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Relationship Between Exposure To Particulate Matter And Biomarkers Among Bus Drivers In Klang Valley, Malaysia

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ABSTRACT: This cross-sectional comparative study investigates the association between particulate matters (PM; PM₁₀, PM₂.₅ and ultrafine particle (UFP) and concentration of biomarkers; Interleukin-6 (IL-6) and Tumor Necrosis Factor- Alpha (TNF-α) using 62 bus drivers as exposed group and 62 administrative staff as comparative group in Klang Valley, Malaysia. T-test results showed that the mean exposure level of PM₁₀(t = 8.14, p<0.01), PM₂.₅ (t = 9.95, p<0.01) and UFP (t = 19.61, p<0.01) were significantly higher among the bus drivers compared to comparative group. Mann-Whitney U test of IL-6 (z = -2.43, p<0.05) and TNF-α (z = -5.88, p<0.01) were also found to be significantly higher in the bus drivers. Positive correlations were found between the exposure level of PM and concentration of biomarkers. In conclusion, the bus drivers showed higher concentration of IL-6 and TNF-α and were at a higher risk of getting respiratory illnesses compared to comparative group. Thus, more attention should be given on the control of high level of exposure to PM in order to minimize the adverse health effects among the groups at risk.

Keywords: PM₁₀, PM₂.₅, UFP, IL-6, TNF-α, respiratory symptoms, bus drivers

Introduction

Increase in the population explosion, vehicular traffic, rapid urbanization and industrialization in the developed and developing countries (Brunekreef and Holgate, 2002) have contributes towards the increase in air pollution and concerns about adverse health effects due to air pollution (WHO, 2000). Air pollutants are divided into particulate matter (PM), volatile organic compounds (VOC) and halogen compounds. Atmospheric particles are generally described according to their morphology and composition. The PM with a diameter of less than 10 micrometers (μm) but greater than 2.5 μm is known as Particulate Matter 10 micron fraction (PM₁₀). Those having a diameter less than 2.5 but greater than 0.1 μm is designated as Particulate Matter 2.5 micron fraction (PM₂.₅) while particles with a diameter of less than 0.1 μm are considered as the ultrafine particles (UFP). The size distinction is important as the particle size reflects in part, the penetration potential into the respiratory tract (Ibald-Mulli and Wichmann, 2002; Bai et al., 2007).

Workers involved in transportation industry are highly exposed to the traffic air pollutants. Thus, they are at high risk in getting respiratory and lung diseases due to the exposure to traffic air pollutant and would seem to deserve particular attention for risk assessment (Jenkins et al. 1992). This present study aims to determine the relationship between PMs and traffic air pollutant’s biomarkers (IL-6 and TNF-α, in this study) among the public bus drivers in Klang Valley, Malaysia. Due to the nature of the job, bus drivers are among the risk group being exposed to highly polluted air consisting of a mixture of air pollutants for about eight hours without any personal protective equipment.
Methodology

Study Background

This cross-sectional comparative study was performed among 62 bus drivers from a public bus company and 62 administrative staff. They were all male, nonsmokers, age between 20 to 55 years, Malaysian nationality and with no history of chronic lung and respiratory diseases. The respondents were participated in PM (PM$_{10}$, PM$_{2.5}$ and UFP) exposure measurement and analysis of sputum biomarkers (IL-6 and TNF-α) concentration. Questionnaires adapted from American Thoracic Society were used to obtain background information about the respondents.

PM Data

Exposures to PMs were sampled using DustTrak Aerosol Monitor, SidePak™ AM510 Personal Aerosol Monitor and P-Trak Ultrafine Particle Counter. For each respondent, the exposure level of PM was measured for eight hours. During the exposure measurement, the instruments were placed within the driving zone of the bus drivers and working zone of the administrative staff. The instruments were also placed away from the direct sources of PM (eg. photocopy machine, printer and vacuum cleaner) to avoid higher particles exposure from direct sources.

Measurement of Human Sputum IL-6 and TNF-α

The concentrations of the biomarkers were analyzed using Enzyme-Linked Immunosorbent Assay (ELISA) according to the manufacturer’s instruction. Sputum induction was performed by inhalation of isotonic saline solution (NaCl 0.9%) (Cataldo et al., 2001) and the aerosols were produced by ultrasonic nebulizer (Cianchetti et al., 2004). Sputum samples collected from the respondents were ultracentrifuged for 90 min at 25100 rpm at 4°C (Out et al., 2001). The IL-6 and TNF-α concentration of the respondents were determined from a standard curve for IL-6 and TNF-α. All sputum biomarkers analysis were conducted at Chemical Pathological Laboratory, Department of Pathology, Universiti Putra Malaysia.

Statistical Analysis

Data were analyzed using Statistical Packages for Social Sciences (SPSS, version 13). Normality test used was Kolmogorov Smirnov with a Lilliefors Significance level (p<0.05) for normal distribution.

Results and Discussions

Socio-demographic Information

TABLE 1 shows the socio-demographic information for both exposed and comparative groups. Basically, no significant differences were observed between the bus drivers and comparative group in terms of age, height, weight and duration of work. The mean age for the study and comparative groups were $38.30 \pm 6.08$ years and $36.64 \pm 5.41$ years, respectively. Aging has been associated with various lung diseases, mainly caused by the participation of thymus in human immunological function. In order to control the aging effects, the present study was restricted to the respondents aged 20-55 years. The mean height of the study group was $170.49 \pm 6.50$ centimeter (cm) and mean height of the comparative group was $169.05 \pm 6.42$ cm. On the other hand, the mean weight was $72.72 \pm 11.57$ kilogram (kg) and $70.37 \pm 7.39$ kg for the study group and the comparative group, respectively.

Comparison of Personal Exposure Level of PM

One of the major finding of this study was the significant difference in personal exposure level to PM between the bus drivers and the comparative group. The mean of personal exposure level of bus drivers for PM was significantly different between the groups (PM$_{10}$, t = 8.137; p < 0.001; PM$_{2.5}$, t = 9.945; p < 0.001 and UFP, t = 19.608; p<0.01) (Table 1). The data shows that the personal exposure level to PM among bus drivers was higher than the administrative staff.

Atmospheric PM in the urban areas was mainly generated by vehicular combustion. The rapid urbanization in the cities such as Kuala Lumpur requires an increased need for transportation (Sydbom et al., 2001). Hence, more vehicles were found in the urban areas compared to the rural areas. The increasing numbers of vehicles especially diesel vehicles increase the atmospheric PM level (Donaldson et al., 2005; Harrison, 1999; Aarnio et al., 2008; Fang et al., 2008; Hussein et al., 2005). Ambient air at the road sides was polluted by the combustion, non-combustion and suspension emission produced by vehicles (Sydbom et al., 2001).

Adverse health effects have been associated with the increase ambient PM10 gobally (USEPA, 2005; Becker et al., 2003; Schwartz et al., 1995). According to USEPA (2005), exposure to the indoor air pollutants inside buses will lead to adverse health effect including acute and chronic effects. The large fraction of combustion from the diesel engines ended up inside buses are particulate
matters (PM$_{10}$, PM$_{2.5}$ and UFP), nitrogen dioxide, carbon monoxide and volatile organic compounds (VOCs).

It was estimated that over 600 million people in urban areas worldwide are exposed to dangerous levels of traffic generated air pollutants. In addition, the mean exposure concentration of PM$_{2.5}$ among bus drivers was higher compared to other traffic related exposure reported by a research conducted among 58 traffic related workers such as bus drivers, vendors, traffic police, and gas station attendants and 10 office workers as controls group (Cacciola et al., 2002). Our findings are in agreement as reported by Cacciola et al. (2002) that the bus drivers were the group with highest exposure concentration of PM$_{2.5}$.

UFP are particles with low mass concentration which are always present in the urban atmosphere in large numbers of quantity. These particles are highly reactive and not very stable but are always freshly-generated from sources such as combustion processes, tailpipe emissions and gas to particle conversions (Oberdorster, 1996). Donaldson et al., (2001) demonstrated that UFP are generally produced by combustion processes and their particle sizes were extremely smaller than the particles in dusty places.

### TABLE 1- Comparison of age, anthropometrical measurements and exposure level of PM among the respondent

<table>
<thead>
<tr>
<th>Variables</th>
<th>Study group (n = 62)</th>
<th>Comparative group (n = 62)</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (Years)</td>
<td>38.30 ± 6.08</td>
<td>36.64 ± 5.41</td>
<td>1.59</td>
<td>0.115</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>167.49 ± 6.50</td>
<td>169.05 ± 6.42</td>
<td>-1.35</td>
<td>0.180</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>72.72 ± 11.57</td>
<td>70.37 ± 7.39</td>
<td>1.35</td>
<td>0.180</td>
</tr>
<tr>
<td>PM$_{10}$ (mg/m$^3$)</td>
<td>0.094 ± 0.063</td>
<td>0.027 ± 0.014</td>
<td>8.137</td>
<td>0.000**</td>
</tr>
<tr>
<td>PM$_{2.5}$ (mg/m$^3$)</td>
<td>0.072 ± 0.032</td>
<td>0.029 ± 0.011</td>
<td>9.845</td>
<td>0.000**</td>
</tr>
<tr>
<td>UFP (pt/cc)</td>
<td>1.31 × 10$^7$ ± 5.04 × 10$^7$</td>
<td>5.40 × 10$^7$ ± 3.00 × 10$^7$</td>
<td>19.608</td>
<td>0.000**</td>
</tr>
</tbody>
</table>

**Comparison of Concentration of Biomarkers**

Our results show that the mean level of biomarkers were significantly lower among the comparative group as compared to the bus drivers (p<0.05). This indicates that the probability for the comparative group to get lung diseases is less than the bus drivers. In the present study, IL-6 was used as a biological indicator of inflammation in the lung. The median and interquartile range for IL-6 among the study and the comparative groups were 6.36 ± 3.88 pg/mL and 5.28 ± 4.14 pg/mL, respectively. Moreover, the median and interquartile range for TNF-α among the study and comparative groups were 24.67 ± 14.41 pg/mL and 13.68 ± 9.10 pg/mL, respectively. A significant difference for the biomarkers concentration between exposed group and comparative group (IL-6, z = -2.43, p<0.05; TNF-α, z = -5.88, p<0.01) is observed (TABLE 2).

### TABLE 2- Comparison of biomarkers concentration

<table>
<thead>
<tr>
<th>Variables</th>
<th>Study group (n = 62)</th>
<th>Comparative group (n = 62)</th>
<th>z-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>IL-6 Level (pg/mL)</td>
<td>6.36 ± 3.88</td>
<td>5.28 ± 4.14</td>
<td>-2.43</td>
<td>0.015*</td>
</tr>
<tr>
<td>TNF-α Level (pg/mL)</td>
<td>24.67 ± 14.41</td>
<td>13.68 ± 9.10</td>
<td>-5.88</td>
<td>0.000**</td>
</tr>
</tbody>
</table>

Generally, biomarkers such as IL-6 increase due to the exposure particles (Veranth et al., 2008; Rosas et al., 2007). Particulate exposures lead to the activation of alveolar macrophages (AM) for clearance mechanism followed by inflammation. Moreover, accumulation of PM in the human lung may lead to chronic inflammation. Mary (1996) demonstrates the role of proinflammatory cytokine IL-6 in pulmonary inflammation induced by exposure to environmental air pollutants. Similar results were also found in a study conducted by Veranth et al., (2008) who found an increased cytokine binding with increasing particles concentration. In line with this, Li et al., (2002) reported a positive relationship between DEP and inflammatory effect with data showing that the increased bronchoalveolar lavage fluid concentration of TNF-α was resulted from the exposure to carbon core particles of diesel exhaust particles. DEP consists of a complex mixture of petrochemical-derived organics adsorbed into particles and causes inflammatory effects on lungs.
TNF-α is released when there is an interaction of AM with atmospheric particles and in the same time increased their phagocytic activity and oxidant production (Goldsmith et al., 1998; Hiramatsu et al., 2003).

**Correlation between Exposure Level to PM (PM$_{10}$, PM$_{2.5}$ and UFP) and IL-6 Concentration**

Spearman Correlation test shows that there is a significant correlation between exposure level of PM and concentration of IL-6 for PM$_{10}$ [study group (r = 0.273, p<0.05) and comparative group (r = 0.268, p<0.05)], PM$_{2.5}$ [study group (r = 0.502, p<0.01) and comparative group (r = 0.443, p<0.01)] and UFP, (TABLE 3). Also, PM$_{2.5}$ and UFP among bus drivers (r = 0.673, p<0.01) and among comparative group (r = 0.538, p<0.01). This clearly shows that the level of PM influences the concentration of IL-6 among the respondents.

### TABLE 3- Correlations between exposure level to PM (PM$_{10}$, PM$_{2.5}$ and UFP) and IL-6 among the respondent

<table>
<thead>
<tr>
<th>Biomarker</th>
<th>PM exposure</th>
<th>Study group (n=62)</th>
<th>Comparative group (n=62)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>r</td>
<td>p</td>
</tr>
<tr>
<td>IL-6 (pg/mL)</td>
<td>PM$_{10}$</td>
<td>0.273</td>
<td>0.032*</td>
</tr>
<tr>
<td></td>
<td>PM$_{2.5}$</td>
<td>0.502</td>
<td>0.000**</td>
</tr>
<tr>
<td></td>
<td>UFP</td>
<td>0.673</td>
<td>0.000**</td>
</tr>
<tr>
<td>TNF-α (pg/mL)</td>
<td>PM$_{10}$</td>
<td>0.249</td>
<td>0.051</td>
</tr>
<tr>
<td></td>
<td>PM$_{2.5}$</td>
<td>0.457</td>
<td>0.000**</td>
</tr>
<tr>
<td></td>
<td>UFP</td>
<td>0.438</td>
<td>0.000**</td>
</tr>
</tbody>
</table>

Note: * Significant at p < 0.05  
** Significant at p < 0.01

Stephan et al., (2001) observed circulating levels of IL-6 elevated in subjects exposed to high levels of PM$_{10}$ during an episode of acute air pollution. The cytokine induced a systemic response that has an important role in the pathogenesis of the cardiopulmonary adverse health effects associated with atmospheric pollution (Stephan et al., 2001). Becker et al, (2005) found that PM$_{10}$ interacts with alveolar macrophages (AM) and airway epithelial cells in vitro. The interactions produce variety of biomarkers including IL-6 as a defense mechanism to fight against the foreign particles that entered the body. The inhaled particles, with a mass median aerodynamic diameter < 10 μm could provoke more inflammatory effects compared to larger particles. PM$_{10}$ could reach the lower respiratory tract where they are actively phagocytized by AM and produced proinflammatory cytokines (Veranth et al., 2008; Monn and Becker et al., 1999).

PM$_{2.5}$, which is smaller in size inhaled deeply into the lung and exerts their toxic effects on alveolar cells including macrophages, neutrophils and epithelial cells (Salvi and Holgate, 1999; Pozzi et al., 2003). During the interaction between the PM$_{2.5}$ and alveolar cells, inflammatory mediators are secreted and phagocytosis takes place in order to protect the organism from the negative effects provoked by the foreign particles (Kreyling et al., 2002). IL-6 is one of the important cytokine involved in the cleaning mechanism against PM$_{2.5}$ (Auger et al., 2006; Lei et al., 2005).

The ultrafine fraction of the urban ambient air particles was slightly, but significantly, more potent to induce IL-6 release than the total urban ambient air (WHO, 2003). It is less than 0.1 μm in size and has a large surface area (Ibald-Mulli and Wichmann, 2002) and can be brought deeply into the alveolar region and may also penetrate into the interstitial spaces (Oberdorster et al., 1992). The deposition of inhaled UFP in the alveolar region of the lung are not efficiently phagocytized by alveolar macrophages, rather, they penetrate into and interact with alveolar epithelial, interstitial, and endothelial cells thereby inducing the release of proinflammatory and anti-inflammatory mediators (Oberdorster et al., 1992; Totlandsdal et al., 2008).

When compared to fine particles, the UFP have a higher deposition probability particularly in small airways and the alveolar region of the lungs, greater access to interstitial spaces and are less well phagocytized by AM. All these characteristic lead the UFP to a high access to the blood circulation, induce more oxidative stress and more pro-inflammatory responses than larger particles (Wilson et al., 2002; Kreyling et al., 2002).

**Correlation between Exposure Level to PM (PM$_{10}$, PM$_{2.5}$ and UFP) and TNF-α Concentration**

Spearman Correlation test shows a correlation between exposure level of PM and concentration of TNF-α for PM$_{10}$ (exposed group, r = 0.249, p=0.051; comparative group, r = 0.287, p<0.01), PM$_{2.5}$ (study group, r = 0.457, p<0.01; comparative group, r = 0.335, p<0.01) and UFP (study group, r = 0.438, p<0.01; comparative group, r = 0.387, p<0.01) (TABLE 3).
Jimenez et al., (2000) reported that the macrophage exposed to PM$_{10}$ stimulates a pro-inflammatory response in lung epithelial cells. The findings showed that PM$_{10}$ may trigger an epithelial cell inflammatory response via macrophage mediators TNF-α if exposed directly to pollutants. TNF-α increases in a dose-dependent manner when AM is exposed to ambient particles and the particles with different composition and size produce a similar response, as also noted by Eeden et al. (2001). Cytokines involvement increases in the systemic inflammatory response induced by PM$_{10}$ (Eeden et al., 2001). The results of Eeden’s study clearly revealed that the productions of TNF-α were elevated by the exposure to PM$_{10}$. The interaction of AM with atmospheric particles increases their phagocytic activity, oxidant production, and the release of inflammatory mediators such as TNF-α (Eeden et al., 2001).

Jalava et al., (2006) found a positive relationship between PM$_{2.5}$ and TNF-α production. The PMs were sampled in four size ranges, i.e. coarse (PM$_{10}$ – PM$_{2.5}$), intermodal size range (PM$_{2.5}$ – PM$_{1}$), PM$_{1}$– PM$_{0.2}$ and ultrafine (PM$_{0.2}$) particles. The particle size range of PM$_{2.5}$ highly provoked the production of inflammatory cytokine of TNF-α compared to other size of particles (Jalava et al., 2006).

UFP are particles with less than 0.1 µm (Ibald-Mulli and Wichmann, 2002) and primarily produced by combustion in diesel engines. These highly reactive particles are present in large numbers in the urban areas. Due to the smaller size, they are able to penetrate the epithelium and vascular walls to enter into the bloodstream. UFP are found to provoke carcinogenicity (Cammer et al., 1988), autoimmune disorder (Yashino and Sagai, 1999) and increase cardiovascular disorders (Schwarts et al., 1995; Seaton et al., 1995). Thus, the present study selected TNF-α as a biomarker to measure the probability of TNF-α production due to the UFP exposures. Our results show that there is a significant correlation between the exposure level to UFP and TNF-α concentration.

**Conclusion**

The study shows that diesel exhaust particles form an important source of pulmonary inflammation among the bus drivers. The diesel exhaust particles include PM$_{10}$, PM$_{2.5}$ and UFP. The exposure levels of the PM$_{10}$, PM$_{2.5}$ and UFP were significantly higher (p<0.01) among bus drivers and associated with elevated concentration of IL-6 and TNF-α (p<0.05). The prevalence of respiratory symptoms (cough and phlegm) were also found significantly higher among the bus drivers compared to the comparative group. The concentration of IL-6 was mainly contributed by the exposure to PM$_{10}$, PM$_{2.5}$ and UFP while TNF-α concentration was mainly contributed by PM$_{2.5}$ and UFP.

**Acknowledgement**

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Preliminary Assessment of Indoor Air Quality in Terrace Houses

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ABSTRACT: Four terrace houses in Shah Alam were chosen for preliminary investigation of indoor air quality in residential buildings. The concentrations of carbon dioxide ($\text{CO}_2$), carbon monoxide (CO) and particulate matters (PM$_{10}$) in indoor of houses were determined. The effects of temperature, air velocity and relative humidity on the indoor air quality were also investigated. The results indicated that all of the average indoor concentrations of CO, CO$_2$, and PM$_{10}$ at the naturally ventilated residential buildings were below the limits of Malaysian guideline standards except for the indoor climate parameters. The indoor/outdoor ratios concentration of all air pollutants were found to be below one which indicates that outdoor air influences indoor air.

Keywords: Carbon monoxide, carbon dioxide, particulate matter, indoor air quality, terrace house

Introduction

Indoor air quality (IAQ) is a term referring to the air quality within and around buildings and structures, its significance especially being its relation to the health and comfort of building occupants. In recent years, scientists and the public have put much concern about indoor air quality, since most people spend their time more than 70 - 90\% indoors (e.g. office, workplace, school, house) (Sharpe, 2004; Triantafyllou \textit{et al.}, 2007). Many studies have found indoor pollution levels to be greater than outdoor levels (Montgomery and Kalman, 1989). Indoor air pollution has occurred since prehistoric times when people moved to live indoors and fire was brought into closed shelters for cooking and space heating (Godish, 1991).

The sources of an air pollutant is one of the factors that contribute to indoor air quality problems. Indoor air pollutants originate from a range of potential sources including cooking, smoking, vacuuming, sweeping and ventilation system. Besides, design, operation and maintenance of a building ventilation system are also considered to be the contributing factors to indoor air pollution (Gang \textit{et al.}, 2005).

Outdoor sources may also contribute to indoor concentrations of a number of air pollutants commonly found in indoor air. Major outdoor sources of pollutant may come from traffic, industrial, construction and combustion sources (Cohen, 2000). The effect of outdoor air on the indoor air quality of a building becomes more significant when the building is situated in an urban area and is close to an industrial zone or street with heavy traffic (Li, 1994).

Maintaining good air quality of residential building environment is essential to the sick, the young and the elderly person because they spend most of their time indoor (Lee \textit{et al.}, 2002; Zain-Ahmed \textit{et al.}, 2005) and continuous monitoring of indoor air quality of residential building is particularly very important in order to understand how well the building is performing overall to mentioned occupants above. In Malaysia, there are guidelines (code of practice on indoor air quality) for indoor air quality and exposure standards to protect workers (DOSH, 2005), but no guidelines have yet been developed that apply specifically to the domestic environment (residential building).

Indoor air quality in a hot and humid climate country is a relatively new issue. Limited data is available on the general understanding about present indoor air quality of tropical regions especially for residential buildings. It is therefore important that indoor air quality be given more attention and further studies be conducted to assess the indoor air quality. Besides, the residential building in tropics can be very different from those in cool climate or temperate region. Investigation of air quality at terrace houses may be useful to characterize and for subsequent implementation of corrective measures if necessary.
The aims of this paper are to characterize air pollution level at selected terrace houses in Shah Alam, Selangor and to compare the measured concentrations with established standards.

Methodology

Sampling Sites

This study was conducted in selected double storey terrace houses in Shah Alam, the capital city of Selangor State. Shah Alam has experienced a rapid urbanization and industrialization in the last decades, with population estimated about 600,000. The houses chosen in the study were located within a 20 km radius of the Shah Alam city in order to keep external environmental factors constant. These houses were located at four different areas; house 1 - Section 7, house 2 – Section 17, house 3 – Section 20 and house 4 – Section 24 (FIG. 1). The terrace houses have opposite sides exposed to the environment while the remaining two sides share common walls with the adjacent houses.

Sample collection and analysis

Monitoring was conducted in living rooms for a 2-3 days for a period of 8 hours in each house from 9.00 am to 5.00 pm. Air velocity, CO and CO₂ were measured every 10 min using Graywolf IQ-410 and Graywolf AS-202A probe. Except for PM_{10}, all the other parameters were sampled utilizing grab sampling technique. The indoor climate parameters were also measured in each house. The parameters measured were indoor air temperature, relative air humidity, and air velocity. The air sampler instrument was placed vertically at a height of 1.2 m, at least 1 - 2 m away from any obstacle in order to avoid potential interferences during sampling. As far as possible, the air sampler instrument was located at the centre of living room inside the house. During the periods of air sampling, each of the monitored houses was occupied. The fan in living room was switched on when occupants spent their time in this area.

Samplings for PM_{10} were conducted by collecting the particulate matter onto 0.45 mm diameter filter papers by using Air Metrics mini-volume air sampler which was runs at a constant flow rate of 5 L/min. All the data obtained were subjected to descriptive statistical analysis including mean; standard deviation; maximum; minimum and analysis of variance (ANOVA) using statistical functions in Microsoft Excel and Statistical Packages for the Social Sciences (SPSS).

Results and Discussions

Indoor Climate

TABLE 1 shows the descriptive statistical data of temperature, relative humidity and air velocity for the four terrace houses. The range of mean values of indoor temperature for all houses was 27.2-30.6 °C, while the relative humidity and air velocity were 70.0-78.6 % and 0.00-0.01 ms^{-1}, respectively. Currently there is no guideline standard limit for indoor air quality for residential building in Malaysia. TABLE 2 shows recommended standard and guidelines for indoor air quality for office building in three different countries. Compared to these guidelines or standards, the results indicated that the mean temperature, relative humidity and air velocity measured in each living room of each house were above the recommended range for acceptable indoor air quality level suggested by Singapore guidelines standard (1996).
The climate of Malaysia in the tropical region with hot and humid condition may affect the indoor climate of terrace houses (Md Zain et al., 2007). **FIG. 2** shows the indoor temperature and relative humidity profile in the selected terrace houses.

Indoor temperature was lower and relative humidity was higher for House 4 (FIG. 2 (d)) compared to other houses due to different weather during the measurement period. During rainy day, outdoor temperature decreases and relative humidity increases and similar pattern also are true for indoor climate in a naturally ventilated building (Ismail et al., 2010). In general, the indoor temperature profile increases slightly from morning to evening, while the trend is reversed for relative humidity.

Most of the natural ventilated terrace houses rely on the combination of cross-ventilation and mechanical ventilation by fan to reduce the extra heat going into a house and to achieve indoor thermal comfort. However, the findings of this study show that this ventilation strategy was difficult to achieve a good indoor climate in a terrace house type building. One of the ways the performance of indoor climate can be improved is by modifying the ventilation such as installing a solar chimney in the terrace houses (Nugroho, 2011).

**Indoor Air Quality**

The descriptive statistical data of CO, CO₂ and PM₁₀ obtained from four different terrace houses in Shah Alam are given in Table 3. Figure 2 shows carbon dioxide (CO₂) and carbon monoxide (CO) profile in selected terrace houses. The mean concentrations at four houses range from 0.1 – 0.3 ppm, 442.64 – 549.57 ppm and 94 – 124 µgm⁻³ for CO, CO₂ and PM₁₀, respectively. The maximum value of CO was measured at House 1 with 0.90 ppm, follow by House 3, House 2 and House 4 with value of 0.60, 0.55 and 0.45 ppm, respectively. The highest concentration of CO at House 1 is due to smoking activities by the resident.

The other potential CO indoor sources was the gas stove usage in the kitchen, which was observed during the sampling period. However, the measurement was conducted in a living room, therefore it can be suggested that the sources of CO may have come from the incomplete combustion process, vehicle exhaust fume from nearby road and parking space that infiltrated into the house through the open windows and doors. The windows

---

**TABLE 1-** Descriptive statistics of indoor climate parameters during the measurement period

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Mean ± SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature (°C)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>House 1</td>
<td>29.1 ± 0.83</td>
<td>27.5</td>
<td>30.5</td>
</tr>
<tr>
<td>House 2</td>
<td>30.6 ± 2.15</td>
<td>26.5</td>
<td>33.0</td>
</tr>
<tr>
<td>House 3</td>
<td>29.6 ± 0.62</td>
<td>28.4</td>
<td>30.7</td>
</tr>
<tr>
<td>House 4</td>
<td>27.2 ± 0.15</td>
<td>26.6</td>
<td>27.4</td>
</tr>
<tr>
<td>Overall</td>
<td>29.1 ± 1.42</td>
<td>26.5</td>
<td>33.0</td>
</tr>
<tr>
<td>Relative Humidity (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>House 1</td>
<td>70.0 ± 3.58</td>
<td>63.7</td>
<td>77.2</td>
</tr>
<tr>
<td>House 2</td>
<td>74.0 ± 4.28</td>
<td>68.4</td>
<td>86.1</td>
</tr>
<tr>
<td>House 3</td>
<td>67.1 ± 2.22</td>
<td>63.6</td>
<td>72.0</td>
</tr>
<tr>
<td>House 4</td>
<td>78.6 ± 1.88</td>
<td>76.4</td>
<td>84.4</td>
</tr>
<tr>
<td>Overall</td>
<td>72.4 ± 4.99</td>
<td>63.6</td>
<td>86.1</td>
</tr>
<tr>
<td>Air velocity (ms⁻¹)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>House 1</td>
<td>0.01 ± 0.01</td>
<td>0.00</td>
<td>0.03</td>
</tr>
<tr>
<td>House 2</td>
<td>0.01 ± 0.02</td>
<td>0.00</td>
<td>0.09</td>
</tr>
<tr>
<td>House 3</td>
<td>0.01 ± 0.01</td>
<td>0.00</td>
<td>0.03</td>
</tr>
<tr>
<td>House 4</td>
<td>0.01 ± 0.01</td>
<td>0.00</td>
<td>0.02</td>
</tr>
<tr>
<td>Overall</td>
<td>0.01 ± 0.01</td>
<td>0.00</td>
<td>0.09</td>
</tr>
</tbody>
</table>

Note: SD – Standard deviation

**TABLE 2-** Recommended indoor air quality standard and guideline

<table>
<thead>
<tr>
<th>Indoor air quality parameter</th>
<th>Malaysia¹</th>
<th>Singapore²</th>
<th>Hong Kong³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide, (ppm)</td>
<td>1000</td>
<td>1000</td>
<td>800 – 1000</td>
</tr>
<tr>
<td>Carbon monoxide, (ppm)</td>
<td>10</td>
<td>9</td>
<td>1.7 – 8.7</td>
</tr>
<tr>
<td>Respirable particulates (PM₁₀), (mgm⁻³)</td>
<td>0.15</td>
<td>0.15</td>
<td>0.02 – 0.18</td>
</tr>
<tr>
<td>Air Temperature, °C</td>
<td>-</td>
<td>22.5 – 25.5</td>
<td>-</td>
</tr>
<tr>
<td>Relative Humidity, %</td>
<td>-</td>
<td>70</td>
<td>-</td>
</tr>
<tr>
<td>Air velocity, m/s</td>
<td>-</td>
<td>0.25</td>
<td>-</td>
</tr>
</tbody>
</table>

¹ Department of Occupational Safety and Health, 2004
² Institute of Environmental Epidemiology, 1996
³ Government of the Hong Kong Special Administrative Region, 2003
of all terrace houses in this study were open during day time to provide fresh air and simultaneously bring the outdoor pollutants such as CO into the building. The presence of CO in the terrace houses building may be related to the external sources such as vehicular exhaust from the nearby road. The concentration of CO in the terrace houses did not exceed the maximum limit (10 ppm) recommended by DOSH (2005).

The recommended values for CO2 exposure was 1000 ppm for an 8-hour period as indicated by DOSH (2005), Singapore (1996) and Hong Kong (1996) for indoor air quality standards. The average concentration of CO2 for all terrace houses did not exceed the recommended standard level. The concentrations of CO2 were influenced by the number of occupants as the primary source of CO2 is the human respiration in terrace houses.

The maximum concentration of CO2 measured was in House 1 (701 ppm), while the minimum concentration of CO2 in House 2 (317 ppm). House 1 and House 4 were occupied by seven occupants compared to House 2 and House 3 with four and five occupants, respectively.

**TABLE 3**- Descriptive statistics of indoor air quality parameters during the measurement period

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Mean ± SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Carbon Monoxide (ppm)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>House 1</td>
<td>0.31 ± 0.24</td>
<td>0.00</td>
<td>0.90</td>
</tr>
<tr>
<td>House 2</td>
<td>0.24 ± 0.13</td>
<td>0.05</td>
<td>0.55</td>
</tr>
<tr>
<td>House 3</td>
<td>0.12 ± 0.21</td>
<td>0.00</td>
<td>0.60</td>
</tr>
<tr>
<td>House 4</td>
<td>0.25 ± 0.14</td>
<td>0.00</td>
<td>0.45</td>
</tr>
<tr>
<td>Average</td>
<td>0.23 ± 0.07</td>
<td>0.00</td>
<td>0.90</td>
</tr>
<tr>
<td><strong>Carbon Dioxide (ppm)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>House 1</td>
<td>539.64 ± 57.88</td>
<td>469.60</td>
<td>700.50</td>
</tr>
<tr>
<td>House 2</td>
<td>442.64 ± 60.79</td>
<td>317.00</td>
<td>549.50</td>
</tr>
<tr>
<td>House 3</td>
<td>493.25 ± 17.79</td>
<td>471.00</td>
<td>567.33</td>
</tr>
<tr>
<td>House 4</td>
<td>549.57 ± 19.63</td>
<td>504.50</td>
<td>581.50</td>
</tr>
<tr>
<td>Average</td>
<td>506.28 ± 49.02</td>
<td>317.00</td>
<td>700.50</td>
</tr>
<tr>
<td><strong>Particulate Matter (µgm⁻³)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>House 1</td>
<td>124.0 ± 16.26</td>
<td>106.0</td>
<td>137.0</td>
</tr>
<tr>
<td>House 2</td>
<td>94.0 ± 15.39</td>
<td>81.0</td>
<td>111.0</td>
</tr>
<tr>
<td>House 3</td>
<td>111.0 ± 9.87</td>
<td>100.0</td>
<td>118.0</td>
</tr>
<tr>
<td>House 4</td>
<td>104.0 ± 16.26</td>
<td>91.0</td>
<td>122.0</td>
</tr>
<tr>
<td>Average</td>
<td>108.3 ± 12.60</td>
<td>91.0</td>
<td>137.0</td>
</tr>
</tbody>
</table>

Note: SD – Standard deviation

**FIG. 2**- Indoor temperature and relative humidity (RH) profile in selected terrace houses
**FIG. 3**- Indoor carbon dioxide (CO$_2$) and carbon monoxide (CO) profile in selected terrace houses

**FIG. 4**- Mass concentration of indoor PM$_{10}$ in selected terrace houses
House 1 and House 4 have the same density of occupants, but CO₂ concentration at House 1 was higher than the House 4 due to the different volume size of living room. The volume size of living room at House 1 was 939.4 m³, smaller than living room at House 4 (1125.6 m³). The smaller room with poor ventilation facilitates the build-up of the level of CO₂ as compared to room with the same size but with good ventilation.

Figure 3 shows the concentrations of particulate indoor at selected terrace houses. The value fell within the range of 94 μgm⁻³ - 124 μgm⁻³ and was within the recommended value by DOSH (2005), Singapore (1996) and Hong Kong (1996) for indoor air quality standard. The highest mean concentration of PM₁₀ (124 μgm⁻³) was measured at House 1 while the lowest concentration (94 μgm⁻³) was at House 2. The highest mean value of House 1 was related to environmental tobacco smoke (ETS) due to the smoking activity by the occupants. Study has shown that each cigarette smoke on average added about 1.0 μg/m³ to indoor PM₁₀ mass concentration (Breyssse et al., 2005). Other factors which may contribute to mass concentration of indoor PM₁₀ were location of the house, ventilation system, number of occupants and their activity, and also the quality of ambient air (outdoor air).

Although the CO, CO₂, and mass concentration value varied from house to house, statistical analysis shows that there is no significant difference from each other.

Conclusion

The indoor climate including temperature, relative humidity and air velocity were identified as major problem affecting indoor air quality of terrace houses. The indoor climate parameters measured in living room of terrace house did not comply with the recommended values. The indoor 8-hours average of CO, CO₂ and PM₁₀ concentrations in the terrace houses were below the recommended indoor air quality standard. Factors which may have contributed to indoor air quality of the terrace houses in this study were location of the house, ventilation system, number of occupants and their activity, and also the quality of ambient air (outdoor air).

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References


The Association between Visceral Fat and Blood Pressure in Adults

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**ABSTRACT:** This cross-sectional study investigates the association between body composition measurements and blood pressure in Malay adults. A total of 296 adults, aged between 18 to 59 years, consisting of 122 males and 174 females underwent measurements of weight and height, waist and hip circumference, body fat and visceral fat, and blood pressure. Body fat and visceral measurements were carried out through bioelectric impedance, using a portable Tanita body fat analyser. Bivariate correlation analysis was used to study the association of each body composition measurement with blood pressure. There was significant association between Body Mass Index (BMI) ($r= 0.25$, $P<0.01$), waist circumference ($r= 0.27$, $P<0.01$), hip circumference ($r= 0.20$, $P<0.01$) and visceral fat ($r= 0.29$, $P<0.01$) with blood pressure, respectively. No significant relationship was found between waist hip ratio (WHR) and total body fat with blood pressure. The association between visceral fat and blood pressure is an interesting finding with regards to this community research setting. It is important to further study the affordability, accuracy and application of bioelectrical impedance technology in community research.

**Keywords:** Body composition, Body Mass Index, blood pressure, obesity, hypertension

**Introduction**

Malaysia has one of the highest prevalences of overweight and obesity in the Asian region (Ismail, 2002). As Malaysia is escalating towards a developed economy status, overweight and obesity cases in Malaysia are rising rapidly and have become the public health concern (Ismail, 2002). The impact of obesity on public health is reflected by the increasing prevalence of chronic diseases amongst Malaysians (Ismail et al., 2002). The effect of the population’s health status will be particularly severe if the sedentary lifestyle of its population continues (Ismail et al., 2002).

Cardiovascular diseases (CVD), cancer, and diabetes mellitus are examples of chronic diseases that are associated with overweight and obesity and which lead to mortality (Rueda-Clausen, Silva and Lopez-Jaramillo, 2008). It has been predicted that CVD will be responsible for 57% of all deaths globally by 2020 (WHO, 2006). China, the most populous country in the world, is also facing an epidemic of diabetes and obesity (Avendano and Mackenbach 2006; Yoon et al., 2006). There are now 40 million people with diabetes in China (Donnelly, Wang and Qu, 2006), where the total population is 1.3 billion.

In Malaysian adults, 20.7% were overweight and 5.8% obese (0.3% of whom had BMI values of $>40.0$ kg/m$^2$) and obesity was found to be more prevalent in women than men (Ismail et al., 2002). In women, obesity rates were higher in Indian and Malay women than in Chinese women, while Chinese men recorded the highest obesity prevalence followed by their Malay and Indian counterparts (Ismail et al., 2002). There are several risk factors contributing to overweight and obesity for both genders; it is significantly associated with older age, not being in a marriage-like relationship, low education, physical inactivity, and poor dietary intake (Brown and Siahpush, 2007).

Overweight and obese are accountable for numerous diseases. One of the consequences is elevated blood pressure (Pang et al., 2008) which is also known as hypertension. In 1996, the prevalence of high blood pressure (BP $>140/90$)
amongst Malaysian adults aged 30 years and above was estimated to be 29.9%, and since then hypertension has become a major public health issue in the region (National Health and Morbidity Survey 2, 1996).

It is important to identify non invasive measures that are closely associated with indicators of chronic disease risk factors such as blood pressure in community setting. Hence, the aim of this study was to investigate the associations between body measurements and blood pressure among adults living in Tawang, Bachok.

Materials and Method

Study design

This was a cross-sectional study conducted in a rural village in Tawang, Bachok. Field work was conducted from October until December 2008. A systematic random sampling method, using a house-tagging approach in the selected area, was used to obtain subjects. Sample size was calculated using PS Software Version 3.0 (Dupont and Plummer, 1998). The Universiti Sains Malaysia Human Research Ethics Committee approved this study (USMKK/PPP/JEPeM [205.4. (1.3)].

Subjects

All subjects were informed about the research design and signed a consent form according to the regulations of the Ethical Committee. The subjects were gathered at the meeting point, and all measurements were obtained on the same morning. For convenience, participants were recruited from the district of Tawang, Bachok. In this area, communities (villages) were randomly selected as sampling units. The inclusion and exclusion criteria are as following:

i) Inclusion Criteria
   a. Adults (Aged between 18 to 59 years old)
   b. Completed consent form
   c. No history of hypertension
   d. Malay proficient

ii) Exclusion criteria
   a. Females are currently pregnant or lactating below six months.
   b. Mental illness
   c. Presence of physical disability

Data collection

Subjects were interviewed using a standard questionnaire comprising of demographic characteristics and medical history. Age, sex, education, occupation and household income were items in the demographic section, whereas diagnosis and treatment of hypertension were items asked in the medical history section.

Body weight was measured using the Innerscan® TANITA body composition analyser model BC545 (Japan). These measurements were taken to the nearest 0.1 kilogram after subjects removed their shoes, wallet, and hat and were wearing light clothing. Body Mass Index (BMI) was calculated using the following formula: Weight (kg)/ [Height (m) X Height (m)] and classified according to the definition as follows (WHO, 1998):

- BMI less than 18.5 = underweight
- BMI between 18.5 to 24.9 = normal weight
- BMI between 25.0 to 29.9 = overweight
- BMI more than 30 = obese

Body height was measured using a stadiometer (SECA Bodymeter Model 208, Germany). The accuracy of this instrument is up to 0.05 centimeter. Percent body fat (%BF) and percent visceral fat (%VF) was determined using the Innerscan® TANITA body composition analyser model BC545 (Japan). This portable device is designed to measure total body fat and also visceral fat by the means of bioelectrical impedance.

A measuring tape was used to measure waist and hip circumference. Three waist circumference readings were taken midway between the inferior margin of the last rib and the iliac crest at the end of expiration (Wang and Beydoun, 2007). Three hip circumference readings were measured around the largest portion of the buttocks (Wang and Beydoun, 2007). The International Diabetes Federation (IDF, 2006) ethnic specific criterion for abdominal obesity is used to define abdominal obesity. According to IDF, abdominal obesity is defined as WC ≥ 90cm for men and ≥ 80cm for women. Waist hip ratio (WHR) is calculated using the following formula: Waist circumference (cm)/ hip circumference (cm) (Welborn, Dhaliwal and Bennett, 2003).

Blood pressure was measured after the subject had rested for at least 5 minutes, using an electric sphygmomanometer (Omron, SEM-1, Germany). The subject’s right arm was placed at heart level and three readings were taken. The mean of the three measurements was calculated. High blood pressure was defined as an average systolic blood pressure of ≥ 140mmHg, an average of diastolic blood pressure ≥ 90mmHg or both (JNC VI, 1997).
Statistical Analysis

Descriptive statistics, including mean and standard deviation (SD) for continuous variables and proportions for categorical variables were calculated. The dependent variable for this study was established blood pressure. Independent t-test was used for categorical data such as gender. Pearson’s correlation coefficient was used to determine the association of each body measurements and blood pressure. Data normality was tested using Kolmogorov-Smirnov test. All analyses were carried out by using Statistical Package for Social Science software for Windows (SPSS) version 12.0. Statistical significance was assigned at \( P < 0.05 \).

Results

Demographic Characteristics

Results of the demographic data of male and female subjects are presented in **TABLE 1**. A total of 306 subjects, aged between 18 to 70 years agreed to participate in this study. However, only 298 subjects completed all measurements and answered questionnaires. Around 85.1% of subjects (37.8% male, and 47.3% female subjects) were married. The majority of subjects (57.1%) had secondary education level (23.0% male subjects and 34.1% female subjects). Around 25.7% of male subjects were self-employed while 39.5% of female subjects were housewives. The mean age for males and females, respectively, was 49.82±11.74 and 48.58±11.67 years.

**TABLE 1**- Demographics characteristics of subjects (n=296)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Male (n =122)</th>
<th>Female (n =174)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Married</td>
<td>112</td>
<td>37.8</td>
</tr>
<tr>
<td>Divorced</td>
<td>1</td>
<td>0.3</td>
</tr>
<tr>
<td>Widowed</td>
<td>3</td>
<td>1.0</td>
</tr>
<tr>
<td>Highest education level</td>
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<td></td>
</tr>
<tr>
<td>Unschooled</td>
<td>6</td>
<td>2.0</td>
</tr>
<tr>
<td>Primary</td>
<td>32</td>
<td>10.8</td>
</tr>
<tr>
<td>Secondary</td>
<td>68</td>
<td>23.0</td>
</tr>
<tr>
<td>Tertiary</td>
<td>16</td>
<td>5.4</td>
</tr>
<tr>
<td>Job title</td>
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<td></td>
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<tr>
<td>Government</td>
<td>20</td>
<td>6.8</td>
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<tr>
<td>Self-employed</td>
<td>76</td>
<td>25.7</td>
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<tr>
<td>Unemployed</td>
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<td>3.7</td>
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<td>Private</td>
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<td>5.1</td>
</tr>
<tr>
<td>Housewife</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Anthropometry and Blood Pressure

Results on anthropometry measurements and blood pressure are shown in **TABLE 2**. Men were significantly taller and heavier than women. Male subjects had significantly higher waist circumferences, higher visceral fat and greater waist hip ratio (WHR) compared to females. On the other hand, women had significantly greater mean hip circumference, body fat, and BMI. The mean values of systolic blood pressure and diastolic blood pressure in males and females were identical.

**TABLE 2**- Anthropometry and clinical characteristics of the subjects (n=299)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Male (n =124)</th>
<th>Female (n =175)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Age(years)</td>
<td>49.82</td>
<td>11.74</td>
<td>48.58</td>
</tr>
<tr>
<td>Anthropometric</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height(m)</td>
<td>1.64</td>
<td>0.06</td>
<td>1.53</td>
</tr>
<tr>
<td>Weight(kg)</td>
<td>66.32</td>
<td>11.42</td>
<td>61.38</td>
</tr>
<tr>
<td>Waist circumference(cm)</td>
<td>86.26</td>
<td>10.32</td>
<td>82.28</td>
</tr>
<tr>
<td>Hip circumference(cm)</td>
<td>93.70</td>
<td>7.05</td>
<td>98.01</td>
</tr>
<tr>
<td>WHR</td>
<td>0.92</td>
<td>0.08</td>
<td>0.84</td>
</tr>
<tr>
<td>BMI(Kg/m²)</td>
<td>24.51</td>
<td>3.58</td>
<td>26.27</td>
</tr>
<tr>
<td>Body fat(%)</td>
<td>20.79</td>
<td>5.92</td>
<td>36.53</td>
</tr>
<tr>
<td>Visceral fat(%)</td>
<td>11.19</td>
<td>4.69</td>
<td>7.57</td>
</tr>
<tr>
<td>Blood Pressure (mmHg)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systolic</td>
<td>135.86</td>
<td>21.84</td>
<td>134.53</td>
</tr>
<tr>
<td>Diastolic</td>
<td>79.19</td>
<td>11.05</td>
<td>79.21</td>
</tr>
</tbody>
</table>
BMI Categories

TABLE 3 shows the number of overweight and obese subjects. More than half of the respondents were overweight and obese (54.9%). Around 25.6% of female subjects were overweight while 10.4% were obese. Male subjects showed a lower prevalence; 16.2% were overweight and 2.7% were obese respectively. In this sub-population, generally more females have excess weight problem compared to male subjects.

<table>
<thead>
<tr>
<th>Nutrition status</th>
<th>Gender</th>
<th>Male (n=123)</th>
<th>Female (n=174)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>N (%)</td>
<td>N (%)</td>
</tr>
<tr>
<td>Underweight</td>
<td></td>
<td>4(3.3)</td>
<td>7(4.0)</td>
</tr>
<tr>
<td>Normal weight</td>
<td></td>
<td>63(51.2)</td>
<td>60(34.5)</td>
</tr>
<tr>
<td>Overweight</td>
<td></td>
<td>48(39.0)</td>
<td>76(43.7)</td>
</tr>
<tr>
<td>Obesity</td>
<td></td>
<td>8(6.5)</td>
<td>3(1.8)</td>
</tr>
</tbody>
</table>

Waist Hip Ratio of Males and Females

The prevalence of abdominal obesity is presented in TABLE 4. In total, WHR >0.9 for male and WHR>0.85 for female were 25.7% and 26.3%, respectively. Results on sex gender is significantly associated with WHR (P<0.001) as more females have abdominal obesity compared to male subjects.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Male (n=125)</th>
<th>Female (n=175)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>48 (16.0)</td>
<td>96 (32.0)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Over</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male (&gt;0.9)</td>
<td>77 (25.7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female (&gt;0.85)</td>
<td>79 (26.3)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Correlation between BP and Anthropometric Indicators

TABLE 5 shows the association of blood pressure and anthropometric indicators. Waist circumference, hip circumference, WHR, BMI, total body fat, and visceral fat were correlated with higher systolic blood pressure. However, only visceral fat and WHR showed a significant association. On the contrary, diastolic blood pressure showed a positive and significant correlation with all anthropometric indicators.

<table>
<thead>
<tr>
<th>Anthropometric variables</th>
<th>SBP (r)</th>
<th>DBP (r)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waist circumference (cm)</td>
<td>0.109</td>
<td>0.266**</td>
</tr>
<tr>
<td>Hip circumference (cm)</td>
<td>0.043</td>
<td>0.199**</td>
</tr>
<tr>
<td>WHR</td>
<td>0.154**</td>
<td>0.189**</td>
</tr>
<tr>
<td>BMI (kg/m2)</td>
<td>0.114</td>
<td>0.250**</td>
</tr>
<tr>
<td>Body fat (%)</td>
<td>0.065</td>
<td>0.197**</td>
</tr>
<tr>
<td>Visceral fat (%)</td>
<td>0.221**</td>
<td>0.293**</td>
</tr>
</tbody>
</table>

**Correlation is significant at the 0.01 level (2-tailed)

Discussions

A number of cross-sectional studies have investigated the relationship between CVD risk factors according to multiple measures of adiposity (Wildman et al. 2005; Zhu et al., 2005). However, it is yet to be determined as to which anthropometric measurements are strongly associated with blood pressure in adults, particularly Asians (Wildman et al., 2005). In Western populations, most studies have demonstrated that central obesity is more closely associated with cardiovascular risks than general obesity (Janssen et al., 2004; Pi-Sunyer, 2000). In contrast, results in the Asian population are still inconsistent (Kawada 2002).
**The Association between Body Mass Index and Blood Pressure in Adults**

This study indicates that general obesity and BMI are associated with diastolic blood pressure among adults in Tawang. Consistent with other studies, this analysis shows that being overweight or obese is an important predictor of elevated BP. In the Framingham Study, it was found that a 10% rise in body weight explains a 7 mmHg rise in SBP in the population at large (Pang et al., 2008). It has also been found that every kilogram excess body weight that is lost is associated with decreases of 0.33 and 0.43 mmHg in SBP and DBP, respectively (Stevens, Corrigan and Obarzanek, 1993).

Results in our study also implied that there is significant sexual dimorphism in regional adiposity and blood pressure, irrespective of the level of overall adiposity (BMI). Indech et al. (1991) had also found significant sex differences in regional adiposity among young (18–29 years) Punjabi adults of Chandigarh, North India.

**The Association between Body Fat Composition and Blood Pressure in Adults**

Percentage of body fat is the percentage of total body weight that is fat (Tanita, 2000). This device can also measure visceral fat percentage based on the algorithm set by the manufacturer. This is an important feature as both general fat and visceral fat plays unique role in relation to chronic disease development.

In this study, the Pearson’s correlation shows there is a weak correlation between percentages of body fat with systolic blood pressure. However, a significant association was found between percentage body fat and diastolic blood pressure. Women have more body fat than men. By nature, a woman’s body is developed to protect a potential fetus. As a result, women have more enzymes for storing fat and fewer enzymes for burning fat. Additionally, women have higher levels of estrogen, which activates fat storing enzymes. Estrogen in women activates fat storing enzymes and causes them to multiply (Tanita, 2000). People who got fatter faster also tended to experience of a more rapid rise in blood pressure (Siervogel, 1998). Those with a slower change in body fat tend to have a gradual increase in blood pressure (Siervogel, 1998). Particularly in women, long-term increases in body fat are associated with increases in blood pressure (Siervogel, 1998).

Interestingly, the findings of this study demonstrate a significant correlation between visceral fat and systolic and diastolic blood pressure. This is an important finding as most anthropometric measurements are focusing on measuring subcutaneous fat only. A similar finding was obtained using an ultrasonography technique which is a more sophisticated and expensive method compared to bioelectrical impedance (Faria et al., 2002). Visceral fat may play a more detrimental role in affecting blood flow within the internal organs such as liver and heart. Rattarasarn et al. (2003) also found that visceral abdominal fat was correlated with systolic and diastolic blood pressure. Higher odds of hypertension were found in people with both abdominal and truncal obesity compared with persons with either abdominal or truncal obesity (Okosun et al., 2006). A higher amount of visceral fat may show a higher risk of hypertension in older adults especially in lean individuals (Ding et al., 2004)

**The Association between Waist Hip Ratio and Blood Pressure in Adults**

WHR was not found to be associated with blood pressure in the study group for both sexes. However, in this study, waist circumference only showed a significant correlation with diastolic blood pressure. According to Taylor et al. (2000) the WC can express abdominal fat accumulation better than the WHR does. This result may be because the hip may reflect changes in bones and muscles more than changes in fat (Al Sendi, 2003). Among obese adolescents, WC serves as a good index of central (abdominal) obesity (Al Sendi, 2003). In adults, among anthropometric indicators of body fat distribution, WC showed the strongest correlation with SBP (Pouliot, Despres, and Lemieux, 1994). This is particularly important in epidemiological studies, given the ease with which this measurement can be obtained. Whereas, the result indicates that the measurement of waist-to-hip ratio provides no advantage over waist circumference alone.

Previously, there is controversy about the best measure in the assessment of abdominal obesity (Hirani, Zaninotto and Primastega, 1998). In this study it was revealed that WC is the best measure in the assessment of abdominal obesity rather than WHR. On the other hand, the use of WHR has been criticized as an indicator of abdominal fat. WC is meant to measure predominantly visceral organs and abdominal fat, both subcutaneous and intra-abdominal, while hip circumference may reflect different aspects of body composition, that is, muscle mass, fat mass and skeletal frame (Mollarius and Seidell, 1998). When these two circumferences are combined in a ratio, it is difficult to interpret differences in the ratio between and within individuals. For example, a reduction in weight usually results in a reduction in both waist and hip circumferences and this will not necessarily
result in a change in WHR (Caan et al., 1994).

People who are android-shaped, also known as apple-shaped, are more vulnerable to disease than those who are gynoid- or pear-shaped (Tanita, 2000). Premenopausal women typically have a lower body adipose distribution (gynoid) characterized by fat deposition in the gluteofemoral region (Tanita, 2000). In this study, the hip circumference among females was higher than males. On the other hand, waist circumference of males is higher in females. In men, an upper body adipose distribution (android) develops, which is characterized by central fat deposition in the abdominal intraperitoneal and subcutaneous regions (Thomas, 2004). The recognition of central obesity that, assessed by WC in the present study as important factor associated with increased risk of developing elevated BP. As in adolescents, the mechanism by which central fat deposition influences BP appears through changes in insulin sensitivity and its compensatory hyperinsulinaemia. Increased insulin secretion has been shown to be present in adolescent obesity and is related to the amount of intra-abdominal fat (Caprio and Tamborlane, 1999). Excessive insulin secretion leads to sodium and water retention and stimulation of sympathetic activity, which may in turn lead to hypertension (Al Sendi, 2003).

The TANITA body-composition analyser is an automated device used to estimate body fat, based on the principles of bioelectrical impedance (Jebb et al., 2000). The bioelectrical impedance technique has better reproducibility than skinfolds, which makes it more suitable for large studies with multiple measurers. It has proven reliability in interlaboratory comparisons (Deurenberg, Westerterp and Velhuis-Te Wierk, 1994). The procedure has become simpler and faster with the development of analysers that only require the subject to stand bare-footed on metal plates that contain the electrodes (Jebb et al., 2000).

A few limitations in this study must be taken into account in the interpretation of the results. Firstly, as a cross sectional study, directionality of the associations between blood pressure measurements and anthropometric measurements cannot be clearly established. Secondly, the study population was relatively small and predominantly females, which limits the generalizability of the findings.

Conclusion

This study has shown that BMI, WC, hip circumference and visceral fat are anthropometric measurements that are strongly associated with BP. BMI is by far the most widely used measurement to reflect general obesity, while WHR, WC and abdominal sagittal diameters are used as indices of central obesity. The first three measures are commonly used in field research related to obesity but, interestingly, visceral fat which is also an important measure is often overlooked by most researchers. Perhaps, this is due to the higher cost of the device used to measure visceral fat. However, with the enhancement of research and development in science and technology, the price of bioelectrical impedance devices is expected to decrease. Furthermore, the size and portability of these devices may favor researchers involved in community nutrition research where most field work is conducted in remote places. However, more conclusive research needs to be conducted to assess the reliability and validity of bioelectrical impedance devices in providing accurate results in community-based studies.

Acknowledgements

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References


Metabolic Syndrome and Occupational Risk Factors among Healthcare Workers in Kelantan

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**ABSTRACT:** Occupational factors such as stress and shift work are found to be risk factors for Coronary Heart Disease (CHD). Several studies have documented increase risk of CHD among individuals with metabolic syndrome. This study was designed to determine the prevalence of metabolic syndrome using the definition by the Third Report of the National Cholesterol Education Program Adult Treatment Panel (NCEP ATP III) and to describe the characteristics of nurses with metabolic syndrome including work related factors. A cross-sectional study was conducted between January to April 2009 among 404 nurses in Hospital Universiti Sains Malaysia (HUSM), Kelantan, Malaysia. All the respondents were female nurses aged 30–56 years. Data was collected using a questionnaire consists of sociodemographic, occupational history and physical activity as well as DASS 42 questions (translated to Malay language and validated). Waist circumference, blood pressure measurement and fasting venous blood for lipid profile and fasting blood sugar were taken from each subject. Data entry and analysis were done using SPSS Version 12.0.1. The prevalence of metabolic syndrome was determined, and factors associated with the metabolic syndrome were analyzed by multiple logistic regression. Majority of the respondents were Malay with mean (SD) age of 42.1 (7.19) years old. The mean (SD) duration of employment was 17.8 (6.33) years. Majority (91.1%) of nurses was physically inactive and 14.1% were having stress. The prevalence of metabolic syndrome was 24.3% (95%CI: 20.1, 28.4). The significant factors associated with metabolic syndrome after statistical adjustments for the confounding factors were total duration of employment (years) and one way commuting time to work (minutes). High prevalence of metabolic syndrome indicates that nurses are occupational risk group for CHD. Further multicentres cross sectional studies or better, a cohort study are needed to plan for an effective intervention programme.

**Keywords:** Metabolic syndrome, nurses, shift work, occupational

**Introduction**

This study aims to find potential association between work factors and having a metabolic syndrome. This is because lately there is a move to cluster the risk factors of coronary heart disease to a syndrome known as metabolic syndrome. The syndrome was previously known as syndrome X or insulin resistance syndrome (IDF, 2005; NCEP, 2005). Metabolic syndrome is a medical disorder that increases the risk of CHD and Type-2 diabetes (Tarani \textit{et al.}, 2006). The risk for coronary heart disease events accompanying the metabolic syndrome is approximately doubled compared with an absence of the syndrome, the relative risk was 1.78 and in women the risk was higher (RR 2.63) (Scott, 2008). Work factors possibly related to metabolic syndrome were stress at work, shift work, duration of employment and commuting time to work.

**Methodology**

This study is a cross sectional study conducted among female nurses working in a teaching hospital, Universiti Sains Malaysia Hospital, (HUSM) Kelantan. Study settings were all hospital units, including wards, clinics and other diagnostic or rehabilitation units. This study was done from January to April 2009. From the 901 eligible female nurses, 477 have fulfilled the inclusion and exclusion criteria. Since our study needs a sample size of 434 respondents, no sampling method was applied as all of them were included in the study.

**Operational definition**

\textit{A. Metabolic syndrome}

A respondent was defined as having metabolic syndrome when there is a presence of three or more of the five criteria based on the ATP III criteria (NCEP, 2005).
a. Central obesity (waist circumference greater than 80 cm (35 inches for Asian women).
b. High blood pressure: ≥ 130/85 mm Hg.
c. Raised fasting blood sugar ≥ 100 mg/dL (5.6 mmol/L) or previously diagnosed type 2 diabetes.
d. Elevated triglycerides ≥ 150 mg/dL (1.7 mmol/L).
e. Reduced high-density lipoprotein (HDL) cholesterol: < 50 mg/dL (1.29 mmol/L) in women.

B. Stress
The prevalence of stress was measured by DASS 42 questionnaire. The questionnaire has been translated to Malay language and validated (Edimansyah et al., 2005). Raw scores for the DASS stress scale were summed and converted into z scores. Based on the z scores, nurses scored less than 0.5 are considered normal; 0.5 to 1.0, mild stress; 1.0 to 2.0, moderate stress; 2.0-3.0, severe stress; and more than 3.0, extremely severe stress (Lovibond and Lovibond, 2002). This study used only the stress score and respondent was defined as having stress when they fall in any of the 4 categories, i.e. from mild to extremely severe.

C. Shift Work
In this study, shift work is defined as working in an eight hour rotating shift schedule. Work schedule commonly practised by the working population of hospital nurses is an eight hour rotating shift and currently in HUSM Kubang Kerian, it is a fast forward rotating shift of two days morning shift, followed by two days evening shift and two days night shift. Then they will have two days off.

D. Total duration of employment
Total duration of employment was the total years of employment as a nurse including either in current setting or in other previous hospitals or health clinics.

E. One way commuting time
To get the duration of one way commuting time, respondents were asked to give the average or common duration usually taken by them either to work or from home to work. Not to consider days with traffic congestion or other events that will delay them to work.

Lifestyle factors
Self-reported smoking frequency and physical exercise were estimated from the questionnaire. In this study, any respondent answering “yes” to either current or former smoking was considered as a smoker and answering “no” to those questions was considered as a non smoker. A respondent was considered to be physically inactive when she answered “no” to the question “Do you exercise or have any physical activity?”, or when she answered “yes” but the amount of exercise was less than 30 minutes per session and less than 3 days in a week (MOH, 2004b; MOH, 2004a).

Anthropometric measurements
The anthropometric examinations were done following the WHO Standard Physical Examination (WHO, 1995). Body weight was measured in light working clothing, with shoes off and recorded to the nearest 0.5 kg, using a calibrated Seca 761 weighing scale. Height was measured to the nearest 0.1 cm without shoes, using a portable mechanical Seca 208 bodymeter. The scale was attached to a wall using a double sided tape. Waist circumference measurement was done by a trained female research assistant following the WHO recommended methods (MOH, 2004a), and measurements were taken to the nearest 0.1 cm.

Cardiovascular risk factors
Systolic and diastolic blood pressures were measured three times on the day of interview using an adult cuff with size 88*14 cm and a standard mercury sphygmomanometer and a stethoscope. The method of measurement follows a standardized protocol (WHO) STEPS Surveillance. Blood pressure was measured using participant’s right and left arms in the sitting position after a five min rest (Karlsson et al., 2003). Three measurements were taken, and the highest reading was taken as the recorded systemic blood pressure (MOH, 2008).

A 10 hours overnight- fasting (MOH, 2004b) venous blood was taken from antecubital vein amounting to 6 ml. Four ml blood for Fasting Lipid Profile was collected in a plain vacutainer with clot activator (BD Vacutainer) and the remaining 2 ml blood for Fasting Blood Sugar was collected in a vacutainer with Potassium Oxalate 4 mg and Sodium Fluoride 5 mg. Storage and transportation of samples were maintained at temperature between 4°C to 25°C and those samples were sent to laboratory on the same day of blood sampling. Blood for Fasting Lipid Profile and Fasting Blood Sugar were analyzed at a private, certified laboratory.

Statistical analysis
Statistical analyses were conducted using the statistical software, SPSS Version 12.0.1 (SPSS Inc, 2003). Continuous variables which are component of metabolic syndrome such as waist circumference, blood pressure, fasting glucose level, triglyceride level and HDL cholesterol level were converted.
into categorical variables according to the cut off point from the NCEP ATP III criteria.

Multiple logistic regression analysis was performed to examine the determinants of the metabolic syndrome among demographic, lifestyle factors, and occupational factors. Covariates included age, ethnic, number of children, marital status, education level, income (RM), physical exercise, family history of CHD, current OCP use, total duration of employment (years), one way commuting time (minutes), type of work and stress. The adjusted odds ratio was estimated with 95% confidence interval (CI). Findings were presented with crude and adjusted OR, 95% CI and p value. The level of significant for all analysis was set at 5% (α= 0.05, two tailed).

Results

The mean (SD) age was 42.2 (7.19) years. Majority of respondents were Malay women and were married. The mean (SD) number of children was 3.6 (1.70). **TABLE 1** shows the sociodemographic characteristics of the respondents.

The mean (SD) total duration of employment was 17.8 (6.33) years, and ranged from 2.0 to 33.0 years in which 177 (43.8%) of them doing day work. The mean (SD) one way commuting time to work was 20.8 (11.38), and ranged from 5 to 60 minutes. All of the respondents were non-smoker, majority were physically inactive, only 14.4% were currently on OCP and 28.2% with family history of CHD.

**Prevalence of the metabolic syndrome**

The prevalence of metabolic syndrome among nurses working in HUSM was 24.3% (95%CI: 20.0, 28.4). Sociodemographic variable that was significantly associated with metabolic syndrome was age. The mean (SD) aged of workers with metabolic syndrome was higher, 44.6 (SD 6.27) years compared to non-metabolic syndrome. Other variables were not significant.

Occupational characteristic significantly associated with metabolic syndrome was total duration of employment and one way commuting time was marginally significant. Participants with metabolic syndrome had a longer mean (SD) duration of employment of 18.3 (6.18) compared to non-metabolic syndrome.

Multiple logistic regression analysis was used to identify the independent associated factors for metabolic syndrome. Sociodemographic variables were included in the analysis as possible confounders. The independent variables that were statistically significant as predictors towards the metabolic syndrome were total duration of employment (years) and one way commuting time (minutes). There were no significant interaction terms and multicolinearity problems noted in the preliminary final model.

**TABLE 1** Sociodemographic characteristics of the respondents (n= 404)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Frequency (%)</th>
<th>Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>42.2 (7.19)</td>
<td></td>
</tr>
<tr>
<td>Number of children</td>
<td>3.6 (1.70)</td>
<td></td>
</tr>
<tr>
<td>Income per month (RM)</td>
<td>2879.1 (585.73)</td>
<td></td>
</tr>
<tr>
<td>Ethnic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malay</td>
<td>379 (93.8)</td>
<td></td>
</tr>
<tr>
<td>Chinese</td>
<td>21 (5.2)</td>
<td></td>
</tr>
<tr>
<td>Indian</td>
<td>2 (0.5)</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>2 (0.5)</td>
<td></td>
</tr>
<tr>
<td>Nursing Education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Certificate in Nursing</td>
<td>127 (31.4)</td>
<td></td>
</tr>
<tr>
<td>Diploma in Nursing</td>
<td>248 (61.4)</td>
<td></td>
</tr>
<tr>
<td>Degree</td>
<td>29 (7.2)</td>
<td></td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>13 (3.2)</td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>376 (93.1)</td>
<td></td>
</tr>
<tr>
<td>Divorced</td>
<td>2 (0.5)</td>
<td></td>
</tr>
<tr>
<td>Widowed</td>
<td>13 (3.2)</td>
<td></td>
</tr>
</tbody>
</table>

Note: SD- standard deviation
TABLE 2- Simple logistic regression analysis to determine factors associated with metabolic syndrome

<table>
<thead>
<tr>
<th>Factors</th>
<th>Crude OR</th>
<th>95% CI for Exp(B)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lower</td>
<td>Upper</td>
</tr>
<tr>
<td>Age</td>
<td>1.07</td>
<td>1.03</td>
<td>1.10</td>
</tr>
<tr>
<td>No. of children</td>
<td>1.12</td>
<td>0.98</td>
<td>1.27</td>
</tr>
<tr>
<td>Income (RM)</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Ethnic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melayu</td>
<td>1.30</td>
<td>0.48</td>
<td>3.56</td>
</tr>
<tr>
<td>Nursing Education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Certificate or Diploma</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Degree</td>
<td>0.99</td>
<td>0.41</td>
<td>2.40</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unmarried</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>2.82</td>
<td>0.83</td>
<td>9.54</td>
</tr>
<tr>
<td>Total duration of employment (years)</td>
<td>1.08</td>
<td>1.04</td>
<td>1.12</td>
</tr>
<tr>
<td>One way commuting time (min.)</td>
<td>1.02</td>
<td>1.00</td>
<td>1.04</td>
</tr>
<tr>
<td>Duration of job experience (years)</td>
<td>1.01</td>
<td>0.97</td>
<td>1.04</td>
</tr>
<tr>
<td>Type of work</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day work</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shift work</td>
<td>.68</td>
<td>0.43</td>
<td>1.08</td>
</tr>
<tr>
<td>Family history of CHD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1.22</td>
<td>0.75</td>
<td>2.01</td>
</tr>
<tr>
<td>OCP</td>
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<td></td>
</tr>
<tr>
<td>No</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>0.89</td>
<td>0.46</td>
<td>1.72</td>
</tr>
<tr>
<td>Physically inactive</td>
<td></td>
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<tr>
<td>No</td>
<td>1</td>
<td></td>
<td></td>
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<tr>
<td>Yes</td>
<td>0.78</td>
<td>0.36</td>
<td>1.69</td>
</tr>
<tr>
<td>Stress</td>
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<td>No</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1.17</td>
<td>0.62</td>
<td>2.22</td>
</tr>
</tbody>
</table>

*OR = Odds Ratio based on Exp. Beta, 
*CI = Confidence Interval, 
*p value of Wald test

TABLE 3- Associated factors for metabolic syndrome by multiple logistic regressions

<table>
<thead>
<tr>
<th>Variables</th>
<th>Adjusted OR</th>
<th>95% CI for Exp(B)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lower</td>
<td>Upper</td>
</tr>
<tr>
<td>Total duration of employment (years)</td>
<td>1.08</td>
<td>1.04</td>
<td>1.12</td>
</tr>
<tr>
<td>One way commuting time (min.)</td>
<td>1.02</td>
<td>1.00</td>
<td>1.04</td>
</tr>
</tbody>
</table>

*OR = Odds Ratio, 
*CI = Confidence Interval, 
p value of Wald test (Multiple logistic regression) 
Hosmer and Lemeshow Test P-Value = 0.157 
Receiver Operating Characteristics (ROC) curve = 0.662 
No outlier by Cook’s test and Leverage value

Discussion
This study documented a high prevalence of metabolic syndrome among nurses working in a teaching hospital. This was higher than the prevalence of metabolic syndrome among municipal workers in Turkey which was 17.8% (Demiral et al., 2006). This result was also higher compared to the prevalence of metabolic syndrome among the general population in Malaysia which was 16.5% (Tan et al., 2008). We also noted that the prevalence of metabolic syndrome in this study was higher than findings among female population in Thailand and Singapore which was 11.7% and 12.3%, respectively (Scott, 2008). All prevalences from studies mentioned above used the NCEP ATP III criteria for the definition of metabolic syndrome.

Occupational factors associated with metabolic syndrome

The factors which significantly associated with metabolic syndrome in this study were total duration of employment and one way commuting time to work (minutes). One way commuting time to work was included in this study as an event that could explain sedentary lifestyle or lead to physical inactivity due to no extra time after work for one to engage in recreational activity or exercise. In the multivariable analysis, one way commuting time to
work was one of the independent variables that can predict the outcome of metabolic syndrome with OR 1.02 (95%CI: 1.00-1.04). We found that, workers taking a longer travelling time of 10 minutes to work compared to others, were 20% more likely to have metabolic syndrome.

Another occupational factor which significantly associates with metabolic syndrome in this study was total duration of employment. In the multivariable analysis, total duration of employment can predict the outcome of metabolic syndrome with OR 1.08 (95%CI: 1.04-1.12). This mean that those workers who worked 10 years more compared to others, were two times more likely to have metabolic syndrome. Our finding was similar to a study in Turkey which found metabolic syndrome was significantly higher among workers who had been working for more than 10 years (p= 0.009) (Demiral et al., 2006).

Other occupational factors such as duration of current job experience and stress were not associated with metabolic syndrome in our study. In this study, stress was neither associated with shift working (p= 0.468) nor with metabolic syndrome (p= 0.890). This finding is in agreement with a study among workers in Turkey which reported no significant association between job strain and metabolic syndrome (OR 1.5, 95%CI: 0.9, 2.5) (Demiral et al., 2006). Our finding, however contradicted to the result of a cohort study in London which reported a double risk of metabolic syndrome among workers with chronic work stress compared to those without work stress (Tarani et al., 2006).

Our study design limits the ability to draw a true causal-effect relationship because the exposures and outcome were measures simultaneously. Thus these study findings were inferior to the findings from prospective cohort studies (Bacquer, 2009;Tarani et al., 2006). Nevertheless, our study design was similar to other studies (Ghiasvand et al., 2006;Demiral et al., 2006;Karlsson et al., 2003). Other limitations include generalization of the findings. Our result is limited to nurses in the teaching hospital in HUSM, Kelantan. However, our findings may be relevant to other similar population such as among nurses in Hospital Selayang, Selangor which showed similar characteristics (Fauziah et al., 2006) or other government hospitals in Malaysia. Our study was also subjected to recall bias. Personal information, occupational, medical and recreational histories were based on self-reports questionnaire. Validation of self reported condition would be better with observation or cross reference. This bias however was minimized by giving the participants enough time (one week) to answer those questions.

Conclusion

High prevalence of metabolic syndrome among nurses working in a teaching hospital in Kelantan indicates that they are occupational risk group for metabolic syndrome. There is significant relationship observed in this study between metabolic syndrome and occupational factors such as total duration of employment (years) and one way commuting time to work (minutes). This study finding shows that occupational factors play an important role in the development of metabolic syndrome. Since duration of employment and commuting time to work are non-modifiable factors, prevention and control strategies at the work place are needed to change the unhealthy lifestyle especially lack of physical activity hence to reduce obesity. Further multicentres cross sectional studies or better, a cohort study are needed to determine other possible factors associated with metabolic syndrome in our country and will be a base for an effective intervention program.

Acknowledgements

Special thanks to Dr. Mohd. Nazri Shafei and Dr. Wan Mohd Zahiruddin Wan Mohamad, and staff of Department of Community Medicine who involved in the research either directly or indirectly. The authors also thank all respondents of the study who provided their valuable responses in this study and to the director of HUSM, head of nursing, matrons, sisters and other staff nurses for their assistance and cooperation. This study would not be possible without fund from the USM short-term research grant (304/PPSP/6139001).

References

Risk Factors for Breast Cancer among Women in Klang Valley, Malaysia

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ABSTRACT: There has been an explosion in the incidence of breast cancer throughout the world. A case-control study was done to identify the lifestyle risk factors for breast cancer among women in Klang Valley. This study was carried out among 70 newly diagnosed breast cancer patients and 138 controls, aged 29-65 years old in Klang Valley. The inclusion criteria for cases were (i) newly diagnosed breast cancer (stage I to III) (ii) not undergone any therapy for cancer (iii) no other chronic diseases such as hypertension and diabetic (iv) not pregnant and lactating (v) not in menstruation for those who are not menopause yet. The control group comprised women, who were healthy, not diagnosed with cancer and other chronic disease, not pregnant, not lactating and not menstruating. Demographic data were obtained through standardized pre-tested questionnaire by trained interviewers. Smoking, alcohol consumption, family history, age at menarche, usage of oral contraceptive pill and hormone-replacement therapy, breast-feeding, chi-square test did not show any significant differences between cases and control. Women who got her first pregnancy at the age of more than 30 years old were at five time higher risk of getting breast cancer [adjusted OR=4.5 (95% CI=1.8-11.1)] (p<0.05) compared to those who got her first pregnancy at the age less than 30 years old. In conclusion, certain lifestyle factors were associated with risk of getting breast cancer. Effort should be taken to increase awareness and understanding of the importance of healthy lifestyle to prevent breast cancer occurrence.

Keywords: Risk factor, breast cancer, women

Introduction

Breast cancer was the commonest cancer among Malaysian women (Yip \textit{et al.}, 2006) with increasing incidence of breast cancer among women. For instances, a total of 3738 female breast cancer cases were reported in 2003 and accounted for 31.0\% of all cancers (Lim and Halimah, 2004). Breast cancer was a cancer of the affluent countries, and the incidence rate increases with industrialization and economic development (Yip \textit{et al.}, 2006).

A growing body of epidemiologic literature has investigated the association of behavioral and lifestyle variables and breast cancer incidence (Lemon \textit{et al.}, 2004). Lifestyle-related and reproductive factors were strongly associated with breast cancer (Norsa’adah \textit{et al.}, 2005). Therefore it was prudent to know the risk factors in breast cancer in order that appropriated screening and prevention measures can be carried out for every individual (Rozanim \textit{et al.}, 2006).

A cohort study demonstrated that Japanese women who had consumed at least a moderate amount of alcohol had an increased risk of breast cancer (Lin \textit{et al.}, 2005). Family history of breast cancer was an established risk factor for breast cancer (Silvera \textit{et al.}, 2005). Family history, however, probably represents more than major gene effects (Carpenter \textit{et al.}, 2003). Multiparity, young age at first child and breast-feeding are associated with a reduced risk of breast cancer in the general population (Andrieu \textit{et al.}, 2006). An early age at first full-term birth is associated with a reduction in the subsequent development of breast cancer among women in the general population (Kotsopoulos \textit{et al.}, 2007). Studies suggest that the use of oral contraceptive (OCP) in women with a strong
family history of breast cancer may further elevate their breast cancer risk (Gabrick et al., 2000).

Observational studies and randomized trials have demonstrated that hormones replacement therapy (HRT) increases the recipient’s risk of developing breast carcinoma (Chen et al., 2004). Rozanim et al. (2006) reported that hormone-replacement therapy (HRT) was not significantly associated with breast cancer risk. HRT was associated with beneficial total cholesterol, low density lipoprotein (LDL-C) and high density lipoprotein (HDL-C) levels in sedentary and active nonathlete women (Hagberg et al. 2003). Lactation reduced the risk of breast cancer (Freund et al., 2000). Study has shown that lactation yielded an odds ratio of [3.07 (95% CI 1.60 to 5.93)] when adjusted with age (Hejar et al. 2004).

Although above mentioned factors have been a well-studied topic worldwide, there are still minimal information and awareness on breast cancer in Malaysia. This case-control study was done to identify the lifestyle risk factors for breast cancer in women in Klang Valley, Malaysia.

Materials and Methods

A retrospective case-control study was done among 70 newly diagnosed breast cancer patients and 138 controls aged 29-65 years in Klang Valley, with 80% statistical power to examine the lifestyle related risk factors for breast cancer in women. The study was carried out from January 2005 to Jun 2006. Study procedures were approved by ethical committee Ministry of Health of Malaysia [KKM/JEPP/Jld. 11 (148)] and Hospital Universiti Kebangsaan Malaysia (UKM 1.5.3.5/244/PPP2). Each subjects provided informed consent.

The inclusion criteria for cases (i) pathologically newly diagnosed breast cancer (Stage I to III) (ii) had not undergone any therapy for cancer (iii) no other chronic diseases such as hypertension and diabetic (iv) no evidence of pregnancy and not lactating (v) absent of menses for pre menopausal women. The control group comprised women, who were healthy, not diagnosed with cancer and other chronic disease, not pregnant, not lactating and not in menstruation time as well as cases. The cases were matched with controls by age (± 5 years) and menopausal status.

Demographic data were obtained through a standardized pre-tested questionnaire by trained interviewers. The questionnaire included the information of background of subjects, education level, family history of breast cancer, history of physical activity, personal habits such as alcohol consumption and smoking habit. Reproductive history such as use of contraceptive pills (OCP), breast-feeding and hormone replacement therapy (HRT) were also asked.

All of the variables asked were analyzed using Statistical Package for Social Science (SPSS) software version 15.0. Multivariate analysis, ie. logistic regression (LR) was used to calculate Adjusted Odds Ratio by controlling for confounding factors.

Results and Discussion

The mean age of cases and control were 47.1 ± 7.8 and 46.2 ± 6.5 years, respectively. The youngest patient was 29 years old and the oldest patient was 65 years old. About 57 cases (76%) were in 40-59 years age group (Yip, 2006). Yip (2006) reported that more than 30% of cases were in this age group. A comparative study between Malaysian and Singaporean women showed that the median age at presentation with breast cancer was the same in both countries (Abdullah and Yip, 2004). The mean age of the cases was consistent with the figure reported in the Second Report of The National Cancer Registry in 2003 (Lim and Halimah, 2004), of which 64.1% of the cases diagnosed were in women between 40 and 60 years of age. Breast cancer in Malaysian women occurs more commonly in younger women, aged between 40 and 49 years, compared to the West, where the peak prevalence is in the 50 to 59 year old age group (Abdullah and Yip, 2004).

It was observed that out of 70 cases of breast cancer, 3 of them (4%) were never married. It was further found that more women in the cases group (5%) were not schooling as compared to controls (0.7%). Cases and controls were similar with respect to their socio demography status which includes marital status, living arrangement and education status. About 50% of the cases were not working compared to 23% in the control group (p<0.05). Monthly household income of most of the case subjects were RM1500-3000 (53%), as compared to 46% in their control group. About 35% of monthly household income of controls was more than RM3000.

There were only 4% of cases used to consume alcohol with differences between cases and control being not significant. Results of most epidemiologic studies in animals have shown that alcohol intake is associated with increased breast cancer risk (Dumitrescu and Shields, 2005). Our result suggests that baseline intake of alcohol is a more important determinant of postmenopausal breast cancer risk than earlier lifetime exposure.
Breast cancer risk was shown to increase as daily consumption of alcohol increases, with a risk of 1.37 (95% CI: 1.07-1.75) being observed among women who consumed 15 or more grams of alcohol per day (Nasca et al. 1990). This study did not show any significant differences between cases and control who consume alcohol. Alcohol consumption may be considered a social activity and less percentage in alcohol use reported by breast cancer patient may be a reflective of an overall decrease in social activities.

A higher percentage of cases having a family history of breast cancer but the differences were not significant. The Crude Odds Ratio (OR) of getting cancer for smokers and those with a family history were 10.9 and 1.2, respectively but the differences between cases and control were not significant. Family history constitutes the strongest known risk factor for development of breast cancer (Charpentier and Aldaz, 2002). However, how their inactivation contributes to the onset or development of breast cancer is still largely unknown (Stewart and Kleihues 2003). Previous study shows that the incidence of breast cancer among current smokers was higher than that among non-smoker [OR 1.32 (95% CI = 1.10 to 1.57)] (Reynolds et al. 2004). This study shows that women who got her first menarche before 11 years old did not have higher risk getting breast cancer.

Parity has a dual association with breast cancer risk in African-American women: among women younger than 45 years, parity is associated with an increased risk; among women 45 years and older it is associated with a decreased risk (Palmer et al. 2003). Women who got her first pregnancy at the age of more than 30 years old were at three time higher risk of getting breast cancer [OR = 3.1 (95% CI = 1.39 to 6.98)] (p<0.05). These result consistent with a previous study reported by Ramon et al. (1996), age at first full-term pregnancy was associated with breast cancer risk with an estimated odds ratio of [3.5 (95% CI 1.41 to 9.83)] for women with their first birth at 30 years in comparison with those whose first birth was before age 21. Exposure to high doses of placental hormones such as estrogens and/or progesterone during pregnancy may play an important role in reducing subsequent breast cancer susceptibility (Persson, 2000). However, chi-squared test did not show any significant differences between cases and control for the usage of oral contraceptive pill and hormone-replacement therapy.

The evidence of an association of lactation with a reduction in the risk of breast cancer among women has been limited and inconsistent (Newcomb et al., 1994). In pre menopausal women who breastfed for more than 25 months, the OR was 0.95 (95% CI: 0.5-3.5), and in postmenopausal women, the OR was 1.27 (95% CI: 0.5-3.1), compared to women who had not breastfed (Tessaro et al. 2003).

Conclusion

A breast cancer awareness campaign with emphasis on breast self-examination is important (Abdullah and Yip, 2003). Lifestyles factor such as first pregnancy at the age of more than 30 years old were at five time higher risk of getting breast cancer. Effort should be taken to increase awareness and understanding of the importance of healthy lifestyle in reducing the risk of breast cancer.

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References


A Study on Oral Mucosal Lesions among Adult Siamese Ethnic Group in Kelantan

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ABSTRACT: Oral health is integral to general health. Behavioural risk factors such as smoking, alcohol drinking and quid chewing may play a role in triggering the initiation and progression of oral mucosal lesions. The objectives of this study were to determine the prevalence and the associated risk habits of oral mucosal lesions among adult Siamese ethnic group in Kelantan. Salivary parameters and their associations with quid chewers having oral mucosal lesions were also determined. A cross sectional study involving 564 Siamese adults was conducted at 14 Siamese villages. Multistage sampling method was applied and respondents underwent an interview, saliva testing and followed by clinical oral examination. Saliva properties were assessed using BUFFER® TEST KIT by GIC Co. Systematic procedures for clinical oral examination was performed. Data was analyzed using SPSS version 12.0. The prevalence of oral mucosal lesions was 46.3% (95% CI; 42.0, 50.0). Analysis revealed that smokers, alcohol drinkers, quid chewers, denture users and those with increasing age were more likely to have oral mucosal lesions. There was an association between quid chewers having oral mucosal lesions and resting saliva pH. Resting saliva pH showed significant difference (p<0.001) between quid chewers who had oral mucosal lesions and non-quid chewers who had no lesions.

Keywords: Oral mucosal lesions, behavioural risk factors, salivary parameters, quid chewing

Introduction

Oral health is integral to general health and is essential to the well being of all individual. Lesions of the oral mucosa may cause impaired speech, impaired mastication and swallowing, impaired in food taste, impaired retention of prostheses, impaired facial and peri-oral aesthetics and pain, which will interfere with daily social activities (Triantos, 2005).

The cognizance of sociobehavioural factors in oral diseases has been shown in various socioepidemiological surveys.Behavioural risk factors such as tobacco consumption, alcohol drinking and quid chewing habit have been positively associated with oral mucosal lesions (Harris et al., 2004). However, there is still limited data and studies on the effect of alcohol on oral mucosal lesions (Harris et al., 2004; Saraswathi et al., 2006; Rooban et al., 2009). The multiethnicity of the Malaysian population is accompanied by variations in oral habits practiced.

Saliva plays an important role in the maintenance of oral health by exhibiting multiple host defense functions. These include homeostatic processes, lubrication, antimicrobial activity and in the balancing of the demineralization/remineralization process (Lamkin and Oppenheim, 1993). Since saliva is important in maintaining the integrity of the oral mucosa by protecting it against soft-tissue damage (Dawes, 2008), analysis of the saliva is useful to verify the risk factors that lead to the development of oral mucosal lesions (Lee et al., 2002).

Limited studies had been conducted on the influence of quid chewing on salivary parameters (Khan et al., 2003; Rooban et al., 2006). In Malaysia, there is no known published study regarding the association of salivary parameters and quid chewing. Therefore, the aim of this study was to measure salivary parameters according to quid chewing status.

Materials and Method

A cross-sectional study was conducted from December 2008 to May 2009 at fourteen randomly selected Siamese villages in the state of Kelantan, Malaysia. The study involved 564 Malaysian Siamese adults who fulfilled the inclusion criteria and consented to the study. The reference population was all Malaysian Siamese adults in
Results and Discussion

A total of 564 respondents consented and participated in the study. TABLE 1 illustrates the socio-demographics characteristics of the respondents. There were 215 (38.1%) denture wearers in the study population.

Nearly half (46.3%) of the respondents (95% CI: 42.0, 50.0) had one or more oral mucosal lesions. The prevalence of oral mucosal lesions was 46.2% among the males and 46.3% among the females respectively; with no statistical significant difference observed between genders (p= 0.987). The most common oral mucosal lesion was denture stomatitis (17.4%), followed by chewer’s mucosa (10.3%) and frictional lesion (6.4%). Pre-malignant lesions were observed in 1.2% of the population. TABLE 2 shows the distribution of various oral mucosal lesions in relation to gender.

TABLE 3 described the associated factors for oral mucosal lesions. Multiple logistic regression analysis showed significant associations between oral mucosal lesions and smoking habit with odds ratio (OR) 2.88 (95% CI=1.67, 4.97), alcohol drinking OR 3.05 (95% CI=1.64, 5.66), quid chewing habit OR 5.32 (95% CI=3.79, 9.10), denture wearing OR 5.97 (95% CI=3.85, 9.29) and age OR 1.02 (95% CI=1.01, 1.04).

There was a significant association between resting saliva pH and quid chewing habit (p<0.001). The mean salivary pH for quid chewers with oral mucosal lesions was 6.3 (SD 0.06) and mean pH for non quid chewers with no lesions was 7.0 (0.04). The difference was statistically significant (p<0.001) (TABLE 4).

The prevalence of oral mucosal lesions in this study was 46.3% (95% CI: 42.0, 50.0), corresponding to the range of expectation of 12%-60% (Lin et al., 2001; Garcia-Pola et al., 2002; Harris et al; 2004). The variations in prevalence may be due to differences in the geographic areas of the studied populations and types of oral mucosal lesions included in the studies. The prevalence of oral mucosal lesions in this study was similar to the study by Zain et al. (1999) which was conducted on the Indian ethnic group (45.5%) in Malaysian estates. The most common oral mucosal lesion encountered was denture stomatitis (17.4%), which was comparatively higher than that observed by Shulman et al. (2004) in the U.S. (8.4%) and Matthew et al. (2008) in India (0.8%). The relatively high proportion of denture wearers (38.1%) may contribute to the high prevalence. As for premalignant lesions, the prevalence was found to be 1.2%, similar to that observed by Muznita et al. (1999) (1.4%).
TABLE 1 - Distribution of Socio-demographic Characteristics of Respondents (n=564)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (SD)</th>
<th>Freq (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td></td>
<td>199 (35.3)</td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td>365 (64.7)</td>
</tr>
<tr>
<td><strong>Age (years)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>55.4 (0.57)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>56.6 (0.95)</td>
<td></td>
</tr>
<tr>
<td><strong>Education level</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No formal education</td>
<td></td>
<td>256 (45.4)</td>
</tr>
<tr>
<td>Primary education</td>
<td></td>
<td>159 (28.2)</td>
</tr>
<tr>
<td>Secondary education</td>
<td></td>
<td>144 (25.5)</td>
</tr>
<tr>
<td>Tertiary education</td>
<td></td>
<td>5 (0.9)</td>
</tr>
<tr>
<td><strong>Job categorization</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unemployed</td>
<td></td>
<td>219 (38.8)</td>
</tr>
<tr>
<td>Private/government</td>
<td></td>
<td>13 (2.3)</td>
</tr>
<tr>
<td>Self employed</td>
<td></td>
<td>331 (58.7)</td>
</tr>
<tr>
<td>Pensioner</td>
<td></td>
<td>1 (0.2)</td>
</tr>
<tr>
<td><strong>Smoking status</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current smoker</td>
<td></td>
<td>120 (21.3)</td>
</tr>
<tr>
<td>Non smoker</td>
<td></td>
<td>419 (74.3)</td>
</tr>
<tr>
<td>Ex-smoker</td>
<td></td>
<td>25 (4.4)</td>
</tr>
<tr>
<td><strong>Alcohol drinking status</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current drinker</td>
<td></td>
<td>89 (15.8)</td>
</tr>
<tr>
<td>Non drinker</td>
<td></td>
<td>466 (82.6)</td>
</tr>
<tr>
<td>Ex-drinker</td>
<td></td>
<td>9 (1.6)</td>
</tr>
<tr>
<td><strong>Quid chewing status</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current chewer</td>
<td></td>
<td>83 (14.7)</td>
</tr>
<tr>
<td>Non quid chewer</td>
<td></td>
<td>481 (85.3)</td>
</tr>
</tbody>
</table>

TABLE 2 - Distribution of Oral Mucosal Lesions According to Gender

<table>
<thead>
<tr>
<th>Oral Mucosal Lesions*</th>
<th>Male (n=92)</th>
<th>Female (n=169)</th>
<th>Total (n=261)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
</tr>
<tr>
<td><strong>White Lesions</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Homogenous leukoplakia</td>
<td>1 (0.5)</td>
<td>0</td>
<td>1 (0.2)</td>
</tr>
<tr>
<td>Non-homogenous leukoplakia</td>
<td>1 (0.5)</td>
<td>0</td>
<td>1 (0.2)</td>
</tr>
<tr>
<td>Lichen planus</td>
<td>3 (1.5)</td>
<td>1 (0.3)</td>
<td>4 (0.7)</td>
</tr>
<tr>
<td>Geographic tongue</td>
<td>2 (1.0)</td>
<td>3 (0.8)</td>
<td>5 (0.9)</td>
</tr>
<tr>
<td>Cheek and lip biting</td>
<td>1 (0.5)</td>
<td>3 (0.8)</td>
<td>4 (0.7)</td>
</tr>
<tr>
<td>Frictional lesion</td>
<td>26 (13.1)</td>
<td>10 (7.7)</td>
<td>36 (6.4)</td>
</tr>
<tr>
<td>Leukoedema</td>
<td>26 (13.1)</td>
<td>0</td>
<td>26 (4.6)</td>
</tr>
<tr>
<td><strong>Red Lesions</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Denture stomatitis</td>
<td>12 (6.0)</td>
<td>86 (23.6)</td>
<td>98 (17.4)</td>
</tr>
<tr>
<td>Erythroplakia</td>
<td>0</td>
<td>1 (0.3)</td>
<td>1 (0.2)</td>
</tr>
<tr>
<td><strong>Ulcerated Lesions</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aphthous ulcers</td>
<td>3 (1.5)</td>
<td>5 (1.4)</td>
<td>8 (1.4)</td>
</tr>
<tr>
<td>Traumatic ulcers</td>
<td>7 (3.5)</td>
<td>9 (2.5)</td>
<td>16 (2.8)</td>
</tr>
<tr>
<td><strong>Quid related Lesions</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chewer's mucosa</td>
<td>10 (5.0)</td>
<td>48 (13.2)</td>
<td>58 (10.3)</td>
</tr>
<tr>
<td>Quid-induced lesions</td>
<td>1 (0.5)</td>
<td>5 (1.4)</td>
<td>6 (1.1)</td>
</tr>
<tr>
<td><strong>Exophytic and pigmented lesions and mucosal swellings</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suspiscious of oral cancer</td>
<td>1 (0.5)</td>
<td>0</td>
<td>1 (0.2)</td>
</tr>
<tr>
<td>Macrocoele</td>
<td>3 (1.5)</td>
<td>5 (1.4)</td>
<td>8 (1.4)</td>
</tr>
<tr>
<td>Papiloma</td>
<td>0</td>
<td>1 (0.3)</td>
<td>1 (0.2)</td>
</tr>
<tr>
<td>Fibroepithelial polyp</td>
<td>0</td>
<td>2 (0.5)</td>
<td>2 (0.4)</td>
</tr>
<tr>
<td>Excessive melanin pigmentation</td>
<td>10 (5.0)</td>
<td>11 (3.0)</td>
<td>21 (3.7)</td>
</tr>
<tr>
<td>Amalgam tattoo</td>
<td>0</td>
<td>1 (0.3)</td>
<td>1 (0.2)</td>
</tr>
<tr>
<td>Fordyce's condition</td>
<td>1 (0.5)</td>
<td>0</td>
<td>1 (0.2)</td>
</tr>
</tbody>
</table>

*Difference of prevalence for oral mucosal lesions between male and female was not significant (Chi-square test, p= 0.987*).
* Significant at p<0.05.
TABLE 3- Associated Factors for Oral Mucosal Lesions (n=564)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Adjusted OR¹</th>
<th>95% Confidence Interval (CI)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>1.02</td>
<td>(1.01,1.04)</td>
<td>0.003*</td>
</tr>
<tr>
<td>Smoking status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoker</td>
<td>2.88</td>
<td>(1.67,4.97)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Non smoker</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alcohol drinking status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alcohol drinker</td>
<td>3.05</td>
<td>(1.64,5.66)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Non alcohol drinker</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quid chewing habit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quid chewer</td>
<td>5.32</td>
<td>(3.79,9.10)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Non quid chewer</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Denture wearing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>5.97</td>
<td>(3.85,9.29)</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>No</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*significant at p<0.05; ¹ Adjusted odds ratio in multiple logistic regression.

TABLE 4- Comparison of Saliva pH between Quid Chewers and Non Quid Chewers (n= 132)

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean (SD)</th>
<th>Mean diff. (95% CI)</th>
<th>F stat.(df)*</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quid chewers (n=64)</td>
<td>6.3 (0.06)</td>
<td>0.73 (0.59, 0.87)</td>
<td>111.5 (1, 130)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Non quid chewers (n=68)</td>
<td>7.0 (0.04)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* One-way ANOVA

Smoking may increase the odds of oral mucosal lesions by 2.88 (95% CI: 1.67, 4.97). This finding was true as had been demonstrated by other studies (Lin et al., 2001; Harris et al., 2004; Jahanbani, 2009). Alcohol drinkers were also more likely to have oral mucosal lesions which concurred with the study by Harris et al. (2004) and Rooban et al. (2009). Quid chewing habit was found to be associated with the occurrence of oral mucosal lesions. These findings were also consistent with a study by Yap et al. (2008) who reported that quid chewers were 4.5 times higher to have oral mucosal lesions (95% CI :1.20, 16.94).

There was a significant difference of mean saliva pH between the quid chewers and non-quid chewers in this study. The mean saliva pH in quid chewers was significantly lower compared to the non-quid chewers (p<0.001). This result is in accordance with the study by Rooban et al. (2006). Among the quid chewers, the lime in the quid ingredient probably reacts with the bicarbonate buffering system in the saliva by the loss of bicarbonate, turning the saliva of quid chewers to be more acidic (Rooban et al., 2006). An acidic oral environment can cause various oral diseases such as candida albicans infection (Choo and Huestis, 2004).

Conclusion

There was a high prevalence of oral mucosal lesions (46.3%) in the Siamese adult population. Oral mucosal lesions were associated with risk habits such as smoking, alcohol drinking and quid chewing. Resting saliva pH showed a significant difference (p<0.001) between quid chewers with oral mucosal lesions and non-quid chewers.

Acknowledgements

The authors thank the community of Siamese villages who participated in this study. The study was funded by USM Short Term Grant (304/PPSG/613904)

References


Investigation on the Level of Furans and Dioxins in Five Commonly Consumed Fish Species

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**ABSTRACT:** Five commonly consumed marine fish from Straits of Malacca were studied for their level of dioxins (PCDDs) and furans (PCDFs). The fish fillets were found to contain low to moderate level of fats. Among the moderate fat content species, *Plotosus spp.* (Sembilang) was found to contain the highest level of total PCDDs/Fs (1.23 ± 0.48 pg/g of wet weight) due to the high fat content of the species. Other species however, contain low level of PCDDs/Fs that range between 0.10-0.18 pg/g of wet weight. Generally the levels of total PCDDs/Fs in fish species determined in this preliminary study were well below the European limits and are therefore safe for human consumption.

**Keywords:** furans, PCDD, dioxins, PCDF, fish

**Introduction**

Polychlorinated dibenzo-para-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) are two clusters of chemical compounds that comprise very similar properties and structures. These chemicals are insoluble in water, lipophilic and very persistent. They are by-products resulting from the production of other chemicals, incineration reactions, and the use of a variety of chemical products (UNEP, 2002). PCDDs are contaminants produced in the manufacture of polychlorinated biphenyls (PCBs) and organochlorine pesticides. PCDDs could also be produced by inefficient burning of organic carbon in the presence of chlorine (Meharg and Osborn, 1995). PCDFs are the key contaminant of PCBs. The toxicity of PCDDs and PCDFs to human have been well documented which include dermal toxicity (chloracne), immunotoxicity, carcinotoxicity, reproductive toxicity and possible neurobehavioral (cognitive) effects (SCF, 2000).

Potential public health risks from environmental exposures to chlorinated dioxins and related compounds continue to be the subject of much research, regulation and debate. Human exposure to PCDDs and PCDFs occurs mainly from foods that contain these chemicals. Among the foods are meat, dairy products and fish which could make up to more than 90% of the intake of PCDDs and PCDFs in diet (Huwe and Larsen, 2005). In Europe, it was reported that fish and fish products contribute to 2-63% of the dietary intake while other animal source such as meat and meat products as well as milk and dairy products contributed to 6-32% and 16-39%, respectively (EC, 2000).

Over the past few decades, nutritional research has identified a number of foods that are recommended for human diet on the basis of their potential beneficial effect on chronic diseases. Among the foods, fish have been recognised as a food group containing high protein with good biological value, low content of saturated fat and rich in certain minerals and vitamins (Sidhu, 2003). Marine foods including fish represent a very important source of vitamin D (Bender, 2002), unique source of long chain polyunsaturated fatty acids (PUFA) of the n-3 family mainly the EPA and DHA (Sidhu, 2003) and source of protein with high biological value (Brown, 2008). Several studies also showed that fish is perceived as a healthy food by consumers (Gross, 2003). However, fish can also be a major source of human exposure to contaminants such as methyl mercury, polychlorinated biphenyls (PCBs), dioxins, organochlorine pesticides and other environmental contaminants (Kris-Etherton et al., 2002).

Due to the health benefits and scientific facts offered in fish consumption and the conflicting toxicological food safety, this study was carried out to obtain new data on the presence of PCDDs and PCDFs in local marine fish. As preliminary, this paper aims to determine the level of PCDDs and PCDFs in 5 species of marine fish collected from...
Straits of Malacca. The 5 species were among 10 species most commonly used in everyday diet of Malaysian (Osman et al., 2001).

Materials and Method

Chemicals and reagents

All reagents used were of analytical grade. Chemicals used include dichloromethane, toluene, and pesticides. The chemicals were used for extraction, pre-treatment, and clean-up of samples before PCDDs and PCDFs determination using high-resolution gas chromatography/high-resolution mass spectrometry (HRGC/HRMS).

Sampling

Stratified sampling method was used to collect fish and shellfish samples. Fresh fish and shellfish samples were collected from several regions of identified fish landing areas along Straits of Malacca: North (Kuala Perlis, Kuala Kedah, Teluk Bahang, Pulau Betong), Middle (Melaka, Port Dickson, Muar) and South (Kuala Selangor, Manjung Utara, Matang). All samples were collected fresh from the various sites in November-December 2008.

Samples

Samples consists of 12 species of fish [(Rastrelliger kanagura) (kembung), Scomberomorus guttatus (tenggiri papan), Pampus argenteus (bawal putih), Megalopsis cordyla (cencaru), Gymnura spp. (pari), Plotosus spp. (sebelah), Eleutheronema tradactylum (senangin), Nemipterus janionicus (kerisi), Epinephalus sefasciatus (kerapu), Psettodes erumei (sebelah), Chiroteus dorab (parang) and Lutianus argentimaculatus (merah)] and 3 species of shellfish [Anadara granosa (kerang), Macrobrachium rosenbergi (udang) and Sepia officinalis (cuttle fish)]. However, as preliminary, only 5 species of fish were analyzed in this report.

Sample preparation

Composite sample of each species from the same region of a fish was prepared by mixing and grinding the respective fish species before storage in the freezer. Upon arrival at Dietetetics laboratory, Universiti Putra Malaysia, fish were individually measured for total body weight and length. Vicera were removed before being beheaded, washed, filleted, packed in polyethylene covered cup. All preparation and cleaning procedures were carried out using contamination-free tools. Samples for organochlorinated pollutants determination were kept frozen at -25°C without any prior treatment.

Fat extraction and clean-up

About 50 µl internal standard were spiked into 10 g of wet sample of fish. Then, 10 g of hydromatrix were mixed into the sample before being homogenized with a mortar. The homogenized sample was then dried in an oven for a few minutes to dehydrate the moisture content until it formed a powder. The powder was then placed into the cell (size 33) and the cell’s surface was closed with otawa sand before placing into Accelerated Solvent Extraction (ASE 200) machine for 20 minutes (Method 11). The mixture of extracted fat and solvent was dried using a rotary evaporator for 20 minutes and then filtered to get crude fat extract. Hexane was mixed into the extract to form eluent. The eluent was placed in the Water-Prep Fluid Management System (FMS) for clean-up process involving three types of column: silica, alumina and carbon. After 23 steps of FMS have been completed, the collected PCDDs and PCDFs (mixed with solvent) mixture was dried using a rotary evaporator before being spiked with 50 µl external standard. The solvent was dried using a heating block (with nitrogen gas) at 60°C. The crude dioxins and furans collected were placed in a small covered aluminium vial before analysis.

Analysis of dioxins and furans

High resolution gas chromatography/high resolution mass spectrometry (HRGC/HRMS) was used for analysis of dioxins and furans. Each analysis included the determination of 17 dioxin and furan congeners with 2,3,7,8-chloro-substitution. Congeners of dioxins and furans determined are as listed below. Selection of congeners was based on the most toxic to human.

a. Dioxins – 7 congeners
   b. Furans – 10 congeners

Determination of PCDDs/Fs compounds in fish lipid samples was carried out at Doping Centre, Universiti Sains Malaysia, Penang.

Results and Discussion

TABLE 1 summarizes the results of the 5 fish species analyzed showing the percentage of lipid and the concentrations of PCDDs/Fs in fish samples. The highest level of total PCDFs/Ds was in Plotosus spp. while in other 4 species the levels were in the range of 0.10-0.18 pg/g of wet weight. The highest level of PCDDs and PCDFs in Plotosus spp was related to higher fat content in the fish sample (5.7% ± 0.4 fat). However, for other species that contain > 5% fat such as Rastrelliger
kanagurta (Kembung) and Scomberomorus guttatus (Tenggiri) the levels of these contaminants were relatively low.

| TABLE 1- Level of total PCDDs and PCDFs in 5 species of marine fish |
|---------------------------------|-----|------------------|
| Species                        | Percent lipid | Total PCDDs/Fs WHO-TEQ (pg/g of wet weight) |
| Rastrelliger kanagurta (Kembung) | 5.0 ± 2.4 | 0.10 ± 0.01 |
| Pampus argenteus (Bawal Putih)  | 3.6 ± 0.1 | 0.13 ± 0.02 |
| Plotosus spp. (Semblang)        | 5.7 ± 0.4 | 1.23 ± 0.48 |
| Megalagias cordyla (Cencaru)    | 3.5 ± 0.1 | 0.12 ± 0.01 |
| Scomberomorus guttatus (Tenggiri)| 5.5 ± 0.2 | 0.18 ± 0.01 |

It is well established that the quality of seafood products is dependent on the genetic basis, size, reproductive period of fish as well as characteristics of the environment (pH, salinity, temperature of water, composition of phyto- and zooplankton during the year and the presence of other fish species) (Orban et al., 2003). For wild fish, the main exposure to PCDD/Fs is associated with chronic contamination due to leaching of agricultural or industrial chemicals into surface waters.

In general, the preliminary data on the level of PCDDs/Fs in the studies samples showed low level of these contaminants in the muscle tissue of local marine fish. The maximum limit suggested by EC Regulation No 119/2006 is 4 pg/g of wet weight for total PCDDs/Fs and 8 pg/g of wet weight for PCDDs/PCDFs-PCBs (including the dioxin-like PCBs), respectively (EC, 2006). Our data indicates PCDDs/Fs in the five local marine fishes are of safe levels for consumption. In comparison, Ministry of Agriculture, Fisheries and Food (MAFF) in United Kingdom has observed a mean concentration of PCDDs, PCDFs and PCBs (of 12 samples) to be 25 pg/g fat in marine salmon (Ministry of Agriculture, Fisheries and Foods. 1999). Earlier reports have also reported significant levels of PCDDs, PCDFs and PCBs in fatty tissue of herring from Baltic sea (Rappe et al. 1989). A more recent study in Ireland on fish and fishery products available in Irish market, the levels of PCDD/Fs including dl-PCBs were, however, generally below 8.0 pg/g of wet weight (Thlustos et al. 2006). Similarly, in another study carried out in Spain on 14 species of fish and shellfish (Bocio et al. 2007), the concentration of PCDD/Fs marked a significant decrease in comparison to an earlier findings in 2003 (Llobet et al. 2003).

Conclusion

The local marine fish is safe for consumption in terms of PCDDs/Fs level based on our samples. Data on PCDDs/Fs exposure to human is important following concerns about the carcinogenicity and other negative health effects. Therefore determination of estimate intake of PCDDs/Fs via other sources should also be carried out. Specific control measures in controlling the emission of these chemicals into the marine environment should be monitored.

Acknowledgements

This work was supported by research grant from Ministry of Science, Technology and Innovation, Malaysia (MOSTI), Vote No. 5450400. The authors thank staff from the Department of Nutrition and Dietetics, UPM and Doping Control Center, USM throughout the research project. Special thanks also go to Universiti Kebangsaan Malaysia for allowing the use of library facilities.

References


A Study on the Variability of Fresh Diesel from Service Station in Kota Bharu Using GC-MS and PCA

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**ABSTRACT:** The variability of the diesel population in Kota Bharu was investigated in this paper. Discrimination of diesel samples was performed by gas chromatography-mass spectrometry (GC-MS). Subsequent statistical analyses of these data were performed including principal component analysis. A data set containing 41 peaks from extracted ion chromatograms normalized to n-22 was used and diesel sample distribution pattern was visualized in the score plot. The results show that GC-MS analyses were able to discriminate different fresh diesel samples into a few groups. Among the diesel samples collected from service station on the same day, Petronas diesels were significant different from Caltex, Mobil, Esso and most of Shell samples. Diesel samples collected from a selected service station over a time scale of weeks varied significantly by GC-MS. Care must be exercised when interpreting data showing similarities or differences in GC-MS profile as to the source where the sample could have come from.

**Keywords:** Diesel, GC-MS, principal component analysis

**Introduction**

Diesel is one of the refined products of crude oil that has been used worldwide as one the fuels for motor vehicle. Most heavy load vehicles use diesel as the fuel compare to other type of fuel. In Malaysia, diesel fuels are subsidised by the government for selected sectors such as land and sea transportation as well as for fishing boats. The price is therefore significantly cheaper compared to the neighbouring countries. Crimes relating to diesel smuggling and abused of fuel-subsidy system are often reported and therefore it may be necessary to compare a seized diesel sample believed to be subsidized by the government to its known source when an offence is suspected. Also, diesel may be discharged into the environment and the ability to identify the party responsible for the spill is important. One technique used to establish the link between a question diesel to its source is via diesel fingerprinting (Stout *et al.*, 2002, Daling *et al.*, 2003)

Gas chromatography mass-spectrometry (GC-MS) is commonly used in hydrocarbon analysis as it also allows more detail characterization and identification of the sample besides giving the description of the distribution of dominating hydrocarbon in the sample (Wang, 1997, Wang *et al.*, 2003, Wang *et al.*, 2007, ASTM D 5739-06). Following GC-MS analysis, two chromatograms can be visually compared using specific extracted ions chromatograms but there might be a risk of subjective error associated with visual comparison of spectra (Hibbert *et al.*, 2008). The used of statistical analysis is therefore useful in discriminating petroleum origin (Stout *et al.*, 1991, Abdullah, 2004, Hupp *et al.*, 2008.). One of the statistical analysis that can be used in exploratory nature is principal component analysis (PCA). It is a multivariate statistical analysis widely used in science and engineering fields that transforms the original data set into new, smaller, and uncorrelated variables called principal component.

This study investigates the variability of diesel fuels collected from service stations in the district of Kota Bharu, Kelantan. Principal Component Analysis (PCA) was used to discriminate the 41 selected peaks of each of the chromatograms from the 27 samples studied. One service station was arbitrarily chosen where diesel samples were collected in one-week interval over a period of four weeks to observe the variability of the diesel fuels.
Materials and Method

Sampling

Sampling was carried out in such a way that all the samples were collected in a day. A Shell service station was sampled four times in an interval of a week for each sampling to investigate the diesel profiles over time. Prior to sampling, about 100 mL of diesel was dispensed into a metal can to flush out any contaminant at the pump. Then, a brown bottle was used to contain about 200 mL of diesel. The bottle was then capped and labeled.

1 µL of diesel was transferred using a 10 µL syringe into a GC vial and diluted with 1 mL of n-hexane (HPLC grade) prior to analysis. The samples were capped and labeled prior to GC analysis.

The analyses of samples were performed using a Varian CP-3800 gas chromatograph with a Varian Saturn 2200 mass spectrometer. The GC-MS is equipped with a VF-5MS fused-silica capillary column (30 m × 0.25 mm × 0.25 µm, Varian). Helium was used as the carrier gas with a flow rate of 0.8 mL min⁻¹. The injection volume for each sample was 1 µL delivered by syringe with a splitless mode for 45 sec before being vented. The temperature in the inlet and transfer line was held at 280°C. The temperature of the oven was initially held at 65°C for 5 min followed by a ramp to 300°C at 5°C min⁻¹ with a final hold time of 10 min, giving a total run time of 62 min. Electron-impact ionization (70 eV) was utilised with a quadrupole mass analyzer operated in full-scan mode (40 to 450 m/z).

Data analysis

The peak selection was based on the previous study (Abdullah, 2004) and Nordtest method (Nordtest, 1991). A total of 41 peaks were selected from 13 extracted ion chromatograms that resolved clearly. All the area of selected peaks were normalised to 2,3,5-trimethylphenanthrene with a retention time at 35.88 minutes (labeled as 220b, FIG. 3). The data was log-transformed prior to Principal Component Analysis using XLSTAT-Pro(Win) incorporated into Windows Excel®.

Results and Discussion

FIG. 1 shows an overlay of chromatograms of four fresh diesel samples from Esso (E1), Caltex (C3), Shell (S1) and Petronas (P20). The chromatograms are dominated by resolved hydrocarbons consisting of n-alkanes and iso-prenoids. The n-alkanes range from n-C10 to n-C31 with a maximum at n-C16 to n-C18. The chromatograms also contain a large amount of “grass” which is unresolved complex mixture of hydrocarbons. Visual examination on total ion chromatogram may be difficult without a more careful and systematic comparison between the samples.

FIG. 1- Total ion chromatograms of Esso, Caltex, Shell and Petronas Diesel, from top to bottom.
The GC-MS software allows selected ions to be extracted using MS Workstation®. An extracted ion chromatogram looks “cleaner” than the total ion chromatogram and makes peak integration easier. **FIG. 2** shows a stack of two selected ion chromatograms showing heptadecane, pristine, octadecane and phytane from different samples. The distribution of pristane and phytane at different intensity indicated that the diesel samples were from different origin. Note that the ratios of these compounds had been used as an indicator to exclude a sample as a potential source or provide supporting evidence of a source (Stout *et al.*, 2002). Wang *et al.* found that the ratios of n-C17/pristine, and n-C18/phytane, and pristane/phytane were unaltered for slightly weathered oil (Wang and Fingas, 1995).

**TABLE 1** shows the distribution of the peaks and their retention time monitored in 13 different m/z groups used in this study.

<table>
<thead>
<tr>
<th>Peak</th>
<th>RT</th>
<th>Peak</th>
<th>RT</th>
<th>Peak</th>
<th>RT</th>
<th>Peak</th>
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</thead>
<tbody>
<tr>
<td>113a</td>
<td>27.49</td>
<td>192a</td>
<td>31.05</td>
<td>206a</td>
<td>32.88</td>
<td>216c</td>
<td>37.62</td>
</tr>
<tr>
<td>113b</td>
<td>27.67</td>
<td>192b</td>
<td>31.15</td>
<td>206b</td>
<td>33.71</td>
<td>216d</td>
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<td>220a</td>
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</tr>
<tr>
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<td>29.79</td>
<td>192d</td>
<td>31.52</td>
<td>212a</td>
<td>32.24</td>
<td>220b</td>
<td>35.88</td>
</tr>
<tr>
<td>156a</td>
<td>20.58</td>
<td>192e</td>
<td>31.62</td>
<td>212b</td>
<td>32.52</td>
<td>220c</td>
<td>36.09</td>
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<tr>
<td>156b</td>
<td>20.66</td>
<td>198a</td>
<td>30.24</td>
<td>212c</td>
<td>32.61</td>
<td>220d</td>
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<tr>
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<td>23.72</td>
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<td>30.92</td>
<td>212e</td>
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<td>226b</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>220b</td>
<td>35.31</td>
</tr>
</tbody>
</table>

*To make the data comparable between samples, the peak height of each ion from extracted ion chromatograms of a diesel sample was normalised to the peak height of 2,3,5-trimethyphenanthrene monitored at m/z 220. The peak is denoted as 220b in **FIG. 3.** This compound was thought to be a good candidate because it has a relatively height molecular weight (higher retention time), thus is more likely to be resistant to evaporative weathering (such as in the case of a spill). In addition, this peak is well defined and has a reasonable intensity in most of the samples. In...*
crude oil samples, peaks such as this are suggested for normalization since the n-alkanes are subjected to biodegradation over extended periods (Millner et al., 1992).

**FIG. 3**- Extracted ion chromatogram showing peaks of m/z 220 and their retention times.

**FIG. 4**- Score plot of PC1 and PC2 of diesel samples

*Keys: Green = Petronas Diesels, Yellow=Shell diesels, Blue=Caltex Diesel, Brown=Mobil diesels, Black=Esso Diesels, S1=Shell service station 1; S1-1, S1-2 and S1-3 – Samples collected from Shell Service station 1 after 1, 2 and 3 weeks, respectively, Red (BLT)=sample for blind test.*
FIG. 4 shows the score plots for the first and second principal components for data derived from GC-MS chromatograms of diesels using principal component analysis. The original datasets contained peak height information for 41 peaks from each chromatogram, normalised to m/z 220b, FIG. 3, and log-transformed. Principal component 1 and principal component 2 accounted for 64.06% and 12.09% of the total variance between the samples, respectively.

Examination of the score plots reveals that Petronas diesel samples (green) were tightly clustered at the left of the score plot indicating similarities among the samples. This can be explained if the same source of petroleum from the refinery was refined or distributed to the service stations. Note that Petronas (the national petroleum company in Malaysia) produces and refines its products in Kerteh, Terengganu and this may explain the close proximity of most Petronas samples on the score plot.

Shell samples (yellow) were most widely scattered, except for a pair appeared close to Petronas samples (arrow), implying that diesel fuels from a given brand can be greatly different, depending on the batch of diesel used as well as how fast the supply from a given batch is consumed.

Mobil (brown), Esso (black) and Caltex (blue) diesel samples were also loosely clustered in the centre of the plot. Note that Mobil and Esso could also have sourced their diesel from the same supplier but the score plot shows that both Mobil and Esso diesels were greatly different based on the distance between each other on the score plot.

Three samples (S1-1. S1-2 and S1-3) collected from Shell service station (S1) at approximately one-week intervals on different days were grouped far away from sample S1 collected as part of one-day survey. This implies that these later three samples were significantly different from sample S1. Such variability is expected if this service station has received one or more new batches of diesel after S1 was collected.

A blind test as performed using one of the diesel samples with its service station unknown to the authors. The result (red) shows that the test sample was nearly overlapping with a Shell sample (labeled as S27), i.e. its original source indicating the test sample can be matched to its original known source, using our data treatment and statistical analysis.

Conclusion

GC-MS data shows that there were similarity among samples from collected Petronas service station in Kota Bharu. Shell, Esso, Mobil and Caltex diesels collected on the same day were significantly different between service stations using GC-MS. Diesels collected from service stations on different occasions were also found to be differentiable upon PCA. Therefore, background information on the variability of diesel is important. Similarities between two samples upon statistical analysis may indicate they were from the same brand (such as seen in most of the Petronas samples). However, samples from different station of a same brand may be different greatly as seen in Shell diesels. The time interval between two samples collected from a service station can affect the diesel profiles.

Acknowledgement

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8. Stout, S.A., et al. (2002) Chemical Fingerprinting of Hydrocarbon, in Introduction to Environmental Forensics, B.L. Murphy and


A Comparative Study of Environmental Subsoil Profile in Four Different Points at Four Different Depths in Kelantan Agricultural Land at Kota Bharu

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ABSTRACT: Soil is present on the outermost layer of the Earth’s terrestrial landmass and playing a pivotal role in the functioning of the contemporary earth system. As soil particles can readily adhere to, and transfer from, items such as clothing, shoes, vehicles and tools, they have the potential to be used as trace evidence, potentially linking or eliminating suspects to and from a crime scene. The environmental soil density analysis has immense applications in various fields like agriculture, forensic science and so on. The research presented here a comparative study of subsoil profile in four different points in four different depths to determine whether the subsoil samples collected from a particular point differs in density with reference to the soil from a different point. Soil samples in an agricultural field, at Kampung Sireh Bawah Lembah, Kota Bharu were studied. So far no subsoil analysis study was conducted in agricultural land using density gradient tube technique. In each point, collected about 500g soil in 4 different depths viz. top soil, soil under ½ foot depth, 1 foot depth and 1½ feet depth. Density gradient tube technique was used in this research, in addition to visual and stereomicroscopic examination for soil comparison. The density gradient column was prepared using bromoform (d = 2.87 g/mL) and bromobenzene (d=1.49 g/mL). The finding of this research indicated discrimination in the soils collected in different points and depths even within the same plot of agriculture field.

Keywords: Environmental soil, subsoil profile, soil comparison, density gradient technique.

Introduction

Soil is present on the outermost layer of the Earth’s terrestrial landmass and as such cover a large proportion of the planetary surface, playing a pivotal role in the functioning of the contemporary earth system (Ritz et al., 2009). As soil particles can readily adhere to, and transfer from items such as clothing, shoes, vehicles and tools, they have the potential to be used as trace evidence, linking or eliminating suspects to and from a crime scene (Andrew et al., 2009). The five main soil forming factors are parent material, climate, organism, topography, and time. The living organisms also gain a foothold to modify parent material lichens often form a pioneer community that traps small particles and chemically alters the underlying rock, causing further fragmentation (Enger and Smith, 2000). In forensic point of view, the value of environmental soil as evidence rests with its prevalence at crime scene and its transferability between the scene and the criminal (Saferstein, 2004). In fact, soil is a complex mixture with varying mineralogical, chemical, biological and physical properties (Marumo, 2003). Considering such complexity, a variety of methods has been developed such as examination of gross appearance, comparing the color and texture of the sample, spectrographic analysis, X-ray diffraction, differential thermal analysis, and others (Nickell and Fischer, 1999). The soil density are being used for many field applications such as in the agriculture field to study the growth of plants (Clifford Tafangenyash et al., 2011), to predict saturated hydraulic conductivity (Rawls et al., 1998) to study soil compaction (Lal, 1999) and application in forensic investigation to solve crimes (Petraço and Kubic, 2000). Soil varies in its chemical and physical properties from place to place, even within the same plot of ground (Siegel and Mirakovits, 2010). Studies have shown that soil profile may differ markedly within a few feet (Nataraja et al., 2005) and meters (Siegel and Mirakovits, 2010) of each other horizontally and vertically.
Objective

This research aimed to study the soil density of subsoil profile in an agricultural field, at Kampung Sireh Bawah Lembah, Kota Bharu in 4 different points [designated as S1 to S4] formed the corners of a square with an interdistance of 70 m, within the same plot of ground. At each point, four soil samples of each about 500 g were collected in different depths viz. top soil, soil under ½ foot depth, 1 foot depth and 1½ feet depth. The color of the soil, texture and presence of any foreign material present in the sample were observed and recorded. The density gradient tube technique was used (Petraco and Kubic, 2000, Dubley, 1979, Nataraja et al., 2005).

Materials and methods

Soil samples collection

The soil samples were collected in an agricultural land situated at Kampung Sireh Bawah Lembah in Kota Bharu, about 15 kilometers from Universiti Sains Malaysia, Kubang Kerian. About 500 g of soil sample from each point and depths and thus a total of 16 soil samples were collected and preserved for analysis. The four points, which formed the corners of a square with an interdistance of 70 m were designated as S1 (first point), S2 (second point), S3 (third point), and S4 (forth point). In each point, four soil samples of each 500 g were collected viz. top soil (S1/1), soil under ½ foot depth (S1/2), 1 foot depth (S1/3) and 1½ feet depth (S1/4). Similar types of collections were made in other points also (FIG. 1).

Soil preparation

The soil samples were allowed to dry under sunlight for two days. About 100 grams of each soil samples were taken into a dish and heated in an oven at 100°C for overnight to remove the moisture if any and then allowed the samples to cool to room temperature (FIG. 2). The samples were then passed through the sieves with 125 micron meshes. Then 1 gram of soil sample was weighed for density gradient analysis.

Density gradient column Preparation

A stock solution of bromoform and bromobenzene mixtures was prepared in a 250 mL volumetric flask as shown in TABLE 1 and four identical graduated tubes of 50 cm length with 10 mm diameter were clamped vertically in glass tube stand.

The density gradient columns were prepared using the stock solutions. The column has seven layers with 6 mL each. The top layer is bromobenzene, a low density liquid (1.49 g/mL) and the bottom layer is high density liquid, bromoform (2.87 g/mL). In between these two layers have five layers of bromoform and bromobenzene mixture with varying densities. Thus the ratios of the two liquids in each layer are such that each successive layer has a lower density than the preceding one, from the bottom to the top of the tube.

The open ends of graduated tubes were sealed with parafilm and then covered with plasticine to prevent evaporation of the liquid mixture. The graduated tubes were allowed to stand for overnight for stabilization.

The density of the mixture was calculated using the following formula as used by Nataraja et al., 2005,

\[
\text{Density of a mixture, } \text{DM} = \frac{[(\text{DBB} \times \text{VBB}) + (\text{DBF} \times \text{VBF})]}{\text{VBB} + \text{VBF}}
\]

where; \(\text{D}_{\text{BB}}\) = Density of bromobenzene, \(\text{D}_{\text{BF}}\) = Density of bromoform, \(\text{V}_{\text{BB}}\) = Volume of bromobenzene, and \(\text{V}_{\text{BF}}\) = Volume of bromoform

Density Gradient Analysis

After the stability of the column, 1 g of sieved soil sample was added gently into the graduated tubes. The graduated tubes were left for overnight to allow the distribution of soil particles in the gradient. The soil particles sank to the portion of the tube that has a density of equal value; the particles remain suspended in the liquid at this point. The distribution pattern of soil particles (Saferstein, 2004) have been obtained and recorded (FIG. 3-6). The temperature of the laboratory was maintained and recorded.
FIG. 1- Collection of soil samples in 4 different points and depths (clockwise from top left: S1, S2, S3 and S4)
FIG. 2- Dried soil samples (clockwise from top left: soil sample marked S1, S2, S3 and S4)

TABLE 1- Bromobenzene and Bromoform Mixture Ratio in the Layers

<table>
<thead>
<tr>
<th>Layer</th>
<th>Bromobenzene (1.49 g/mL)</th>
<th>Bromoform (2.87 g/mL)</th>
<th>Total volume of mixture of each layer (mL)</th>
<th>Density (g/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Top)</td>
<td>6</td>
<td>0</td>
<td>6</td>
<td>1.49</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>1</td>
<td>6</td>
<td>1.72</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>2</td>
<td>6</td>
<td>1.95</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>3</td>
<td>6</td>
<td>2.18</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>2.41</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>5</td>
<td>6</td>
<td>2.64</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>6</td>
<td>6</td>
<td>2.87</td>
</tr>
<tr>
<td>(Bottom)</td>
<td></td>
<td></td>
<td>Total column volume (42)</td>
<td></td>
</tr>
</tbody>
</table>

Results

The visual and stereomicroscopic examination for the samples collected at the point S1 is as shown in TABLE 2. Similar observations were made for the samples collected at the points S2, S3 and S4 and recorded. Foreign materials like grass root fragments, dead leaves and paint flakes were also found in soil samples when examined through visual and stereomicroscope.

The density gradient analysis of top soil at point S1 with different depths and soil at point S3 in different depths showed variation in pattern. No
two samples were found to have the similar distribution pattern of soil particles (FIG. 3 and 4). The density distribution pattern of soil samples collected in points S1 and S3 in different depth is as shown in FIG. 3 and 4.

Similar variations in density distribution pattern of soil particles were observed in the points S2 and S4 and recorded. Also soils samples collected at different points, S1 to S4 with similar depths viz. top soil samples and soil samples at 1 foot depth showed variations in density distribution pattern as shown in FIG. 5 and 6. Similar variation in density gradient pattern was observed in soil samples collected at the depth of ½ foot and 1½ feet depths and were recorded.

Blind test was conducted in order to verify these findings by collecting top soil samples in different points viz. C1 to C4 (known soil samples) and soil adhered in the bottom outsole in a shoe (J-questioned sample) that stepped on point C4. The color, texture, presence of foreign materials in the samples J and C4 including the density gradient pattern showed similarity and recorded this observations. The questioned soil sample J and known soil sample C4 showed similar density gradient pattern as shown in FIG. 7 and 8.

<table>
<thead>
<tr>
<th>Types of examination</th>
<th>Sample</th>
<th>Color</th>
<th>Texture</th>
<th>Foreign material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual examination</td>
<td>S1/1</td>
<td>wet:</td>
<td>Felt sticky and hard to squeeze. Became powder on application of force. So it is clay.</td>
<td>Presence of some fragment of grass roots. Presence leaf fragments Presence of a small red paint flake</td>
</tr>
<tr>
<td></td>
<td></td>
<td>dry:</td>
<td>Yellowish brown</td>
<td>Presence of grass root fragments Presence of dead leaves fragments.</td>
</tr>
<tr>
<td></td>
<td>S1/2</td>
<td>wet:</td>
<td>Clay soil.</td>
<td>Presence of grass root fragments Presence of dead leaves fragments.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>dry:</td>
<td>Yellowish brown</td>
<td>Clay soil.</td>
</tr>
<tr>
<td></td>
<td>S1/3</td>
<td>wet:</td>
<td>Clay soil.</td>
<td>No foreign material present</td>
</tr>
<tr>
<td></td>
<td></td>
<td>dry:</td>
<td>Yellowish</td>
<td>No foreign material present</td>
</tr>
<tr>
<td></td>
<td>S1/4</td>
<td>wet:</td>
<td>Clay soil.</td>
<td>No foreign material present</td>
</tr>
<tr>
<td></td>
<td></td>
<td>dry:</td>
<td>Yellowish</td>
<td>No foreign material present</td>
</tr>
<tr>
<td>Stereomicroscopic examination</td>
<td>S1/1</td>
<td>Color ranges from light yellowish brown, dark brown, to orange</td>
<td>Clay soil.</td>
<td>Presence of grass root fragments Presence of pieces of black dead leaves Small blue paint flake present</td>
</tr>
<tr>
<td></td>
<td>S1/2</td>
<td>Color range from yellowish brown, light brown, to dark brown Some soil has lustrous appearance</td>
<td>Clay soil.</td>
<td>Presence of grass root fragments</td>
</tr>
<tr>
<td></td>
<td>S1/3</td>
<td>Yellowish to black lustrous appearance</td>
<td>Clay soil.</td>
<td>Presence of plant root pieces. black vegetations</td>
</tr>
<tr>
<td></td>
<td>S1/4</td>
<td>Yellowish to dark brown.</td>
<td>Clay soil.</td>
<td>No foreign material present</td>
</tr>
</tbody>
</table>
FIG. 3- Density gradient pattern of soil collected at point S1

FIG. 4- Density gradient pattern of soil collected at point S3

FIG. 5- Density gradient patterns of top soil samples

FIG. 6- Density gradient patterns of soil sample under 1 foot depth
Discussion

The colour of soil is resulted from the presence of various organic matter and coloring agents present in soil. The soil color when wet and dry were observed carefully using munsell chart and recorded. The wet soil is darker than the dry. Agricultural sub soil contains moisture and hence it appeared dark. On physical observation of the land, the claylike color and texture of the soil appeared same throughout that agricultural land. But after drying, sieving, examining of soil samples through the stereomicroscope and subsequent density gradient tube technique analysis showed difference in colors and variation in density distribution pattern. The density gradient tube technique indicated discrimination in the soils collected in the agriculture field, Kota Bharu.

Conclusion

Even though the agricultural land appeared same color and same clay type, examination of soil samples by color, presence of foreign material and by density gradient tube technique showed discrimination of soil even within the same plot of ground. The density gradient tube technique is a simple, easy and inexpensive technique for environmental soil analysis and can be applied for forensic science investigation to link the crime and criminal.

References


Waste Management and Society: A Case Study of Public Participation In Waste Management Kota Kinabalu City

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ABSTRACT: The increase in world population will cause impact on solid waste. This impact is mostly felt by local authorities. Therefore, cooperation with other stakeholders is essential to ensure that municipal solid waste plan works perfectly. Among the most important element is the involvement of public society. This study aimed to introduce waste recycling in the city. In this study, questionnaire was used to achieve the objectives stated. The study found that residents in the study area are not satisfied on the services provided by the municipal. Furthermore, people in the study area ‘refuse’ to engage actively in the recycling activities. This is because they are not motivated and did not realize the benefits to the environment. Thus, the provision of adequate infrastructure is essential. It can help people to change lifestyles to a more environmentally friendly. Municipal level planning should emphasize methods to increase motivation to carry on recycling.

Keywords: Waste management, public participation, Sabah

Introduction

The increase in the world population and industrialisation of more cities mean that managing the waste produced by city inhabitants is a complex issue due not only to the increasing volume of waste through high material consumption but also to the changing characteristics of waste and uncertainty regarding uncontrolled dumping and overflowing landfills. This is especially significant for many cities in the developing world, where populations and economies are rapidly expanding but the infrastructure necessary to manage the ensuing problems remains inadequate.

Over the last century, the world has seen a considerable increase in amounts of waste discharged into the environment. The high generation of solid waste has been identified as a factor contributing to the world environmental problems, and the decrease in suitable landfill sites and scarcity of natural resources is creating greater demand for remanufacturing and reuse. Waste creates environmental consequences such as surface and groundwater contamination by leachate; contamination of the soil by direct waste contact or leachate and of the air when burnt; the spread of diseases by vectors such as birds, insects and rodents; and the uncontrolled release of methane from anaerobic waste decomposition (Ebreo et al., 2002; Mosler et al., 2006; Vidanaarachchi et al., 2006).

At present, annual production of solid waste is estimated to be about 1.6 billion metric tonnes, with a large proportion coming from many developing countries (Ahmed and Ali, 2006). Urban areas in Asia alone produced approximately 760,000 tonnes of municipal solid waste per day in 1998, predicted to rise to 1.8 million tonnes per day in 2025, while waste management costs in this region will almost double from US$ 25 billion (1998) to US$ 47 billion by 2025. This becomes more problematic when the amount of waste produce is affected by an urban lifestyle high in consumption, particularly of packaged consumer goods. To this end, most developing countries spend 20–40% of their revenue employing 3–6 workers per 1000 members of the population on solid waste management (Wilson et al., 2006, Alam et al., 2007).

The introduction of sustainable waste management for today must therefore ensure that waste is managed in such a way that will reduce both the amount and the hazards it presents, and that it is used as a resource wherever possible. The different waste treatment methods suggested in the waste hierarchy have different benefits and drawbacks that are mostly associated with environmental conditions.
considerations. Choosing the best method to manage the waste we produce depends on several interdependent factors including community acceptance, the informal sector, the formal waste collector’s initiative and the local authorities to achieve sustainability in waste management. Achieving a high rate of recovered materials in an environmentally sound manner requires high levels of investment, expenditure and public participation.

Public Participation – Some Important Issues

The public form the largest category of stakeholders in waste management systems and have a multi-faceted relationship with waste management activities: as waste generators, waste service clients, receivers of information and participants in waste management and urban sanitation (Ball and Tavitian, 1992, Joseph, 2006). To support the public in performing its role, it is important to recognise that within a neighbourhood community, households may belong to a variety of social or religious groups and so may vary in their cultural and religious beliefs and practices, main occupations, income and expenditure patterns, access to community and infrastructure services, gender and age. To discover the impact of these factors, many researches have tried to relate individual recycling behaviour to demographic variables; attitudes and understanding of recycling, and the influence of education and publicity materials (De Young, 1990, Coggins, 1994, Ebree et al., 1999). The involvement of the public in waste management depends on initiatives from the local authority (Al-Bakri et al., 1988, Al-Yaqout and Hamoda, 2002) such as provision of basic facilities that possibly attract the public to participate in the local program through waste segregation (De Young, 1990).

Studies found that the cost of waste management is reduced if the community participates by segregating its waste (Agarwal et al., 2005, Rathia, 2006). The substantial reduction in cost with community participation is achieved due to separation of waste at source, which in turn leads to a reduction in the requirement for community bins and transportation of waste (Gupta et al., 1998, Agarwal et al., 2005, Rathia, 2006). However, many local authorities do not recognise the importance of the public in their waste management systems (Awortwi, 2004; Barnes, 1999; Beecher and Goldstein, 2005).

Public cooperation is influenced by the perceived logistics (location of the recycling centre) and convenience of the system. Previous research shows that logistics and convenience have a direct influence on the level of participation (Boldero, 1995, Berger, 1997, Martin et al., 2006). Factors such as time and effort may also play some part in the initiation to participate in recycling but can reinforce the public’s persistence in recycling (Garces et al., 2002). Personal difficulties with space, time availability and distance to and from the containers have a negative effect on recycling performance which shows up in the total recovery rate (Margai, 1997, Seik, 1997, Martin et al., 2006). Study shows that the public will not participate if there is no facility (recycling bank) close to their home or if they are not provided with recycling boxes (Perry et al., 2007). The convenience factor also significantly influences the amount and the variety of materials set aside for recycling (Domina and Koch, 2002).

Geographical location also plays an important role in determining the volume of waste generated per capita and recycling rates, which may vary widely among locations in different municipalities. Differences in regional characteristics such as residential composition, the living and natural environment, types of industries, municipal policies regarding waste disposal and community activities are considered the causes of these variations (Alexander, 1993). The volume of solid waste generated per capita in rural municipalities, which have larger residences, is lower due to the tendency of the residents to store items regarded as waste by city dwellers rather than disposing of them. In contrast, the volume of solid waste generated per capita in urban municipalities is much higher with the high concentration of stores and restaurants in this area (Matsuto and Ham, 1990). Similarly Upadhyaya and Shukla (1987) found that municipality in India shows per capita production in urban areas is greater than in rural areas, at about 350g/day and about 200g/day respectively.

Waste Management in The Study Area

Solid waste management in the study area is under the administration of Kota Kinabalu City Hall (KKCH). There are three departments in KKCH responsible for dealing with solid waste management, i.e. (i) the Urban Service Section, responsible for cleaning the streets, beaches and lagoon and for waste collection, (ii) the Engineering Section, responsible for landfill operations in Kayu Madang, and (iii) the Enforcement Section, responsible for the enforcement of the Anti-litter bylaw. KKCH has passed two bylaws, namely the Kota Kinabalu Municipal Council (conservatory and hygiene) bylaw of 1984 and Kota Kinabalu Municipal Council (Anti-litter) bylaw of 1984. Waste generation in KK rises yearly. In December 2003, the total waste collected was 5755 tonnes, which increased to 6045 tonnes in January 2004 (DBKK, 2002).
It is estimated that in 2015 the amount of waste generated per resident will be 647,112 kg, a rise from 371,700 kg per year (2000) (Department of Statistics Malaysia, 2002). The SUDP study (2000) shows that 50% of residents’ waste is recyclable (paper, plastic, bottle and metal); 40% is compostable (food waste and garden waste), and only 5% cannot be recycled or composted and should go to landfill (TABLE 1). The increasing amount of waste has caused problems for the efficiency of collection. Only 77% of city residents were covered by municipal collection services; this is expected to rise to 94% in the year 2015 (SUDP, 2000). With the estimated waste generated at 6,401 tonnes a month in 2003, the total cost of solid waste management is estimated at RM123.00 per tonne, and most of the solid waste management operation is financed from general revenues such as property assessment rates (Chua 2003, Tunggolu, 2003).

TABLE 1- Sources, quantities and type of waste disposal in study area

<table>
<thead>
<tr>
<th>Source</th>
<th>Waste disposal tonnes/day</th>
<th>Type and quantity of recyclables (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing</td>
<td>99.4</td>
<td>Paper 19.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cardboard 1.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Metal 4.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Plastic 17.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Glass 3.0</td>
</tr>
<tr>
<td>Commercial and Institutional</td>
<td>116</td>
<td>Paper 19.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cardboard 5.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Metal 4.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Plastic 16.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Glass 1.8</td>
</tr>
<tr>
<td>Industry</td>
<td>22.9</td>
<td>Paper 23.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cardboard 4.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Metal 2.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Plastic 25.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Glass 2.4</td>
</tr>
<tr>
<td>Total</td>
<td>238.3</td>
<td></td>
</tr>
</tbody>
</table>

Source: Modified from SUDP, 2000

Research objectives

The objectives of this study are to:
1. Determine public perceptions on waste management in the city
2. Identify the barriers in effort to introduce waste recycling in the city

Methodology

In this study, questionnaire was employed to gather public attitudes to waste management and recycling in the Kota Kinabalu area as it is the suitable approach to collect data from a large population. In a survey, a questionnaire is administered to a selected sample of a specific population. Information can be collected from individuals, households, or larger social institutions.

The public survey was carried out in three main areas: KK (Kota Kinabalu), Menggatal and Telipok. These areas were selected because they form the main part of KK city and are included in the national recycling program. The questionnaire for this study was administered face to face via a brief interview which usually lasted 20–30 minutes. The response was very high (89%). The majority of the questions in the questionnaire were ‘multiple choice’. It was decided that open-ended questions be kept to a minimum, due to the time required to analyse the results and the amount of time required by respondents to answer this type of question.

This study used the total population of Kota Kinabalu (the study area), (355,435 people) as the sampling frame (DOS 2001). To obtain the sample, the population was divided into strata according to location (three major town areas – Kota Kinabalu city centre, Menggatal town centre and Telipok town centre). Upon completion of the survey, 738 questionnaires had been completed. The sample size was considered satisfactory for the purposes of presenting an overall public view on recycling issues in the study area, and fitted the time and cost constraints faced during the data collection process. Chi-square analysis was used.

Study Area

The area selected for this study is Kota Kinabalu, the capital city of Sabah. The study area covers an area of 351 km² and is divided into four types of land use, namely urban, suburban, rural, and marine (coastline and small islands). The KKCH administration area comprises four state legislative areas; Inanam, Likas, Api-Api, and Sembulan. In 2000 the total population was about 371,700
Kota Kinabalu district recorded the highest population density of 598 persons per square kilometre in 1991 and was declared a city with Kota Kinabalu Municipal being upgraded to Kota Kinabalu City Hall in 2000.

![Map of study area](source.png)

**FIG. 1-** Location of study area (Source: SUDP, 2000)

### Results

Four questions were asked to determine public opinion towards waste management services in the study area. There is a clear difference between those who were satisfied with their waste management services and those who were not. Over two thirds (67%) of respondents were not satisfied (including very unsatisfied) with the level of waste management services provided, while only 27% from the total sample stated that they were satisfied or very satisfied. In the city centre more respondents (28.6%) were satisfied than elsewhere (18.7%). The chi-square hypothesis that there is no relationship between location and satisfaction is therefore rejected ($X^2=10.07, df=1, p<0.01$). This seems to represent the fact that respondents in the city centre were 0.572 less satisfied than
respondents from elsewhere.

To obtain information on respondent’s understanding on recycling, five questions were asked. Even though the recycling program has been promoted since 2000, the level of understanding among the public is considered poor (Kuman 2003). 92% of respondents claimed knowledge of recycling, particularly those with a high level of education. The majority of respondents had a good understanding of the objective of recycling (80.6%), with a high number of respondents mentioning the environmental benefits; 52% of respondents stated that recycling will reduce environmental pollution and, 21.7% of the respondents stated that it will reduce the use of virgin material.

The results indicate that respondents in the study area possess a high level of resistance to the practice of reducing and reusing waste. The low response to the question on recycling intention behaviour is one example of the lack of willingness to practising recycling. In general, personal attitudes are the most frequent reasons quoted as barriers to waste segregation as seen in respondent’s answer which indicate only 20% respondents currently claimed to separate their waste. When asked on willingness to practise reuse behaviour, only 19.4% of the respondents are willing to reuse recyclable materials. With regard to recycling behaviour, the result shows that the main reason given by respondents for not recycling was lack of motivation (58.7%), or that they do not consider separating their recyclable waste to be their job (18%).

The final part of the analysis was trying to identify the relationship between knowledge and behaviour. It clearly shows that respondents who know or think they know about recycling (677), 27.2% say they are willing to consider reducing their use of non-biodegradable materials, while 72.8% do not. Respondents who know about recycling are 2.47 times more likely to reduce their use of non-biodegradable materials than those who do not know about recycling ($X^2=5.75, df=1, p=0.01$).

Discussion

Sometimes there are situations in which the difficulty experienced by urban managers in planning and directing concrete projects in a cost effective way may overshadow the need for technical solutions to municipal solid waste management (MSWM) problems. In other cases, there is a tendency for MSWM decisions to be made without sufficient planning, to take into account only some aspects of a situation, to be based on a short-term view of the situation, or to be influenced by the interests of political elites. Adequate MSWM is much more than a technological issue – always also involves institutional, social, legal, and financial aspects and involves coordinating and managing a large workforce and collaborating with many involved stakeholders as well as the general public.

The preparation and management of a good solid waste management system needs inputs from a range of disciplines, and careful consideration of local conditions. Municipal solid waste collection schemes of cities in the developing world generally serve only a limited part of the urban population. The people remaining without waste collection services are usually the low-income population living in peri-urban areas. One of the main reasons is the lack of financial resources to cope with the increasing amount of generated waste produced by the rapid growing cities. Often inadequate fees charged and insufficient funds from a central budget can not finance adequate levels of service. However not only financial problems affect the availability or sustainability of a waste collection service. Operational inefficiencies of SW services operated by municipalities can be due to inefficient institutional structures, inefficient organizational procedures, or deficient management capacity of the institutions involved as well as the use of inappropriate technologies. With regard to the technical system, often the "conventional" collection approach, as developed and used in the industrialized countries, is applied in developing countries.

The public survey result indicates that most of the public are still not satisfied with the level of waste management service in Kota Kinabalu. Most respondents mention that collection efficiency is the main reason for their lack of satisfaction with only resident in city area satisfied with the service. This might be related to the failure of a private contractor to deliver the service during the privatisation of waste collection in KK area. The level of recycling knowledge among KK residents is very high, particularly in those with tertiary education and students. This might be related to a fact that these groups have been exposed to this matter at school level. To this end, most respondents believed that the recycling program is a good initiative to protect the environment from pollution. Knowledge and understanding do not necessarily mean that they really know all elements of the program. In general, the actual knowledge of respondents in KK is very low.

Even though many respondents claimed to know about the recycling program from the television, they still could not give a positive answer to recycling questions. This study revealed that a high
percentage (5%) of respondents claim to not separate their waste, and very few are willing to change their behaviour, particularly to reducing their use of or reusing non-biodegradable material. Most respondents believe that this matter is the responsibility of the local authority, and due to this attitude many claim to have a problem separating their waste (38%) either at home or in the workplace. Lack of motivation is the main reason for this. This relates to a low understanding of the importance of the program and insufficient recycling facilities in the housing area, which hinders public participation and leads them to dispose of waste in the usual way.

Conclusion

The results obtained from the analysis identify several important areas for discussion. Providing relevant information will enhance respondents’ knowledge and behavior. Respondents with a high level of education also have a good understanding of the benefits of recycling. Apart from the public attitude to the recycling program, contributions from other sectors are also important. Customer satisfaction is an important aspect in the administration of solid waste management in urban areas. Thus, the provision of adequate infrastructure is essential. It can help people to change lifestyles to more environment-friendly. Municipal level planning should emphasize methods to increase motivation to carry on recycling.

References


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