (NWQS). These exceedingly high metal concentrations in leachates and its surrounding groundwater and river water relative to their respective standards implies potential leachates migration to the waterbodies within the surrounding vicinity of Beris Lalang dumpsite (Fadhullah *et al.* 2019). The studies point towards environmental and health risks associated with the existence of the landfill.

In line with this effort, therefore, the main objective of this study is to investigate the respiratory symptoms among residents living within 2 km radius of Beris Lalang Landfill, Bachok, Kelantan. Specifically, we conducted a cross sectional survey to estimate the frequency of respiratory symptoms among residents, to calculate the score of respiratory symptoms among residents, to determine the association between respiratory symptoms with gender and exposure to tobacco smoke among residents and to predict the relationship between score of symptoms among residents with the age of respondents, duration of living current home and residential distance from landfill. Another existing study reported on health symptoms associated with living near to Sabak landfill (Norsa'adah *et al.,* 2020) but not specifically on respiratory symptoms in Beris Lalang landfill, Kelantan. Our study provides the baseline data for better waste management practices to minimize the risk of air pollution from the landfill to the residents.

Materials and Methods

Description of Study Area

A cross-sectional study was conducted among the residents of Kampung Beris Lalang which is located within 2 km radius to Beris Lalang landfill, Bachok, Kelantan (Figure 1). The distance of 2 km radius provides the basis for the likely limit of dispersion for landfill emissions (Elliott *et al.,* 2001). The approximate total number of populations in Beris Lalang is 1196 people (PTJB, 2018). The land use of the area is dominated by agriculture (21.54 km^2, 54.2 percent) mainly by tobacco plantation (11.81 km^2), empty or abandoned land (12.28 km^2, 30.9 percent), residential areas (1.56 km^2, 3.9 percent), institution and public amenities (1.47 km^2, 3.7 percent), waterbodies (1.06 km^2, 2.69 percent) and 0.93 km^2 of coastal zones as shown in Figure 2 (JPBD, 2018). The meteorological condition of the nearest station in Kota Baru was: average relative humidity (78.1 percent), maximum wind speed was 9.2 m/s and the wind direction were within 30 º North/North East to 120 º East/South East during the northeast monsoon (January to March 2019; Malaysian Meteorological Department, 2018).

The landfill has two phases. The first phase began in 2010 by the local state authority and later was taken over by the private waste sector. The second phase started its operation in May 2018 and is contracted to operate until 2030. The current management is actively trying to make this facility a sanitary landfill.

The landfill is a controlled dump with no liner system installed to assess the gas collection and to control Landfill gas (LFG) emissions into to the ambient air. Therefore, this facility has the potential to emit toxic air pollutants due to unavailability of any engineered measures, leachate management and LFG management.

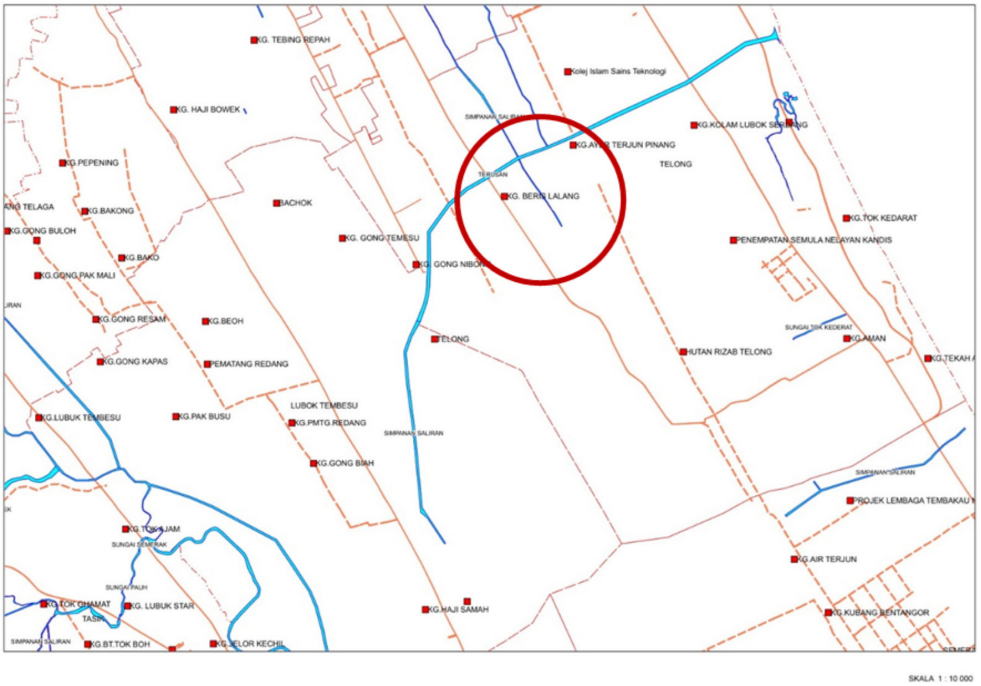

Figure 1: Map of sampling location marked with red circle (JUPEM, 2018)

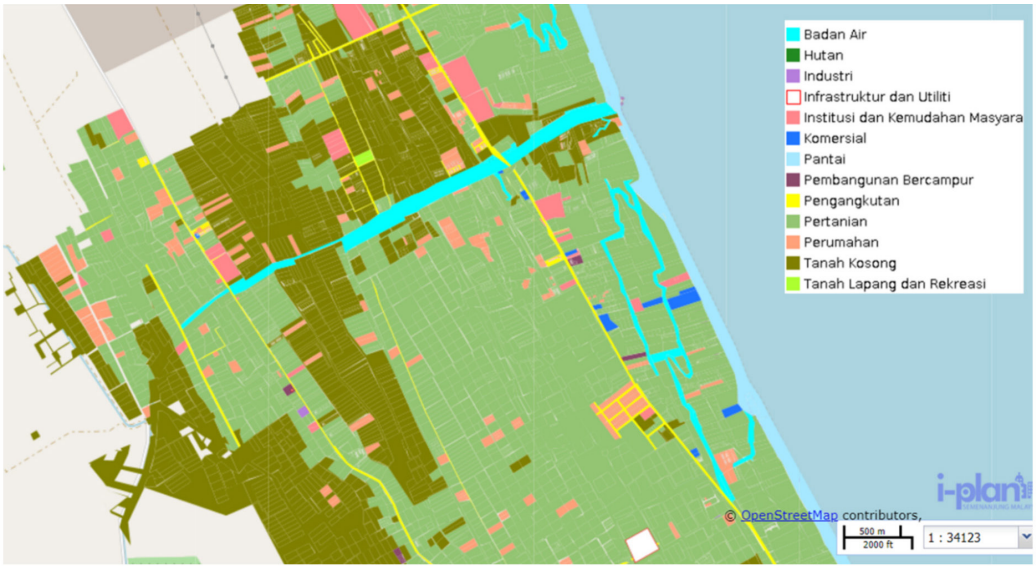

Figure 2: Land use map of Telong sector (mukim) in Bachok, Kelantan (JPBD, 2018)

Data Collection

Sample and Sampling Population

Residents aged 18-65 years old living within 2 km radius from Beris Lalang waste landfill from Kampung Beris Lalang were selected as respondents of this study. The eligibility criteria also included (i) male and female and (ii) respondents who understands Malay Language. A non-probabilistic survey using purposive and convenience sampling was conducted through

door-to-door survey from January until March 2019. The respondents were recruited by house-to-house visit. The purpose of the study was explained to the respondents and they were invited to participate voluntarily.

The written consents were signed, and the respondents were asked to fill in the questionnaires with guidance of two trained research assistants. Unavailable respondents or respondents who refused to participate were excluded from the survey. Some were not willing to participate because their perspective is that the dumpsite will still be in operation and nothing is done despite answering the questionnaire.

Research Instruments

This study used the respiratory symptom-based questionnaires because it is a cost-effective tool to enable the identification and baseline assessment of participants with respiratory illnesses (Abbasi *et al.,* 2012). The questionnaire approach was used to identify the incidence or prevalence of respiratory symptoms among respondents. The presence of respiratory symptoms in a person can be early signs that their lungs may react differently, depending on the severity of exposure.

The questionnaire comprises of three parts: Section A consists of socio-demographic information, including age, gender, ethnicity, education level, occupation, smoking habit, length of residence and distance from landfill. Section B was on self-reported respiratory symptoms among respondents within the past 12 months and Section C involved activity and impacts of respiratory problems to their current health. The questionnaire consisted of 37 questions, 78 items and 7 sections comprising of dichotomous (yes and no questions) and a four-point Likert scale.

The survey included questions about eight perceived respiratory symptom variables among the households completing the surveys:(1) sneezing, runny or blocked nose (when you did not have cold or a flu); (2) sore throat; (3) cough; (4) chronic cough (for 6 weeks or more); (5) phlegm from your chest on most days for as much as 3 months each year); (6) wheezing (and whistling when you did not have any cold); (7) shortness of breath (woken up by an attack at any time) and (8) chest tightness (woken up by an attack at any time).

The questionnaire was adopted from St. George's Respiratory Questionnaire (SGRQ) to assess the respondent's perception of their recent respiratory problems (Jones, 2009). SGRQ has been used in a range of disease groups including asthma, chronic obstructive pulmonary disease and bronchiectasis, and in randomised controlled therapy trials and population surveys (Jones, 2009).

From the questionnaire, the symptoms score were determined from the effect of respiratory symptoms, their frequency and severity. The symptoms include frequency of cough, wheezing, breathlessness and duration, and frequency of breathlessness or wheezing. The activity components are concerned with routines or any conditions that cause or are limited by breathlessness.

Impacts cover aspects concerning social functioning and psychological disturbances resulting from chest trouble and breathing. The scoring for the symptom score ranged from 0-100, where a higher number indicates poorer health (Gelpi *et al.,* 2016). The symptom score was calculated using the SGRQ apps from the Viro-immunology Research Unit, Department of Infectious Diseases, Copenhagen University Hospital (Gelpi *et al.,* 2016). The score was derived by dividing the summed weights (of all questions related to respiratory symptoms, activity, and impacts) by the maximum possible weight using an Excel calculator (Jones, 2009). The step-by-step calculation was outlined in the St George's Respiratory Questionnaire Manual (Jones & Ford, 2009).

The survey was initially made in English and then translated into Malay for better public participation. The translation was checked and validated by experts in language and translation. A pilot test was conducted to around 30 persons from representative samples of the households

(number of subjects) and 10-15 minutes were taken by the respondents to answer the given questionnaire. The pilot test was conducted to determine the suitability of the terms, the arrangement of items and arrangement of choices for each item as well as the time taken by respondents to complete the questionnaires.

The reliability Cronbach's alpha test of this questionnaire was found to be acceptable (α=0.80). Ethical approval for this study was obtained from the Ethic Committee of Universiti Sains Malaysia (USM/JEPeM/18110638).

Data Analysis

All the data were analysed using Statistical Package for Social Science (SPSS) software, version 24.0 for windows. Normality test was checked using skewness, kurtosis and Kolmogorov-Smirnov test and it was found that these data were not normally distributed, hence non-parametric tests were used. Descriptive statistics were used to analyse the socio-demographic information, respiratory symptoms, and symptoms score.

To measure differences in the means of continuous variables such as respondent's age, duration of living in current home and residential distance from the landfill, the Mann-Whitney and Kruskall-Wallis tests were used. Inferential data analysis was conducted using Pearson's Chi Square test to measure the association between respiratory symptoms with demographic and smoking factors which fell under categorical data.

Spearman's rank correlation was used to predict the relationship between score of symptoms among residents that live within 2 km from Beris Lalang landfill with age of respondents, duration of living in current home and residential distance from landfill.

Results and Discussion

Socio-demographic Background

Majority of the respondents who lived within 2 km radius from the dumpsite were female (N=141, 64.7 percent) and belonged to the Malay ethnicity group (N=205, 94 percent) as shown in Table 1. Majority of the respondents who participated in this survey (N=218) were Malay (94 percent) as many of the villagers are Muslim Malay (Huat *et al.,* 2012) and the major ethnicity in Kelantan are Malays (Department of Statistics, 2010).

The questionnaires were distributed, and the sessions were done during daytime where we believed that during that time, the males were at work and were not at home; therefore, the feedback was mostly from female respondents (64.7 percent). The highest education received by respondents are tertiary level (N=95, 43.6 percent), which could be hypothesise that these respondents are educated enough to understand and know the area very well to take precautions to avoid any health issues primarily related to air pollution.

Education is critical to social and economic development and has a profound impact on population health (Zimmerman & Woolf, 2014). Environmental education has shown that people of all ages have positive attitudes and are aware of air pollution issues associated with population increase, industrialization and consumption patterns (Teksoz, 2011). The majority of the respondents were also employed (N=73, 33.5 percent) and full-time house person (N=53, 24.3 percent).

Most of the respondents were also non-smokers (N=186, 85.3 percent) and were not regularly exposed to tobacco smokes (N=126, 57.8 percent). This low prevalence could be influenced by the gender distribution of the respondents who were mainly females.

Females are generally non-smokers due to traditional norms and perception that smoking is a male dominant habit among Asians (Parkinson *et al.,* 2009). Out of the 218 respondents, most of them did not have any respiratory condition (N=156, 71.6 percent) whereas 12.8 percent reported to have asthma (N=28) within the last 12 months. There were also respondents who did not know their respiratory condition which is related to the question about emphysema (N=34, 15.6 percent).

Table 1: The sociodemographic background of the respondents (N=218)

Variables	Category	N (%)
Age (year)	Mean ± standard deviation	39.79 ± 0.89
Duration of living in the current home (year)	Mean ± standard deviation	8.05 ± 0.14
Residential distance from landfill (km)	Mean ± standard deviation	1.15 ± 0.023
Gender	Male	77 (35.3)
	Female	141 (64.7)
Ethnicity	Malay	205 (94.0)
	Chinese	9 (4.1)
	Indian	4 (1.8)
	Other	0
Level of education	None	0
	Primary	43 (19.7)
	Secondary	80 (36.7)
	Tertiary	95 (43.6)
Smoking habit	No	186 (85.3)
	Sometimes	5 (2.3)
	Yes	27 (12.4)
	Ex-smoker	0
Regularly exposed to tobacco smoke	No	126 (57.8)
	Yes	92 (42.2)
	Do not know	0
Respiratory condition	No	156 (71.6)
	Yes	28 (12.8)
	Do not know	34 (15.6)
Occupation	Employed	73 (33.5)
	Self-employed	43 (19.7)
	Unemployed	18 (8.3)
	Not working because of poor health	2 (0.9)
	Full-time house-person	53 (24.3)
	Student	17 (7.8)
	Retired	12 (5.5)
	Other	0

Respiratory Symptoms

A higher percentage of respondents' experience cough (N=80, 36.7 percent) and sneezing, runny or blocked nose (N=78, 35.8 percent) compared to the other respiratory symptoms in the past 12 months (Table 2). Coughing is a symptom of both respiratory and non-respiratory origin which functions to clear the lung airways of fluids, mucus or foreign materials including dust or particulate matter apart from being a physiological barrier against irritant substances that reach the respiratory tract (Singh & Singh, 2013).

Coughs can be categorized as acute (less than three weeks) or chronic (greater than three weeks) (Sharma *et al.,* 2019). In this study, only 36.7 percent (N=80) of respondents' experience acute cough while another 8.3 percent (N=18) experience chronic cough. Hence, it is important for individuals to be aware of prolonged coughing attack which may persists more than 3 weeks' time. An individual's lifestyle, quality-of-life and sense of well-being can be significantly affected by the presence of cough (Iyer & Joshi, 2013).

Nevertheless, in this study, overall, respondents who do not have respiratory symptoms (wheezing, wheezing when did not have cold, chest tightness, cough, chronic cough, phlegm, breathing trouble, shortness of breath, sore throats and sneezing, runny or blocked noses) are higher than the ones having respiratory symptoms (Table 2). Majority of the respondents also reported that their current health is in very good (N=66, 30.3 percent) and good conditions (N=70, 32.1 percent).

Overall, this self-reported respiratory symptom survey pointed out that the respiratory health of the respondents was in good condition. According to Voll-Aanerud *et al.* (2008), the burden of respiratory symptoms is more strongly associated with generic health related quality of life than is lung function in the general population sample.

The determinants of health include the social and economic environment, the physical environment, the person's characteristics, and behaviours and many others including income and social status, education, social support networks, genetic, health services, and gender (World Health Organization, 2019).

Table 2: Distribution of respiratory symptoms among respondents [N (%)]

Variable	**N (%)**
Wheezing	
No	156 (71.6)
Yes	62 (28.4)
Wheezing when did not have cold	
No	161 (73.9)
Yes	57 (26.1)
Chest tightness	
No	179 (82.1)
Yes	39 (17.9)
Cough	
No	138 (63.3)
Yes	80 (36.7)
Chronic cough	
No	200 (91.7)
Yes	18 (8.3)
Phlegm	
No	203 (93.1)
Yes	15 (6.9)

Breathing trouble	
No	189 (86.7)
Yes	29 (13.3)
Shortness of breath	
No	179 (82.1)
Yes	39 (17.9)
Sore throat	
No	184 (84.4)
Yes	34 (15.6)
Sneezing, runny or blocked nose	
No	140 (64.2)
Yes	78 (35.8)
How respondents rated their current health?	
Very good	66 (30.3)
Good	70 (32.1)
Fair	49 (22.5)
Poor	18 (8.3)
Very poor	15 (6.9)

Association between Respiratory Symptoms with Gender and Exposure to Tobacco Smokers

Significant associations were found between respiratory symptoms with gender and exposure to tobacco smoke (Table 3 and 4). Females are more vulnerable to experience breathing conditions compared to males. This factor could be related to the difference in the physiology of the nose between men and women; men are characterised by larger nasal cavities, and longer, narrower and higher nasal floors than females of the same body size (LoMauro & Aliverti, 2018). García-Martínez *et al.* (2016) suggest that difference dimorphism in the human skull of male and female influences the morphology of the upper airways.

The respiratory symptoms were significantly different among those who were directly exposed to tobacco smoke (Table 4). The current findings showed that wheezing followed by sneezing, runny, or blocked nose and cough symptoms are higher proportion compared to other symptoms. Passive smoking or environmental tobacco smoke is strongly related to respiratory symptoms including wheezing, chronic coughing and phlegm production (Larsson *et al.,* 2003). The frequent exposure to the landfill airborne irritants like hydrogen sulphide may eventually irritate the nose and lung of the individual.

Highly water-soluble and reactive irritants (such as chlorine, ammonia, sulphur dioxide, and formaldehyde) readily dissolve in mucous membrane water and quickly interact with the nose's sensory structures called rhinitis (Shusterman, 2011). Rhinitis or inflammation of the nasal membranes is characterized by sneezing, nasal congestion, nasal itching, and rhinorrhoea (Sheikh, 2018).

Our results showed that respondents who were not exposed to tobacco smoke experienced less respiratory symptoms; wheezing (N=8, 3.7 percent,) shortness of breath (N=4,1.8 percent), chest tightness (N=8, 3.7 percent) and squeezing, runny or blocked noses (N=25, 11.5 percent). Thus, this finding implies that people

who smoke and are regularly exposed to tobacco smoke may develop respiratory symptoms, because of the tobacco smoke itself. Smoking status was directly related to the presence of respiratory symptoms (Amela *et al.,* 2012).

Table 3: Results of the chi-square test for associations between the dependent variable 'reported respiratory symptoms' with gender

Variable	Gender, N (%)		X^2(df)	*P* value
	Male	Female		
Sore throat			18.456 (1)	0.001
Yes	24 (11.0%)	12 (5.5%)		
No	53 (24.3%)	129 (59.2%)		
Chronic cough			9.982 (1)	0.002
Yes	13 (6.0%)	6 (2.8%)		
No	64 (29.4%)	135 (61.9%)		
Phlegm			10.188 (1)	0.001
Yes	11 (5.0%)	4 (1.8%)		
No	66 (30.3%)	137 (62.8%)		
Wheezing			10.066 (1)	0.002
Yes	32 (14.7%)	30 (13.8%)		
No	45 (20.6%)	111 (50.9%)		
Shortness of breath			5.474 (1)	0.019
Yes	18 (8.3%)	16 (7.3%)		
No	59 (29.4%)	125 (57.3%)		
Wheezing without cold			8.175 (1)	0.006
Yes	29 (13.3 %)	28 (12.8%)		
No	48 (22.0%)	113 (51.8%)		

Note: Only significant associations are shown in the table.

Symptoms Score, Age, Duration and Distance

Exposure to outdoor and indoor environmental contaminants can cause a variety of respiratory symptoms, such as breathing problems (Al-Delaimy *et al.,* 2014). The proximity to the landfill site is identified as the indicator of exposure and determined by measuring the distance from the households to the landfill (Mataloni *et al.,* 2016). Apart from the distance from the landfill, duration of living at the current home are identified as significant factors affecting the respiratory symptoms (Rusaik, 2016). Out of 218 respondents, the symptoms score ranged from 2.12 to 99.20 (Table 5). Symptom score of more than 90 were associated with older respondents aged between 50 and 65 years old and among the middle-aged respondents between 35 and 49 years old compared to the younger respondents.

Among the respondents, the majority were people who were nearly 40 years old. This group is considered to be middle-aged adults (Petry, 2002). The respiratory system changes with age, declining in function in a similar manner as other organs. Age-related changes in the lungs include decreases in measures of lung function,

Table 4: Results of the chi-square test for associations between the dependent variable 'reported respiratory symptoms' with exposure to tobacco smokes

Variable	Exposure to tobacco smokes, N (%)		X^2(df)	*P* value
	Yes	No		
Sore throat			59.057 (1)	0.001
Yes	36 (16.5%)	0 (0.0%)		
No	56 (25.7%)	126 (57.8%)		
Chronic cough			28.506 (1)	0.001
Yes	19 (8.7%)	0 (0.0%)		
No	73 (33.5%)	126 (57.8%)		
Phlegm			22.061 (1)	0.001
Yes	15 (6.9%)	0 (0.0%)		
No	77 (35.3%)	126 (57.8%)		
Wheezing			71.593 (1)	0.001
Yes	54 (24.8%)	8 (3.7%)		
No	38 (17.4%)	118 (54.1%)		
Shortness of breath			34.996 (1)	0.001
Yes	30 (13.8%)	4 (1.8%)		
No	62 (28.4%)	122 (56.0%)		
Chest tightness			27.071 (1)	0.001
Yes	31 (14.2%)	8 (3.7%)		
No	61 (28.0%)	118 (54.1%)		
Squeezing, runny or blocked nose			24.486 (1)	0.001
Yes	49 (22.5%)	25 (11.5%)		
No	43 (19.7%)	101 (46.3%)		

Note: Only significant associations are shown in the table.

decreases in peak inflow and gas exchange, weakening of the respiratory muscles and a decline in the effectiveness of lung defence mechanisms (Lechtzin, 2017). According to Kalhan *et al.* (2018), the persistent respiratory system in adults is associated with an accelerated decline in lung function, incident obstructive and restrictive physiology, and a higher probability of future radiographic emphysema.

There is a significant relationship between age and symptoms score (R=0.185, p=0.006) as shown in Table 6. This significant positive relationship indicates that the older the respondents, the higher the symptom score. Although the relationship is significant, but the R value is weak; hence this study implies that age does not largely impact the symptoms score.

Similarly, weak significant relationships were found between duration of residence at current home with the symptom scores suggesting no relations between these two factors. Most of the respondents have lived at their residence for about nine years which is within the range of the existence of the landfill which started in 2010.

The landfill facility was in operation for the past nine years, replacing the previous landfill in Telok Kitang, which has ceased operation. More recently buried waste (less than ten years) produces more landfill gas through bacterial decomposition, volatilization, and chemical reactions than do older waste (Agency for Toxic Substances and Disease Registry, 2001). According to Rawat & Ramanathan (2011), the rate and volume of landfill gas produced at a specific site depends on the characteristics of the waste (e.g., composition and age of the refuse) and a number of environmental factors (e.g., the presence of oxygen in the landfill, moisture content, and temperature).

However, due to no high significant correlation between the symptoms score and duration of living at current home among respondents (R=0.165, p=0.015), therefore we hypothesise that the landfill did not reach the 'severity stage' after nine years of operation.

The residential distance from landfill and symptom score were not significant (Table 6), suggesting that distance was not the prominent factor for the community to develop the respiratory symptoms. The non-significant and weak relationship is due to multiple possible confounding risk factors related to developing respiratory symptoms in individual including diet and nutrition, indoor air pollution, passive smoking, early life risk factors, outdoor air pollution, tobacco smoking, genetic susceptibility and occupational risk factors (European Lung Foundation, 2019).

Besides, environmental factors such as meteorological condition may also affect the dispersion of the LFG and airborne pollutants and particles from the landfill to the community. Landfill sites may be a source of airborne toxic chemical contamination by evaporation or via windblown particles (Vrijheid *et al.,* 2002).

Atmospheric dispersion can travel from a landfill site depending on the wind direction and weather patterns at that specific time (Okeke &Armour 2000). The wind direction from the nearest station in Kota Baru, 20 km radius from the study area was from 30º N/NE to 120º E/SE during the northeast monsoon (January to March 2019). Hypothetically, this wind direction might plausibly direct the wind away from Kg Beris Lalang, hence the trivial relationship.

Conclusion

In conclusion, our study found out that a higher percentage of respondents' experience cough (N=80, 36.7%) and sneezing, runny or blocked nose (N=78, 35.8 percent) compared to the other respiratory symptoms in the past 12 months among residents living within 2 km radius of Beris Lalang Landfill, Bachok, Kelantan.

Significant associations were found between respiratory symptoms with gender and exposure to tobacco smoke ($p<0.001$). These associations imply that firstly, females are more vulnerable to experience breathing conditions compared to males and secondly, respondents who smoke and are regularly exposed to tobacco smoke may develop respiratory symptoms because of the tobacco smoke itself.

Many confounding factors affect the health of individuals and communities which can be determined by their circumstances and environment.

There is weak significant relationship between age and symptoms score (R=0.185, p=0.006) and between duration of residence at current home with the symptom scores R=0.165, p=0.015), suggesting no relations between these two factors. Similarly, the relationships between the residential distance from landfill and symptom score were not significant (R=0.028, p=0.635), suggesting that distance was not a prominent factor for the community to develop the respiratory symptoms.

Apart from the many confounding factors, there are several limitations of this study. Firstly, a cross-sectional study could not ascertain the cause-effect relationship because it simply measures association between dumpsite exposure and the respiratory effects. The study could not verify that the sources of toxicants and

LFG dispersion in the air caused the respiratory symptoms among respondents who live in 2 km radius from Beris Lalang Landfill.

Secondly, the main approach of our study depends on self-reported symptoms, which may be subject to bias. Thirdly, the trivial relationship between symptom score and age, duration and distance from the landfill could be improvised by incorporating comparisons with more municipal landfills and control areas.

Despite not showing any conclusive determinants of respiratory symptom, this study does provide initial evidence about reported symptoms in this population to support more substantial and more complex epidemiologic designs as a baseline for community health, management and sustainability.

Further study is required to investigate which toxicants residents are being exposed to and the source of that exposure considering meteorological conditions in the area. The finding from this study calls for a more focused and sustained public awareness programs in relation to respiratory health among rural residents. Such studies will be able to document the source of toxicants and how air toxicants may lead to exposure of grossly underserved populations and potential plans to prevent future exposure through planning remediation effort among municipalities, district health officers, and nearby residents.

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