

Urban Environmental Health: Respiratory Infection and Urban Factors in Urban Growth Corridor of Petaling Jaya, Shah Alam and Klang, Malaysia

(Kesihatan Persekitaran Bandar: Jangkitan Pernafasan dan Faktor Bandar di Koridor Pertumbuhan Bandar Petaling Jaya, Shah Alam dan Klang, Malaysia)

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ABSTRACT

Environmental health in general is referring to the aspect of concern on healthy environment, and the interrelations between environment and human health. Due to the urbanization, urban development is changing the natural environment into a man-made environment. Along with the process, level of environmental quality and human health are decreased. Air quality as reference shows that urban ambient air is more polluted than rural. Due to high density of human population and their activities in urban areas, it produces air pollutants with higher rate as compared to less-developed areas. Air pollutants contribute to various health problems. People suffering from respiratory diseases are the most likely to be affected by air pollution. This paper aimed to examine the rate of respiratory infection among residents in an urban growth corridor (Petaling Jaya-Shah Alam-Klang) and the relationship with the urban land uses, traffic volume and air quality. There were four major types of data used in this study i.e., respiratory infection of the respondents, air quality, land use and traffic volume. A health questionnaire survey was carried out besides the secondary data collection from the various government departments. Relationship analysis was performed between respiratory health and the urban factors (air quality, traffic volume and land uses). The study found out that the relationship between the respiratory health and the urban factors is different in city-wide land use and traffic factors, as compared to the localised air quality and land use factors. To conclude, the urban factors are potentially affecting the respiratory health.

Keywords: Acute respiratory infection (ARI); air pollution index (API); land use; relationship; traffic volume

ABSTRAK

Kesihatan persekitaran secara amnya, merujuk kepada aspek kesihatan persekitaran dan hubungkaitan antara alam sekitar dan kesihatan manusia. Disebabkan oleh urbanisasi, pembangunan telah mengubah alam semula jadi kepada alam binaan. Dengan ini, paras kualiti persekitaran dan kesihatan manusia telah menurun. Dengan merujuk kepada kualiti udara, udara ambien bandar adalah lebih tercemar berbanding dengan luar bandar. Disebabkan oleh kepadatan populasi manusia yang tinggi dan aktivitinya di bandar, ia telah menghasilkan pencemar udara pada kadar yang lebih tinggi berbanding dengan kawasan yang kurang maju. Pencemar udara menyumbang kepada pelbagai masalah kesihatan. Manusia yang berpenyakit pernafasan adalah lebih cenderung menerima kesan daripada pencemaran udara. Kertas ini bertujuan untuk mengkaji jangkitan pernafasan bagi penduduk di koridor pertumbuhan bandar (Petaling Jaya - Shah Alam - Klang) serta hubungkaitannya dengan guna tanah bandar, bilangan trafik dan kualiti udara. Terdapat empat data utama yang digunakan untuk kajian ini, iaitu jangkitan pernafasan bagi penduduk, data kualiti udara, guna tanah dan bilangan trafik. Satu temu bual kesihatan telah dilakukan di samping pengumpulan data sekunder daripada jabatan kerajaan. Analisis hubungkaitan telah dilakukan di antara kesihatan pernafasan dan faktor bandar (kualiti udara, bilangan trafik dan guna tanah). Kajian ini menemui hubungkaitan antara kesihatan pernafasan dan faktor-faktor bandar adalah berbeza antara faktor guna tanah dan trafik di peringkat bandar serta faktor kualiti udara dan guna tanah di peringkat tempatan. Sebagai rumusan, faktor bandar adalah berpotensi member impak kepada kesihatan pernafasan.

Kata kunci: Bilangan trafik; guna tanah; hubungkaitan; indek pencemaran udara; jangkitan pernafasan akut

INTRODUCTION

The rapid economic growth and the target of achieving industrial country status by the year 2020 together with the fast pace of urbanization rate in Malaysia has now brought about potential negative impact such as industrial pollution and the degradation of urban environment. Due to high density of human population and their activities in urban areas, it produces air pollutants with higher

rate as compared to less-developed areas and natural environment (Ling et al. 2012). Besides the degradation of the natural environment and reduction of natural land covers, vegetation and urban environmental services, an un-sustainable urban development pattern (low density, sprawl and car oriented) can increase the dependence on automobiles as the means of major urban transportation and increases travelling time and distance (Ling et al. 2011).

This phenomenon is contributing towards the increment of air emission in urban area. Studies showed that the urban area is more polluted than rural area. Furthermore, air quality in high-traffic (traffic-oriented) areas is more polluted than general urban areas. In Klang Valley, for the years 1997 and 2002, NO_x concentrations were recorded as the highest in Kuala Lumpur as compared to other cities and towns nearby (Petaling Jaya, Klang, Shah Alam, Kajang & Gombak) (Mohamed Elnour et al. 2005). In Europe, the air pollution of PM₁₀ and NO₂ concentrations were higher in urban areas than in rural areas, and highest in high-traffic areas (Sivertsen 2006). Besides, Kinney and O'Neill (2006) also showed that the traffic-oriented sites in Amsterdam had average concentrations for the primary pollutants (black smoke, CO and nitric oxide) that were two or more times larger than those measured at background (non traffic-oriented) sites.

Air pollutants (e.g. PM, O₃, SO₂ and NO₂) contribute to various respiratory problems including bronchitis, emphysema and asthma (Botkin & Keller 2003; Romieu 1999; US EPA 2007; Utell et al. 2006; WHO 2005). People suffering from respiratory diseases are the most likely to be affected by air pollution (Botkin & Keller 2003). In Malaysia, there are a large number of asthmatic patients, approximately around two million people (Cruetz 2007), which is 7% of the total population. Besides, there are 13.8% of primary school children who suffer from asthma (Shamarina 1998). Hence, the health of Malaysians is potentially affected by air pollution. Moreover, studies by the Asian Development Bank showed that air pollution was killing more than half a million people in Asian cities each year and it showed no sign of improvement as urban centers expanded (NST 2006). Furthermore, from the results of a study of 14 regions worldwide, the evidence showed that environmental risk factors played a role in more than 80% of the diseases regularly reported by the World Health Organization (WHO). In addition, globally, nearly one quarter of all deaths and of the total disease burden can be attributed to the environment (WHO 2007).

Actually, health research has established that air pollution aggravates respiratory illness and also cardiovascular. It adds stress to the cardiovascular system, forcing the heart and lungs to work harder in order to provide oxygen, speed up the natural aging process of the lungs, accelerating the loss of lung capacity, damages cells in the airways of the respiratory system, damages the lungs even after symptoms of minor irritation disappear and contributes to the development of diseases including bronchitis, emphysema and possibly cancer (Boyce 1997). Furthermore, relationship studies have been carried out in several U.S. cities (NIEHS 2007), Manila and Chinese cities (WHO-Western Pacific 2005) including Beijing (United Nations 2001). These investigations showed a significant relationship between various types of air pollutants and respiratory diseases. For example, a study in the South Coast Air Basin (SoCAB) of Southern California demonstrated that eye and throat irritation were the most frequent effects of O₃ exposure (Hall 1996).

It shows the effect of human health especially on the respiratory from the urban development (indirectly) and air quality (directly). However, most of the previous studies were focusing on the health data from hospital. The actual health scenario of the general public (the community) and the relationship with the air pollution level and urban land use coverage are not really been studied, especially for Malaysia. Furthermore, there were a very limited number of such studies in Malaysia. Besides, there is lacking of study on the Malaysian urban regional context. For instance, Norela et al. (2008) and Rafia et al. (2003) examined the possible health effects (acute respiratory infection, ARI, asthma and conjunctivitis) of forest fires (haze) by using public hospital data but not the health data direct from the local community. Another study had been carried out to identify risk factors in childhood asthma at Ipoh General Hospital via self-administered questionnaires (Shamarina 1998). Ling et al. (2012) carried out a study on air-related health and its relationship with the ambient air quality and urban factors in one city only (Kuala Lumpur). Thus, this paper aims to examine the rate of respiratory infection among residents in an urban growth corridor, which consists of Petaling Jaya, Shah Alam and Klang and the relationship with the urban land uses, traffic volumes and air quality.

MATERIALS AND METHODS

AREA OF STUDY

Urban growth corridor of Petaling Jaya, Shah Alam and Klang has been chosen as the area of study. This corridor had been chosen due to the corridor is located in the Central Region of the Peninsular Malaysia, namely Kuala Lumpur Conurbation or Klang Valley. This region is the most urbanised area in Malaysia, which comprised of Kuala Lumpur as the core and other cities or towns in the state of Selangor and Negeri Sembilan. The three (3) study areas are located continuously from the west (Klang town) to the east (Petaling Jaya city), with the Shah Alam city at the centre. Thus, it is suitable for the aim of the study that focuses on the urban growth corridor/region.

Due to the limitations of time and costs, the health questionnaire survey (via the random sampling) did not cover all housing estates in the areas. Thus, only one housing area that is located nearest to the air monitoring station was selected for the health questionnaire sampling survey. The chosen areas were located adjacent to the DOE's air quality monitoring stations (Figures 1 to 3). Table 1 and Figures 1-3 show the study areas with the location of air monitoring stations, and the surrounding land use.

The Petaling Jaya continuous air quality monitoring station is located at Sri Petaling Primary School, Petaling Jaya, Selangor (N03° 06.612', E101° 42.274'). This sampling station is located in a housing area and beside the Jalan Utara (road) and light industrial area. It is surrounded by residential, commercial, light industrial and green areas

TABLE 1. Study areas and the surrounding land uses

Study area	Air monitoring station	Housing area for health survey	Surrounding land use
Petaling Jaya	Sri Petaling Primary School	Sri Petaling	<ul style="list-style-type: none"> Residential area Beside to light industrial area Near to small green area and recreation land A distance to Federal Highway No clear air pollution source located adjacent to the station
Shah Alam	TTDI Jaya Primary School	TTDI Jaya	<ul style="list-style-type: none"> Residential area Beside a light industrial area Near to water body & airport A distance to the large green space (golf) and recreation area A distance to highways 1 air pollution source (light industries located adjacent to the station), but large green space (golf) is located near to it
Klang	Raja Zarina (Girls) Secondary School	Pandamaran	<ul style="list-style-type: none"> Residential area (& village) Beside the major road to Port Klang Adjacent to industrial area Small green area 2 air pollution sources (major road to seaport & industries located adjacent to the station)



Source: Adapted from Google (2013)

FIGURE 1. Location of study area and Sri Petaling Air Monitoring Station (marked with A), Petaling Jaya

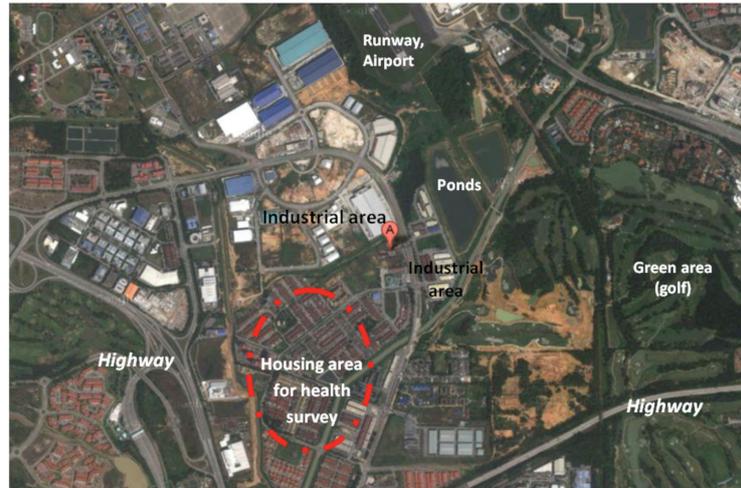
(Figure 1). It is the nearest to Kuala Lumpur city (among the three study areas). The Shah Alam continuous air quality monitoring station is located at TTDI Jaya Primary School ($N03^{\circ} 06.287'$, $E101^{\circ} 33.368'$), Shah Alam, Selangor (Figure 2). This station is located in a residential area and surrounded by industrial, airport and ponds. Besides, it is located near to major roads, however, the traffic density is lower as compared to Petaling Jaya and usually, only significant during the morning and late afternoon rush hours (Siti Zawiyah et al. 2010). The continuous air quality monitoring station of Klang is located at the Raja Zarina Girls School ($N03^{\circ} 00.620$, $E101^{\circ} 24.484$), Port Klang, Selangor (Figure 3). The station is located in the residential

area and just beside the major road of Port Klang (Persiaran Raja Muda Musa). Besides, it is surrounded by housing area and industrial area. Port Klang is one of the major industrial towns in Malaysia with high volume of heavy vehicle.

METHODS OF DATA COLLECTION AND ANALYSIS

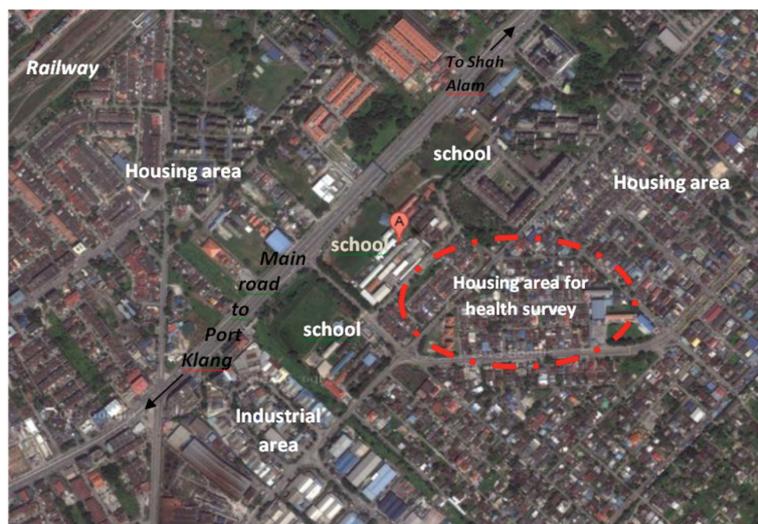
There were four (4) major types of data used in this study i.e., air-related health conditions (respiratory infection) of the residents (based on the respondents), data on the air quality (in API), land use data and traffic volume.

The air-related health data was collected via a questionnaire survey. The face-to-face methodology was



Source: Adapted from Google (2013)

FIGURE 2. Location of study area and TTDI Jaya Air Monitoring Station (marked with A), Shah Alam



Source: Adapted from Google (2013)

FIGURE 3. Location of study area and Raja Zarina Girls School Air Monitoring Station (marked with A), Klang

used. As stated by Van Oyen et al. (1997), information on ill-health and lifestyles is best collected through the questionnaire sampling survey. It is the best means to contact the respondent as compared to a postal survey or a telephone survey. By using stratified random sampling technique, a total of 403 respondents were chosen from the total of 3588 estimated numbers of population at the selected areas consisting of different category of housing type (Table 2). The survey covers general households (Malaysian only) with various socio-economic, demographic and pre-existing health backgrounds. Table 3 shows the general demographic characteristics of the respondents.

For the purpose of this paper, data of three (3) air-related health indicators were only analysed and discussed in this paper. Cases of ARI incidence were measured based on the reported ARI symptoms by respondents, including cough, nasal discharge, nasal block, sore throat, loss of voice and throat irritation, with a duration of less than 14 days per case (less than 14 days is considered as acute infection). ARI outpatient cases were measured based on self-reported (by respondents) number of cases of getting medical advice or treatment without hospitalization due to ARI. Meanwhile, the asthmatic emergency visit cases were measured based on self-reported number of visits to hospital emergency departments/units due to asthma.

TABLE 2. Distribution of samples among the three study areas

Study areas	Estimated number of population of the selected housing area ¹ for health survey	Number of samples (respondents) ²
Petaling Jaya (Sri Petaling)	1,320	133
Shah Alam (TTDI Jaya)	1,216	126
Klang (Pandamaran)	1,052	144
Total	3,588	403

¹An area with 1.5km radius, located beside to the air monitoring station (Figures 1, 2 & 3)

²Total sample size is identified based on the 95% level of confident

TABLE 3. General demographic background of respondents

Age groups	Frequency	Percentage (%)
0-10	7	1.7
11-60	371	92.1
61 & above	25	6.2
Gender		
Male	196	48.6
Female	207	51.4
Ethnic groups		
Malay	156	38.7
Malaysian Chinese	153	38.0
Malaysian Indian	82	20.3
Others	12	3.0
Total	403	100.0

The calculating formula for the three (3) air-related health indicators as:

ARI incidence rate (cases/10000) = (ARI incidence cases ÷ total respondents in each area) × 10000

ARI outpatient rate (cases/10,000) = (ARI outpatient cases ÷ total respondents in each area) × 10000

Asthmatic emergency visit rate (visits/10,000) = (asthmatic emergency visit cases ÷ total respondents in each area) × 10,000

The ambient air quality data was recorded by the air quality monitoring station of Department of Environment Malaysia (DOE 2012). Figures 1, 2 and 3 show the location of the three (3) air monitoring stations. Analysis of air quality has been presented in term of the number of good days and unhealthy days based on the Malaysian Air Pollution Index (API). Meanwhile, the traffic volume was provided by Highway Planning Unit (2006). The traffic volumes were based on the counts for both directions at the selected roads. The traffic data was recorded hourly manually by the Highway Planning Unit (Ministry of Works Malaysia) for 16 h (06.00-22.00) during sampling day. Data of land uses was collected from Petaling Jaya City Council, Shah Alam City Council and Klang Municipal Council. The relationship study is being explained and critically argued with the aid of tables.

RESULTS AND DISCUSSION

RATE OF RESPIRATORY INFECTION

According to the Table 4, all three (3) zones had their highest rate of ARI incidences during the dry season that was on June-September 2012. However, the transitional periods show higher rates if mentioned in average monthly rate. The wet season shows the lowest rate of ARI incidences. It is due to the precipitation effects during the wet season, thus the air quality in the wet season is expected to be better and subsequently lesser the negative health impact. The wet season with more rainfall could reduce the concentration of air pollutants in the air through the washout and rainout effects (Ling et al. 2012).

For the ARI outpatient rates (Table 5), as in Shah Alam and Klang, the highest rates were in June-September 2012 (dry season) with the rate 1905 and 1944, respectively. This was related to the number of API unhealthy days in Shah Alam and Klang. Both the areas had the highest number of unhealthy days in that period of time. However, in Petaling Jaya, the highest ARI outpatient rate was in October 2012 (transitional period) with the rate of 150 (per 10000) and the lowest rate is identified during the dry season. The scenario in Petaling Jaya was different than another two study areas.

Comparing the three (3) areas (Table 4), Petaling Jaya seemed to be the one with the highest rate of ARI incidences (7970) followed by Klang (6250) and Shah Alam (5714).

TABLE 4. ARI incidences in Petaling Jaya, Shah Alam and Klang

Zones	Nov. 2011- Mar. 2012 (wet season)	Apr.-May 2012 (transitional period)	June-Sept. 2012 (dry season)	Oct. 12 (transitional period)	Total
Petaling Jaya	21	28	36	21	106
No. of cases					
Total respondents	133	133	133	133	133
Rate (/10000)	1,578	2,105	2,706	1,578	7,970
Shah Alam	0	24	31	17	72
No. of cases					
Total respondents	126	126	126	126	126
Rate (/10000)	0	1,904	2,460	1,349	5,714
Klang	4	24	36	26	90
No. of cases					
Total respondents	144	144	144	144	144
Rate (/10000)	277	1,666	2,500	1,805	6,250

Rate is calculated at number of cases per 10000 people

TABLE 5. ARI outpatient rates in Petaling Jaya, Shah Alam and Klang

Zones	Nov. 2011-Mar. 2012 (wet season)	Apr.-May 2012 (transitional period)	June-Sept. 2012 (dry season)	Oct. 12 (transitional period)	Total
Petaling Jaya					
No. of cases	1	1	0	2	4
Rate (/10000)	75	75	0	150	301
Shah Alam					
No. of cases	15	17	24	14	70
Rate (/10000)	1,190	1,349	1,905	1,111	5,556
Klang					
No. of cases	15	23	28	24	90
Rate (/10000)	1,042	1,597	1,944	1,667	6,250

Rate is calculated at number of cases per 10000 people

This scenario was not in-line with the scenario of air quality. Whereby, the Petaling Jaya was recorded as the healthiest area (in API) among the study areas (Table 7). It might be due to the reason that the human health condition is not only influenced by air quality (physical factor) but also the socio-economic (such as income level), demography (such as gender and age), and behavioural factors (such as smoking habit) as discussed by other researchers (Gouveia & Maisonet 2006; Janssen & Mehta 2006; Kinney & O'Neill 2006; Rozlan et al. 1999; Shahrudin 1989; Utell et al. 2006). Besides, it might be also due to reason that the respondents were also been exposed to air pollutants outside from their housing area, perhaps also at the working area and traffic corridor. Petaling Jaya city was recorded with large road traffic volume as compared to the other two areas (Table 8). Furthermore, high percentage of pollution-prone land uses (25.88%) is located in Petaling Jaya city (the city-wide land use coverage, Table 8). It might be the reason of having the result as the air monitoring station located beside the housing area was recorded with good air quality, but respondents were suffering with higher rate of ARI incidences.

However, in term of the ARI outpatient cases (Table 5), Petaling Jaya showed the lowest rate and Klang showed the highest rate. This scenario is in-line with the scenario of air quality. Klang was the unhealthiest area and Petaling Jaya is the healthiest area as measured in API (Table 7). Besides, the localised land use coverage (land use of the air monitoring station's surrounding area) also supported the healthier of Petaling Jaya, and unhealthier of Klang (Table 7). There is no clear major land use that potentially increased the air pollution in study site in Petaling Jaya. Meanwhile, there are clear major land uses that potentially contributed to the air pollution in study site in Klang (major road from Klang to Port Klang is located beside the study area of Klang and industries are located nearby).

In term of the physical factors, the conflicting scenario as measured in ARI incidences and ARI outpatient cases can be related to a possible reason of that the ARI outpatient rates were potentially more influenced by the localized environmental condition (air quality in the housing area and nearby land use coverage) as compared to the rates of ARI incidences which were potentially more influenced by the city-wide environmental condition (city-wide land

use coverage and higher traffic volume in the city). The localized air quality level and the land use coverage pattern are potentially having a more serious health impact (ARI outpatient rate) as compared to the city-wide traffic volume and land use coverage.

Besides the ARI, one of the common used health indicators is the asthmatic rate. People with pre-existing respiratory diseases (such as asthma) are more susceptible to the air pollution (Gouveia & Maisonet 2006). Thus, they are expected to suffer with more emergency visits due to air pollutants. From the analysis, Klang showed

the highest rate of asthmatic emergency visits followed by Shah Alam. Petaling Jaya respondents only suffered with two (2) emergency visit cases during the period of study (Table 6).

The scenario of asthmatic emergency visit rates among the three (3) areas is also in-line with the scenario of air quality, whereby Klang is the unhealthiest area, and Petaling Jaya is the healthiest area (Table 7). This result further support the argument that the localized air quality level is potentially having a more serious health impact (including the ARI outpatient and asthmatic rates)

TABLE 6. Asthmatic emergency visit rates in Petaling Jaya, Shah Alam and Klang

Zones	Nov. 2011-Mar. 2012 (wet season)	Apr.-May 2012 (transitional period)	June-Sept. 2012 (dry season)	Oct. 12 (transitional period)	Total
Petaling Jaya					
No. of cases	1	0	1	0	2
Rate (/10000)	75	0	75	0	150
Shah Alam					
No. of cases	0	3	4	1	8
Rate (/10000)	0	238	317	79	635
Klang					
No. of cases	0	4	5	5	14
Rate (/10000)	0	278	347	347	972

Rate is calculated at number of cases per 10000 people

TABLE 7. Respiratory infection, air quality and localised land use at Petaling Jaya, Shah Alam and Klang

Study area	Health (respiratory infection)	Air quality	Localised/nearby land use of the air monitoring station
Petaling Jaya (Sri Petaling)	Lower in API outpatient & asthmatic emergency visit rates (Table 5 & 6)	Most healthy Reported to have the highest number of good days in API (197 days, 54.12%) and the lowest number of unhealthy days in API (2 days, 0.55%) as compared to the other 2 stations, Nov. 2011- Oct. 2012 (DOE 2012)	With greens; no major pollution-prone land use/activity (Figure 1) <ul style="list-style-type: none"> • Consist of large residential area • Light industrial area located at the surrounding area • A few spots of agriculture land use • Commercial land use • Open space and recreation land use were there too
Shah Alam (TTDI Jaya)	Higher in API outpatient & asthmatic emergency visit rates (Table 5 & 6)	The air quality as moderate as compared to another 2 stations, Nov. 2011- Oct. 2012 But, it is the unhealthiest area in 2010 and 2011 with 32 and 22 unhealthy days, respectively (DOE 2012)	Large industrial area (potential pollution) but also large green area (able to reduce pollution) (Figure 2) <ul style="list-style-type: none"> • Residential area • Large area of industrial • Large area of open space and recreation too • Agriculture land use spotted there • Commercial land use was nearby • There was water body and airport near to the residential area
Klang (Pandamaran)	Higher in API outpatient & asthmatic emergency visit rates (Tables 5 & 6)	Most polluted The good days (API) were reported as the lowest (117 days, 31.97%) and the unhealthy days (API) were the highest (11 days, 3%) as compared with other 2 stations, Nov. 2011- Oct. 2012 (DOE 2012)	Clear air pollution sources (Figure 3) <ul style="list-style-type: none"> • Beside the major road to Port Klang • Industrial land use situated not far from the study area Other land uses: <ul style="list-style-type: none"> • Majority of the area covered with the residential (& villages) • Agriculture land use category involved too • Commercial land use was nearby

as compared to the city-wide traffic volume and land use coverage.

Relationship between Respiratory Infection and Localised Air Quality and Land Use Factors To summarise the relationship study, Table 7 shows lower rates of ARI outpatient and asthmatic cases in Petaling Jaya as compared to Klang, and Shah Alam. At the same time Petaling Jaya is identified with the healthiest air (largest number of good API days and smallest number of unhealthy days). Besides,

the area of study in Sri Petaling (Petaling Jaya) showed no major air pollution-prone land use.

On the other hand, Klang and Shah Alam show higher rates of ARI outpatient and asthmatic cases, higher percentage of unhealthy days, and high percentage of air pollution-prone land use/activities in the areas (localised land use coverage, Table 7).

As a findings of relationship analysis between the localised air quality and land use factors, and human health (respiratory infection), it is suggested a clear positive

TABLE 8. Respiratory infection, road traffic volume and city-wide land use in Petaling Jaya, Shah Alam and Klang

Study area	Health (respiratory infection)	Road Traffic volume (16 h) ¹	City-wide land use of Petaling Jaya city, Shah Alam city & Klang town ²
Petaling Jaya	Higher in API incidences (Table 4)	Higher traffic volume Apr. 2006 = 309,828 Sep. 2006 = 397,047 (Federal Highway, KL-PJ)	Higher % of land uses which potential to increase air pollution (25.88%): <ul style="list-style-type: none"> • Industrial- 3.58% • Transportation- 16.94 • Infrastructure & utilities- 5.36% • Residential- 19.40% • Commercial & service- 3.45% • Institution- 13.64% • Water body- 2.02% Land uses which potential improve air quality (35.59%): <ul style="list-style-type: none"> • <i>Open space & recreation- 9.83</i> • <i>Empty land- 19.60%</i> • <i>Green lung- 6.16%</i>
Shah Alam	Lower in API incidences (Table 4)	Lower traffic volume Apr. 2006 = 55,582 Sep. 2006 = 64,460 (Road from Batu 3 to Damansara)	Higher % of land uses which potential to increase air pollution (34.11%): <ul style="list-style-type: none"> • Industrial-12.79% • Transportation- 16.33% • Infrastructure & utilities- 4.99% • Residential- 34.34% • Commercial & service- 3.92% • Mix development- 1.16% • Institution- 8.80% • Water body- 2.69% Land uses which potential improve air quality (15.15%): <ul style="list-style-type: none"> • <i>Open space and recreation- 7.62%</i> • <i>Agriculture-0.32%</i> • <i>Green lung- 7.19%</i>
Klang	Lower in API incidences (Table 4)	Lower traffic volume Apr. 2006 = 39,397 Sep. 2006 = 36,494 (Langat Road to Pandamaran)	Low % of land uses which potential to increase air pollution (5.25%): <ul style="list-style-type: none"> • Industrial- 4.73% • Infrastructure & utility- 0.52% • Residential- 8.32% • Commercial- 0.85% • Institution- 1.12% • Special use- 0.84% • Others- 20.01% High % of land uses which potential improve air quality (73.59%): <ul style="list-style-type: none"> • Open space & recreation- 0.71% • Natural ecology- 34.33% • Agriculture- 38.55%

¹Adapted from Highway Planning Unit (2006)

²Adapted from Petaling Jaya City Council (n.d.), Shah Alam City Council (2012) & Klang Municipal Council (2008)

relationship between ARI outpatient rates or asthmatic emergency visit rates and air quality (unhealthy days) as well as the coverage of air pollution-prone land uses. Higher number of unhealthy days in API and lower number of good days in API (more polluted) is positively related to the higher of respiratory infection rates as measured in ARI outpatient and asthmatic emergency visit cases (Table 7). Besides, higher percentage of air pollution-prone land uses and activities (road/traffic and industries) was indirectly causing the higher rates of ARI outpatients as well as asthmatic emergency visits.

Relationship between Respiratory Infection, and city-Wide Land Use and Traffic Volume Analysis at the city-wide level (Table 8) showed a higher rate of ARI incidences in Petaling Jaya as compared to Klang and Shah Alam. At the same time, Petaling Jaya is identified with the higher number of traffic volume as compared to Klang and Shah Alam. For the factor of city-wide land uses, Petaling Jaya showed a higher percentage of air pollution-prone land uses (25.88%) than Klang (2.25%) but lower than Shah Alam (34.11%).

On the other hand, Klang shows a lower rate of ARI incidences, lower traffic volume and lower percentage of air pollution-prone land uses/activities (and higher percentage of greens, 73.59%) (Table 8). However the Shah Alam with the highest percentage of air pollution-prone land uses/activities (34.11%) and lowest percentage of greens (15.15%) was identified with the lowest rate of ARI incidences (Table 8). It might be due to the lower amount of traffic volume that is the more dominant factor of ARI incidences as compared to the factor of land use.

From the relationship analysis on the impact of city-wide land use and traffic volume on human health (respiratory infection), it is suggested a positive relationship between ARI incidence rates and traffic volume in the area. However, the relationship between city-wide land use factor and respiratory infection is not clearly identified.

CONCLUSION

As compared to the previous similar study in Malaysia, the Kuala Lumpur city (Ling et al. 2012), the recent study is suggesting a different finding that includes relationships between respiratory health and urban factors in a localised, as well as in city-wide levels. In the city-wide scenario, the higher traffic volume in the town is potentially affecting the rate of ARI incidences positively. However, it is not positively affecting the more serious respiratory infections as measured in ARI outpatient cases and asthmatic emergency visit cases. For the localised scenario, the unhealthy days (in API) and the localised pollution-prone land uses are positively affecting the respiratory infection (ARI outpatient and asthmatic emergency visit cases). However, this finding is not supported by any previous study. Furthermore, due to the small number of case

studies (three study areas only), this new finding can only be treated as reference for future study.

To conclude, the air quality, traffic volume and urban land uses are potentially affecting the human health (respiratory infection). However, from the study in the context of urban growth corridor (consist of three cities/towns), the relationship is not being constructed concretely. This is the first intent of such study in the regional context in Malaysia. More study on the regional context should be carried out in the future to re-examine the relationship between respiratory health and urban factors in localised level as well as city-wide level.

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