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**USM J/P- 06**

**BAHAGIAN PENYELIDIKAN & PEMBANGUNAN**
**CANSELORI**
**UNIVERSITI SAINS MALAYSIA**



Laporan Akhir Projek Penyelidikan Jangka Pendek

1) Nama Penyelidik : **Prof Madya (Dr) Zulkifli bin Ahmad**

Nama Penyelidik-Penyelidik Lain (Jika berkaitan) : **Prof Madya (Dr) Syed Hatim Noor**
**Dr Sharina bt Dir**

2) Pusat Pengajian/Pusat/Unit : **Jabatan Perubatan Masyarakat, Pusat Pengajian Sains Perubatan.**

3) Tajuk Projek: **Respiratory symptoms, lung function and cognitive performance of the primary school children exposed to secondhand smoke at home in Kota Bharu Kelantan.**

4) (a) Penemuan Projek/Abstrak
(Perlu disediakan makluman di antara 100 – 200 perkataan di dalam Bahasa Malaysia dan Bahasa Inggeris. Ini kemudiannya akan dimuatkan ke dalam Laporan Tahunan Bahagian Penyelidikan & Pembangunan sebagai satu cara untuk menyampaikan dapatan projek tuan/puan kepada pihak Universiti).

**- seperti lampiran-**

(b) Senaraikan Kata Kunci yang digunakan di dalam abstrak:

| Bahasa Malaysia | Bahasa Inggeris |
|---|---|
| Simptom pernafasan | Respiratory symptoms |
| Fungsi paru-paru | Lung function |

Keupayaan kognitif — Cognitive performance

Perokok pasif — Secondhand smoke exposure

Pelajar sekolah rendah — Primary school children

5) Output Dan Faedah Projek

(a) Penerbitan (termasuk laporan/kertas seminar)
(Sila nyatakan jenis, tajuk, pengarang, tahun terbitan dan di mana telah diterbit/dibentangkan).

**Pembentangan**

| No. | Topic presentation | Place of presentation | Date |
|---|---|---|---|
| 1. | Secondhand smoke exposure and respiratory symptoms of primary school children in Kota Bharu Kelantan. | Kolokium Kebangsaan Kesihatan Masyarakat ke XI di Hotel Summit Subang | 21 – 22 Sep 2004 |
| 2. | Effect of Secondhand smoke on cognition of Primary School Children in Kota Bharu Kelantan. | 4th National Public Health Conference 2005 Marriot Putrajaya | 15 – 17 Mac 2005 |
| 3. | Respiratory symptoms and lung function of primary school children exposed to secondhand smoke at home in Kota Bharu Kelantan | Persidangan Kesihatan Negeri Kelantan Ke IV Pusat Pengajian Sains Pergigian USM Kelantan | 6 – 7 Jul 2005 |

**MANUSCRIPT SENT FOR PUBLCATION (MJPHM)**

1. Secondhand smoke exposure at home and respiratory symptoms among primary school children in Kota Bharu Kelantan

2. Lung function and cognitive performance of the primary school children exposed to secondhand smoke at home in Kota Bharu Kelantan.

(b) Faedah-Faedah Lain Seperti Perkembangan Produk, Prospek Komersialisasi Dan Pendaftaran Paten.
(Jika ada dan jika perlu, sila guna kertas berasingan)

**Tiada**

(c) Latihan Gunatenaga Manusia

**i)** Pelajar Siswazah: **Dr Sharina bt Dir**

ii) Pelajar Prasiswazah: **Tiada**

iii) Lain-Lain : **Seorang pembantu penyelidik**

6. Peralatan Yang Telah Dibeli:

2 unit Child Mini Wright peak expiratory flow meter

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**UNTUK KEGUNAAN JAWATANKUASA PENYELIDIKAN UNIVERSITI**

Laporan kemajuan penyelidikan telah dapat mendapat objektif.

T/TANGAN PENGERUSI
J/K PENYELIDIKAN
PUSAT PENGAJIAN

PROFESSOR ABDUL AZIZ BABA
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## ABSTRACT

**TOPIC:**

Respiratory symptoms, lung function and cognitive performance of the primary school children exposed to secondhand smoke at home in Kota Bharu Kelantan.

**INTRODUCTION:**

In recent years, there has been concern that non-smokers may also be at risk for some of health affects from secondhand smoke exposure, especially children. Among the harmful effects of secondhand smoke exposure were increased risk of respiratory symptoms, middle ear diseases, sudden infant death, behavioral problems, neurocognitive decrements and becoming adolescent smokers.

**OBJECTIVE:**

This study was aimed at determining the prevalence of secondhand smoke exposure at home, the association between secondhand smoke exposure and respiratory symptoms, lung function and cognitive performance among primary school children in Kota Bharu, Kelantan.

**METHOD:**

A comparative cross-sectional study was conducted from September 2003 to March 2004 on 795 primary school children who were randomly selected from 10 government primary schools in Kota Bharu, Kelantan. A self-administered questionnaire was used to obtain information on sociodemography status, respiratory symptoms and smokers in the household. Peak expiratory flow rate (PEFR), height and weight of the children were measured. Cognitive performances were assessed using Arithmetic, Digit Span Forward and Backward and Coding subtests of the Wechsler Intelligence Scales for Children-III (WISC-III). Analyses were conducted using SPSS version 11 and STATA.





**RESULTS:**

A total of 795 children involved in this study with 48.6% boys and 51.4% girls. The distribution by class was: Primary 4; 35.3%; Primary 5; 29.9% and Primary 6; 34.7%. 45% of the children lived with 1 smoker, 9.2% lived with 2 smokers, 1.1% lived with 3 smokers and 0.3% lived with 4 smokers. A total of 55.6% children lived with at least 1 smoker in the house. The most common source for the exposure was smoking by fathers. Significant associations were observed between secondhand smoke exposure and cough in the morning (OR=1.67, 95% CI=1.18, 2.39), cough at night (OR=1.59, 95% CI=1.10, 2.30), cough most days for the previous 3 months (OR= 1.76, 95% CI=1.16, 2.65), phlegm in the morning (OR=1.57, 95% CI=1.14, 2.17), phlegm during daytime or at night (OR=1.49, 95% CI=1.08, 2.07), nose problems in the morning (OR=1.38, 95% CI=1.03, 1.86), nose problems at night (OR=1.40, 95% CI=1.03, 1.90), throat problems in the morning (OR=1.57, 95% CI= 1.05, 2.36), throat problems during daytime (OR=1.81, 95% CI=1.15, 2.85) throat problems at night (OR=1.78, 95% CI=1.14, 2.78) and ever wheeze or diagnosed asthma by doctor (OR=1.55, 95% CI=1.06, 2.26). The odds ratios increased with increasing number of smokers at home for cough in the morning, cough most days for the previous 3 months, phlegm in the morning, ever wheeze or diagnosed asthma by doctor, throat problems in the morning, throat problems during daytime and throat problems at night. The PEFR was lower in exposed children but not statistically significant. Digit Span Forward, Digit Span Backward and Coding scores were lower in exposed children but also not significant.

**CONCLUSION:**

More than half of the primary school children in Kota Bharu were exposed to secondhand smoke from at least one smoker in the house. The most common source of exposure was smoking by fathers. There was an association between secondhand smoke exposure and respiratory symptoms among the school children. No significant associations were observed between secondhand smoke exposure and PEFR and cognitive performance. In view of significant health risks posed to children by secondhand smoke exposure, public health policies and education are needed to protect this vulnerable population.

## ABSTRAK

**TAJUK:**

Simptom pernafasan, fungsi paru-paru dan kepayaan kognitif di kalangan pelajar sekolah rendah di Kota Bharu yang terdedah kepada asap rokok secara pasif semasa berada di rumah.

**PENGENALAN:**

Kebelakangan ini banyak diperkatakan bahawa mereka yang tidak merokok juga berisiko untuk mendapat masalah kesihatan hasil daripada pendedahan kepada asap rokok terutamanya di kalangan kanak-kanak. Di antara kesan negatif yang dihadapi oleh perokok pasif adalah peningkatan masalah pernafasan, penyakit telinga tengah, kematian bayi secara mengejut, masalah kelakuan, penurunan neurokognitif dan peningkatan kebarangkalian merokok semasa remaja.

**OBJEKTIF:**

Kajian ini bertujuan untuk menentukan prevalens kanak-kanak sekolah rendah di Kota Bharu yang terdedah kepada asap rokok di rumah dan juga mengetahui kaitan di antara pendedahan tersebut dengan simptom pernafasan, fungsi paru-paru dan keupayaan kognitif di kalangan mereka.

**KAEDAH:**

Kajian hirisan lintang secara perbandingan telah dijalankan ke atas 795 pelajar sekolah rendah yang dipilih secara rawak daripada 10 buah sekolah rendah kerajaan di Kota Bharu, Kelantan. Kajian tersebut telah dijalankan pada bulan September 2003 sehingga March 2004. Borang soal selidik yang mengandungi data sociodemografi, simptom pernafasan dan bilangan ahli rumah yang merokok telah digunakan. 'Peak expiratory flow rate' (PEFR), ketinggian dan berat badan pelajar telah diukur. Keupayaan kognitif pelajar dinilai menggunakan ujian 'Arithmetic', 'Digit Span Forward', 'Digit Span Backward', dan 'Coding' daripada 'Wechsler Intelligence Scale for Children' (WISC-III). Analisa adalah menggunakan SPSS versi 11 dan STATA.

**KEPUTUSAN**

Seramai 795 pelajar terlibat dalam kajian ini dan terbahagi kepada 48.6% lelaki dan 51.4% perempuan. Taburan mengikut kelas adalah: Kelas 4; 35.3%; Kelas 5; 29.9% dan Kelas 6; 34.7%. 45% daripada mereka tingggal bersama seorang perokok, 9.2% tinggal bersama 2 orang perokok, 1.1% tinggal bersama 3 orang perokok, dan 0.3% tinggal bersama 4 orang perokok. 55.6% daripada pelajar tinggal bersama sekurang-kurangnya seorang perokok. Perokok utama adalah bapa pelajar. Terdapat perkaitan yang signifikan di antara perokok pasif dengan batuk waktu pagi (OR=1.67, 95% CI=1.18, 2.39), batuk waktu malam (OR=1.59, 95% CI=1.10, 2.30), batuk kebanyakan hari pada 3 bulan yang lepas (OR= 1.76, 95% CI=1.16, 2.65), kahak waktu pagi (OR=1.57, 95% CI=1.14, 2.17), kahak siang hari ataupun malam (OR=1.49, 95% CI=1.08, 2.07), masalah hidung waktu pagi (OR=1.38, 95% CI=1.03, 1.86), masalah hidung waktu malam (OR=1.40, 95% CI=1.03, 1.90), masalah kerongkong waktu pagi (OR=1.57, 95% CI= 1.05, 2.36), masalah kerongkong waktu siang (OR=1.81, 95% CI=1.15, 2.85) masalah kerongkong waktu malam (OR=1.78, 95% CI=1.14, 2.78) dan masalah dada berbunyi seperti siulan atau berpenyakit asthma (OR=1.55, 95% CI=1.06, 2.26). Terdapat peningkatan nisbah odds dengan bertambahnya bilangan perokok di rumah untuk simptom batuk waktu pagi, batuk kebanyakan hari pada 3 bulan yang lepas, kahak waktu pagi, masalah kerongkong waktu pagi, masalah kerongkong siang, masalah kerongkong waktu malam dan masalah dada berbunyi atau berpenyakit asthma. Nilai 'PEFR' adalah rendah di kalangan kanak-kanak yang terdedah kepada asap rokok tetapi tidak bermakna secara statistik. Nilai 'Digit Span Forward', 'Digit Span Backward' and 'Coding' juga rendah di kalangan kanak-kanak yang terdedah kepada asap rokok tetapi tidak bermakna secara statistik.

**KESIMPULAN:**

Lebih separuh daripada pelajar sekolah rendah di Kota Bharu terdedah kepada asap rokok secara pasif di rumah terutamanya daripada bapa yang merokok. Terdapat kaitan yang siknifikan di antara pendedahan kepada asap rokok secara pasif di kalangan pelajar

dengan masalah pernafasan. Tiada kaitan yang siknifikan di antara perokok pasif dengan PEFR dan keupayaan kognitif. . Oleh sebab terdapat risiko masalah kesihatan yang tinggi terhadap kanak-kanak yang terdedah kepada asap rokok, polisi kesihatan awam dan





**SECONDHAND SMOKE EXPOSURE AT HOME AND RESPIRATORY SYMPTOMS AMONG PRIMARY SCHOOL CHILDREN IN KOTA BHARU, KELANTAN.**

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**ABSTRACT**

In recent years, there has been concern that non-smokers may also be at risk from secondhand smoke exposure, especially children. This study was done to determine the prevalence of secondhand smoke exposure at home and the association between secondhand smoke exposure and respiratory symptoms among primary schoolchildren in Kota Bharu, Kelantan. This was a comparative cross-sectional study involving children, aged 10-12 years. A structured questionnaire was used to obtain the information on sociodemographic, respiratory symptoms and smokers in the house. A random sample of 10 from 95 primary schools in Kota Bharu was included. Six classes were randomly selected from each school, two classes each from each school year of primary 4-6. A total of 795 children completed the questionnaire during September 2003 till March 2004. 386 of children (48.6%) were boys and 409 children (51.4%) were girls. Most of the children were Malay (99.9%). A total of 442 (55.6%) children lived with at least 1 smoker in the house mainly from the smoking fathers. Significantly increased odds ratios due to secondhand smoke exposure were observed for most of the respiratory symptoms. The odds ratios (95% confidence interval) were 1.67 (1.18, 2.39) for cough in the morning, 1.59 (1.10, 2.30) for cough at night, 1.76 (1.16, 2.65) for cough most days for the previous 3 months, 1.57 (1.14, 2.17) for phlegm in the morning, 1.49 (1.08, 2.07) for phlegm during daytime or at night, 1.38 (1.03, 1.86) for nose problems in the morning, 1.40 (1.03, 1.90) for nose problems at night and 1.78 (1.14, 2.78) for throat problems at night, 1.55 (1.06, 2.26) for ever wheeze or diagnosed asthma by doctor, 1.57 (1.05, 2.36) for throat problems in the morning and 1.81 (1.15, 2.85) for throat problems during daytime. The odds ratios increased with increasing number of smokers at home for cough in the morning, cough most days for the previous 3 months, phlegm in the morning, ever wheeze or diagnosed asthma by doctor, throat problems in the morning, throat problems during daytime and throat problems at night. In view of the significant health risks posed to children by secondhand smoke, public health policies are needed to protect this vulnerable population. The aim of such policies is to ensure the right of every child to grow up in an environment free of tobacco smoke.

## INTRODUCTION

Secondhand smoke is derived from a mixture of side-stream smoke and mainstream smoke. Side-stream smoke contains considerably higher concentrations of many carcinogenic and toxic substances than the mainstream smoke (US EPA, 1992). Exposure to secondhand smoke is defined as the exposure of a person to tobacco combustion products from smoking by others (US DHHS, 1986). Exposure to secondhand smoke is also used to describe exposure of a fetus to tobacco combustion products and/or their metabolites from an actively or passively smoking mother (Spitzer *et al.*, 1990). Given that more than a thousand million adults smoke worldwide, WHO estimated that around 700 million, or almost half of the world's children breathe air polluted by tobacco smoke, particularly at home (WHO, 1997). When the exposure was classified into numbers of household smokers, Lam *et al.* (1999) in Hong Kong found that 32.9% of the children were living with one smoker, 8.6% with two smokers, 2.5% with three smokers, 1.3% with 4 smokers and 2.1% with 5 or more smokers.

Respiratory diseases are a major health burden in children. An estimated 150,000-300,000 case of lower respiratory tract infections in children younger than 18 months are annually attributed to secondhand smoke (US EPA, 1992). In Malaysia, symptoms of upper respiratory tract infections represented about 35% of medical problems among adolescents who seek treatment from health clinics in certain districts (MOH, 2000). Many studies have shown that secondhand smoke exposure can cause respiratory ill health in children. For example, Strachan & Cook (1997) found that in households where both parents smoked, young children have a 72 % increased risk of respiratory illnesses. Lam *et al.* (1999) found that in never smokers who were exposed to secondhand smoke, there was an increased risk of throat problems, any cough, any phlegm, ever wheezing and nose problems. The excess risks ranged from 15 to 46%. The odds ratios for the symptoms increased with increasing number of smokers at home. These results suggested a 'dose-response relationship' and provided strong evidence that the association between respiratory ill health and secondhand smoke exposure was likely to be causal.

The objectives of the present study were to determine the prevalence of secondhand smoke exposure at home among primary school children in Kota Bharu, Kelantan and to determine the association between secondhand smoke exposure and respiratory symptoms among them.

## Methods

A comparative cross-sectional study was conducted to determine the association between secondhand smoke exposure at home and respiratory symptoms. Ten out of ninety five government primary schools in Kota Bharu were selected by simple random sampling. For each school, two classes were randomly selected from each primary four, five and six. All children who were consented by parents or guardian and fulfilled the inclusion criteria were included in the study. A questionnaire was used in this study which consisted of 2 sections. The first section of the questionnaire was answered by the children in the classroom with the guidance from the researcher. It required responses on name, sex, race, class and school, respiratory symptoms and secondhand smoke exposure of the children. Questions on respiratory symptoms were adapted and translated from the Medical Research Council Respiratory Questionnaire 1986. Minor changes were made to several questions in the questionnaire to suit the local situation. The second section of the questionnaire was answered by parents or guardian. It required responses on sociodemographic, medical history of the children and household smoking status. Data collection commenced in September 2003 and data collection was completed in March 2004.

Data analysis was done using Stata Intercooled 7.0 software. Children were classified as exposed to secondhand smoke at home when at least one household member smoked (Lam *et al.*, 1999). Simple logistic regression and Multiple logistic regression were used to determine the association between secondhand smoke exposure and respiratory symptoms among schoolchildren and the confounders selected were sex, class, family history of asthma, parental educational status and family income.

## Results

A total of 795 children from ten selected government primary schools in Kota Bharu were included in this study. A total of 386 of children (48.6%) were boys and 409 children (51.4%) were girls. The distribution by class was: Primary 4; 35.3%; Primary 5; 29.9% and Primary 6; 34.7%. Most of the children were Malay (99.9%) with only 1 Indian child who was included in this study. There was no Chinese child. There were 358 (45%) children who lived with 1 smoker, 73 (9.2%) lived with 2 smokers, 9 (1.1%) lived with 3 smokers and 2 (0.3%) lived with 4 smokers in the household. A total of 442 (55.6%) children lived with at least 1 smoker in the house. There were 389 (48.9%) children having currently smoking fathers. None of the mothers smoked.

Table 1 shows the prevalence and risks of respiratory symptoms in exposed and non-exposed children to secondhand smoke at home. The most prevalent symptom among the exposed group was nose problems in the morning (48.2%). The least prevalent symptom among the same group was throat problems during daytime (15.8%). For the unexposed children, the most prevalent symptom was also nose problems in the morning (41.1%) and the least prevalent symptom was also throat problems during daytime (9.1%). At multivariate level, 11 respiratory symptoms were significantly associated with secondhand smoke exposure. Only nose problems during daytime were not associated with the exposure. The odds ratios (95% confidence interval) were 1.67 (1.18, 2.39) for cough in the morning, 1.59 (1.10, 2.30) for cough at night, 1.76 (1.16, 2.65) for cough most days for the previous 3 months, 1.57 (1.14, 2.17) for phlegm in the morning, 1.49 (1.08, 2.07) for phlegm during daytime or at night, 1.38 (1.03, 1.86) for nose problems in the morning, 1.40 (1.03, 1.90) for nose problems at night and 1.78 (1.14, 2.78) for throat problems at night, 1.55 (1.06, 2.26) for ever wheeze or diagnosed asthma by doctor, 1.57 (1.05, 2.36) for throat problems in the morning and 1.81 (1.15, 2.85) for throat problems during daytime.

Table 1 Prevalence and risks of respiratory symptoms among exposed and unexposed children to secondhand smoke

| Symptoms | Exposed No (%) | Non exposed No (%) | Crude OR 95% CI | Adjusted OR 95% CI |
|---|---|---|---|---|
| Yes | 119 (26.9) | 66 (18.7) | 1.60 | 1.67 |
| No | 323 (73.1) | 287 (81.3) | (1.14, 2.25) | ( 1.18, 2.39) |
| 2. Cough night | | | | |
| Yes | 117 (26.5) | 66 (18.7) | 1.56 | 1.59 |
| No | 325 (73.5) | 287 (81.3) | (1.11, 2.20) | (1.10, 2.30) |
| 3. Cough 3 months | | | | |
| Yes | 99 (22.4) | 46 (13.0) | 1.93 | 1.76 |
| No | 343 (77.6) | 307 (87.0) | (1.32, 2.82) | (1.16 2.65) |
| 4. Phlegm morning | | | | |
| Yes | 152 (34.4) | 85 (24.1) | 1.65 | 1.57 |
| No | 290 (65.6) | 268(75.9) | (1.21, 2.26) | (1.14 2.17) |
| 5. Phlegm day or night | | | | |
| Yes | 130 (29.4) | 77 (21.8) | 1.49 | 1.49 |
| No | 312 (70.6) | 276 (78.2) | (1.08, 2.07) | (1.08, 2.07) |
| 6.Ever wheeze or diagnosed asthma | | | | |
| Yes | 93 (21.0) | 51 (14.4) | 1.58 | 1.55 |
| No | 349 (79.0) | 302 (85.6) | (1.08, 2.95) | (1.06, 2.26) |
| 7. Nose problems morning | | | | |
| Yes | 213 (48.2) | 145 (41.1) | 1.33 | 1.38 |
| No | 229 (51.8) | 208 (58.9) | (1.00, 1.77) | (1.03, 1.86) |
| 8. Nose problems daytime | | | | |
| Yes | 168 (38.0) | 111 (31.4) | 1.34 | 1.34 |
| No | 274 (62.0) | 242 (68.6) | (0.99, 1.80) | (0.99, 1.80) |
| 9. Nose problems night | | | | |
| Yes | 182 (41.2) | 120 (34.0) | 1.36 | 1.40 |
| No | 260 (58.8) | 233 (66.0) | (1.02, 1.82) | (1.03, 1.90) |
| 10. Throat problems morning | | | | |
| Yes | 80 (18.1) | 45 (12.7) | 1.51 | 1.57 |
| No | 362 (81.9) | 308 (87.3) | (1.02, 2.25) | (1.05, 2.36) |
| 11. Throat problems daytime | | | | |
| Yes | 70 (15.8) | 32 (9.1) | 1.89 | 1.81 |
| No | 372 (84.2) | 321 (90.0) | (1.21, 2.94) | (1.15, 2.85) |
| 12. Throat problems at night | | | | |
| Yes | 75 (17.0) | 35 (9.9) | 1.86 | 1.78 |
| No | 367 (83.0) | 318 (90.1) | (1.21, 2.88) | (1.14, 2.78) |

The associations between secondhand smoke exposure and the respiratory symptoms were further compared according to number of household smokers (no smoker, 1 smoker and two or more smokers). The odds ratios increased with increasing number of smokers at home for cough in the morning, cough most days for the previous 3 months, phlegm in the morning, ever wheeze or diagnosed asthma by doctor, throat problems in the morning, throat problems during daytime and throat problems at night. No increased in odds ratio observed for cough at night, phlegm during daytime or at night, nose problems at any time (table 2).

Table 2 Adjusted odds ratios (OR) for respiratory symptoms by number of smokers at home

| Symptoms | 0 smoker | 1 smoker OR (95% CI) | ≥ 2 smokers OR (95% CI) |
|---|---|---|---|
| 1. Cough, morning | 1.00 | 1.51 (1.06, 2.17) | 2.22 (1.31, 3.76) |
| 2. Cough, night | 1.00 | 1.62 (1.11, 2.36) | 1.48 (0.80, 2.71) |
| 3. Cough for 3 months | 1.00 | 1.76 (1.15, 2.70) | 2.34 (1.18, 4.23) |
| 4. Phlegm, morning | 1.00 | 1.48 (1.06, 2.07) | 2.04 (1.23, 3.41) |
| 5. Phlegm, day or night | 1.00 | 1.49 (1.06, 2.09) | 1.52 (0.90, 2.58) |
| 6. Ever wheeze or diagnosed Asthma | 1.00 | 1.48 (0.99, 2.20) | 1.88(1.05, 3.36) |
| 7. Nose problem, morning | 1.00 | 1.47 (1.08, 2.00) | 1.02 (0.61, 1.71) |
| 8. Nose problem, daytime | 1.00 | 1.34 (0.98, 1.83 | 1.31(0.80, 2.17) |
| 9. Nose problem, night | 1.00 | 1.38 (1.02, 1.87) | 1.23 (0.75, 2.01) |
| 10. Throat problem, morning | 1.00 | 1.45 (0.95, 2.22) | 2.20 (1.18, 4.08) |
| 11. Throat problem, daytime | 1.00 | 1.74 (1.09, 2.79) | 2.11 (1.08, 4.11) |
| 12. Throat problem, night | 1.00 | 1.71 (1.07, 2.71) | 2.17 (1.10, 4.27) |

## Discussion

In this study the exposure was measured by questionnaire and Jennifer A. Seifert *et al.* (2002) has proved that a questionnaire survey reflected the child's exposure to secondhand smoke and the survey was sensitive to varying levels of exposure. Assuming that the smoking family members did smoke at home this study found that 55.6% of the children were exposed to at least one smoker at home mainly from the father. None of the children have a smoking mother. One advantage of not having mothers who smoked was that the problem of determining whether the effects of secondhand smoke exposure were intra or extra uterine can be avoided. However the use of paternal smoking as a proxy for secondhand smoke exposure of children can be problematic, as fathers were generally less likely to be the main caregiver these children. When categorized into number of smoking household, 45% children lived with 1 smoker, 9.2% lived with 2 smokers, 1.1% lived with 3 smokers and 0.3% lived with 4 smokers. The prevalence of secondhand smoke exposure among children in this study was comparable to other studies in other countries. For example, WHO estimated that almost half of the world's children breathe

air polluted by tobacco smoke, particularly at home. Lam *et al.* (1999) in Hong Kong also observed about 47% of the children exposed to secondhand smoke particularly at home.

This study found a number of statistically significant associations between secondhand smoke exposure and respiratory symptoms among children. Significant associations were seen for cough in the morning (OR=1.67), cough at night (OR=1.59), cough most days for the previous 3 months (OR=1.76), phlegm in the morning (OR=1.57), phlegm during daytime or at night (OR=1.49), nose problems in the morning (OR=1.38), nose problems at night (OR=1.40), throat problems at night (OR=1.78), ever wheeze or diagnosed asthma by doctor (OR=1.55) throat problems in the morning (OR=1.57) and throat problems during daytime (OR=1.81). No significant odds ratios observed for nose problems during daytime. In this study, ever wheeze or diagnosed asthma was combined because it was felt that 'doctor diagnosed asthma' alone was inappropriate since a large number of Malaysian children with symptoms may not have been diagnosed by a doctor giving rise to possible bias. It must be borne in mind that all the symptoms studied were self reported by the children, and what was considered 'usually' may vary from one child to another. Nevertheless, the term was probably a reasonably good measure because it expresses the child's own feeling. A study by Burr *et al.* (1999) supported that symptoms of wheeze and cough were reported more frequently by children than by parents answering on their behalf; presumably because the children were aware of symptoms that occurred when they were not in their parents' company. Therefore, if he or she has the symptoms enough to be aware of it and considered it to be frequent, it is clearly a health problem. Many studies which showed a positive association between secondhand smoke exposure and respiratory symptoms also demonstrated a dose-response relationship for example Lam *et al.* (1999) showed that the adjusted odds ratio increased with increasing number of smokers at home for throat problems, cough, phlegm and nose problems. This study also observed a dose response relationship for cough in the morning, coughs most days for the previous 3 months, phlegm in the morning, ever wheeze or diagnosed asthma by doctor, throat problems in the morning, throat problems during daytime and throat problems at night.

This study provided evidence that secondhand smoke exposure can cause respiratory ill health among primary school children in Kota Bharu. In view of that public health policies are needed to protect this vulnerable population. The aim of such policies is to ensure the right of every child to grow up in an environment free of tobacco smoke. Government has a responsibility to legislate and to enforce the legislation to control exposure to secondhand smoke in public places. Legislation is of limited value in reducing exposure in private homes. Educational strategies including education about the risks to children from secondhand smoke exposure and steps to eliminate exposure are likely to be more effective in these setting.

However our study also has several limitations which were beyond the control of the author and scope of the study. The main limitation of the study was that the smoking status of the children was not asked in the questionnaire. This is because it is a very sensitive issue and the children may not give a valid answer to the question. The second limitation was the cross-sectional design of the study. Because passive smoking and respiratory symptoms were measured at the same time, the time sequence of the associations observed could not be ascertained definitively. Other sources of indoor air pollution such as cooking stoves and domestic insect repellents were not included and this factor should be considered in the future.

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# LUNG FUNCTION AND COGNITIVE PERFORMANCE OF THE PRIMARY SCHOOL CHILDREN EXPOSED TO SECONDHAND SMOKE AT HOME IN KOTA BHARU, KELANTAN.

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## ABSTRACT

**Introduction**: Exposure to secondhand smoke has consistently been linked with adverse health effects in children, including middle ear disease, various respiratory difficulties, decreased lung function and sudden infant death syndrome. There was increasing but inconsistent evidence that tobacco smoke exposure was also linked with intellectual impairments and behavioral problems in children.

**Objectives**: To determine the association between secondhand smoke exposure and peak expiratory flow rate (PEFR) and the association between secondhand smoke exposure and cognitive performance among the primary school children in Kota Bharu Kelantan.

**Methodology**: In this cross sectional study, a random sample of ten out of ninety five government primary schools in Kota Bharu was included. For each school, two classes were randomly selected from each primary four, five and six. A questionnaire was used to obtain information on sociodemography and smoking status of the household. A child Mini Wright peak expiratory flow meter was used to measure the PEFR. Cognitive performance was assessed by using four subtests of WISC III. Data analysis was done using SPSS version 11. Children were classified as exposed to secondhand smoke when at least one household member smoked.

**Result**: A total of 795 children were included in this study and 442(55.6%) children exposed to secondhand smoke at home. Mean(SD) PEFR for unexposed and exposed children were 266.18(60.80) l/min and 266.06(57.70) l/min respectively. Mean(SD) scores for Digit Span Forward, Digit Span Backward Coding and Arithmetic in unexposed children were 6.84(1.80), 4.27(1.68), 45.25(9.99) and 8.04(1.04) respectively. Mean (SD) scores for exposed children were 6.73(1.77), 4.07(1.65), 45.11(11.03) and 8.13(1.00) respectively. After controlling for confounders analysis showed no significant difference of the mean PEFR between exposed and unexposed children (p=0.816) and no significant difference of the mean cognitive test scores between exposed and unexposed children (p = 0.739).

**Conclusion**: These data indicate no association between secondhand smoke exposure and PEFR or cognitive performance among primary school children in Kota Bharu Kelantan.

## Introduction

Secondhand smoke is also called "environmental tobacco smoke" and secondhand smoke exposure is frequently used interchangeably with "involuntary smoking" and "passive smoking" (NCI, 1999). Secondhand smoke is derived from a mixture of side-stream smoke and mainstream smoke. Side-stream smoke contains considerably higher concentrations of many carcinogenic and toxic substances than the mainstream smoke (US EPA, 1992). Nearly 85 % of smoke in a room results from side-stream smoke. Secondhand smoke is a major source of indoor air pollution, contributing to a noxious environment, eye irritation and unpleasant odour (Fielding & Phenow, 1988). .

Almost half of the world's children breathe air polluted by tobacco smoke, particularly at home (WHO, 1997). Children's exposure is involuntary, arising from smoking, mainly by adults, in the places where children live, work and play (WHO, 1999). The Centers for Disease Control and Prevention (CDC) reported prevalence of children's secondhand smoke exposure in the home ranging from 11.7% to 34.2% by state, based upon numbers of homes with an adult smoker where smoking was reportedly allowed in some or all areas (CDC, 1997).

Exposure to environmental tobacco smoke has consistently been linked with adverse health effects in children, including middle ear disease (Cook & Strachan 1999), asthma exacerbations and reduced lung function (Chilmonczyk *et al.*1993; Martinez *et al.* 1992), various respiratory difficulties (Cook & Strachan 1999). Lung function, as indicated by the $FEV_1$ and FVC was significantly decreased by 8.1% and 5.6%, respectively, in children with high levels of smoke exposure compared with those children with low levels of exposure (Mannino *et al.*, 2002). Chilmonczyk *et al.* (1993) reported that pulmonary function was impaired and acute exacerbation of asthma increased as secondhand smoke exposure increased. A meta-analysis of 21 studies found a reduction in forced expiratory volume in 1 second of 1.4%, mid-expiratory flow rate of 5 % and end-expiratory flow rates of 4.3% in children exposed to secondhand smoke (Cook & Strachan, 1998).

There is increasing but inconsistent evidence that tobacco smoke exposure is also linked with intellectual impairments and behavioral problems in children. Associations with cognitive and achievement problems such as early grade retention (Byrd & Weitzman 1994), reduced vocabulary and reasoning abilities (Eskenazi & Bergmann 1995), and cognitive and intellectual deficits among children (Bauman *et al.* 1991) have also been reported. Still, questions about the role of secondhand smoke exposure remain (Eskenazi & Castorina 1999).

The objectives of this study were to determine the association between secondhand smoke exposure and peak expiratory flow rate (PEFR) and to determine the association between secondhand smoke exposure and cognitive performance among the primary school children in Kota Bharu Kelantan.

## Methodology

A cross-sectional study was conducted to determine the association between secondhand smoke exposure at home and difference in peak expiratory flow rate (PEFR) and cognitive tests scores of primary schoolchildren in Kota Bharu Kelantan. Ten out of ninety five government primary schools in Kota Bharu were selected by simple random sampling. For each school, two classes were randomly selected from each primary four, five and six. All children who were consented by parents or guardian and fulfilled the inclusion criteria were included in the study. The children were excluded from the study if they were identified by their teacher to be a slow learner or they were absent from school on the day of survey or they have any medical illness except asthma. This was a part of study to determine the association between secondhand smoke exposure and respiratory symptoms among primary school children in Kota Bharu. The required sample size was calculated based on this objective which has dichotomous dependent outcome, detectable odds ratio of 2.0 with 80% power and 95% confidence interval. The calculated sample size was 783 (considering 10% non response rate and design effect of 2.0).

Demography, socioeconomic background and household smoking status of the children were obtained from the questionnaire. Standing height was measured in centimeters in stockinged feet and weight was measured fully clothed with the pockets empty (Azizi & Henry, 1991). A child Mini Wright peak expiratory flow meter was used to measure the PEFR. It was measured with the child standing and the measurement taken was the best of three attempts of forceful expiration. Cognitive performance was assessed by using four subtests of Wechsler Intelligence Scale for Children (WISC-III). The subtests used in this study were Arithmetic which measured mathematical knowledge, mental computations and concentrations. Coding subtest measured motor coordination, speed of mental operation and short term memory. Digit Span Forward and Digit Span Backward subtests measured attention span and short-term memory. These subtests measured a factor called freedom from distractibility (Kamphaus, 1993). Hadidjaja *et al.* (1998) used the similar subtests to study the effect of intervention methods on cognitive function of primary school children infected with *Ascaris Lumbricoides* in Indonesia. The WISC-III subtests were performed on each of the children.

Data analysis was done using SPSS version 11. Children were classified as exposed to secondhand smoke at home when at least one household member smoked (Lam *et al.*, 1999). To determine the association between secondhand smoke exposure at home and peak expiratory flow rate (PEFR), independent t- test was used to determine whether there was significant difference between exposed and non exposed children. A univariate analysis of covariance (ANCOVA) was done to determine any significant difference of the PEFR in exposed and non exposed children while controlling for other confounders in the model. The fixed factor or main effect was secondhand smoke exposure whereas the confounders were sex and family history of asthma. Covariates were height and weight.

To determine the association between secondhand smoke exposure and cognitive performance, the dependent variables were the scores obtained for Digit Span Forward, Digit Span Backward, Coding, and Arithmetic. Independent t test was used to compare each scores of subtests between exposed and unexposed children then continued with multivariate analysis of variance (MANOVA). Sex, year of study, parental educational status and family income were the confounding factors.

## Results

A total of 795 children from ten selected government primary schools in Kota Bharu were included in this study. A total of 386 of children (48.6%) were boys and 409 children (51.4%) were girls. The distribution by class was: Primary 4; 35.3%; Primary 5; 29.9% and Primary 6; 34.7%. Most of the children were Malay (99.9%) with only 1 Indian child who was included in this study. There was no Chinese child. There were 358 (45%) children who lived with 1 smoker, 73 (9.2%) lived with 2 smokers, 9 (1.1%) lived with 3 smokers and 2 (0.3%) lived with 4 smokers in the household. A total of 442 (55.6%) children lived with at least 1 smoker in the house and considered as exposed children.

Table 1 shows comparison of mean and standard deviation of PEFR, height and weight among exposed and non exposed children to the secondhand smoke at home. There was no significant difference in PEFR between the exposed and non-exposed children.

Table 1 – Differences of the PEFR and covariates between exposed and non-exposed children to secondhand smoke at home

| Variables | Non exposed Mean (SD) | Exposed Mean (SD) | # p value |
|---|---|---|---|
| 1. Height | 136.24 (7.74) | 137.25 (7.54) | 0.017 |
| 2. Weight | 35.44 (5.91) | 36.59 (6.00) | 0.006 |
| 3. PEFR | 266.18 (60.80) | 266.06 (57.70) | 0.978 |

# Independent t-test

Table 2 shows a univariate analysis of covariance (ANCOVA) used to examine the difference in PEFR between exposed and unexposed group while potential confounders were controlled. At alpha 0.05, the overall multivariate analysis shows no significant difference of the PEFR between exposed and unexposed children (p=0.816)

Table 2 Summary of the overall multivariate analysis in explaining PEFR

| Variables | F statistic (df) | p value |
|---|---|---|
| Secondhand smoke exposure | 0.054 (1) | 0.816 |
| Sex | 111.52 (1) | <0.001 |
| Family history of asthma | 10.48 (1) | 0.001 |
| Height | 27.35 (1) | <0.001 |
| Weight | 1.57 (1) | 0.210 |

# ANCOVA test

Table 3 shows the difference of mean cognitive test scores between exposed and non exposed children. The mean score for Digit Span Forward, Digit Span Backward and Coding were higher among unexposed children. However the mean score for Arithmetic was higher among exposed children. At alpha 0.05, there was no significant difference in all cognitive tests scores between the groups.

Table 3 Differences in mean cognitive test scores between exposed and unexposed children

| Variables | Non exposed | Exposed | #p value |
|---|---|---|---|
| | Mean (SD) | Mean (SD) | |
| 1. Digit Span Forward | 6.84 (1.80) | 6.73 (1.77) | 0.364 |
| 2. Digit Span Backward | 4.27 (1.68) | 4.07 (1.65) | 0.089 |
| 3. Coding | 45.25 (9.99) | 45.11 (11.03) | 0.858 |
| 4. Arithmetic | 8.04 (1.04) | 8.13 (1.00) | 0.197 |

# Independent t-test

Table 4 Summary of the overall multivariate analysis in explaining the cognitive tests scores

| Variables | F statistic | p value |
|---|---|---|
| Secondhand smoke exposure | 0.49 | 0.739 |
| Sex | 16.34 | <0.001 |
| Year of study | 163.47 | <0.001 |
| Maternal educational status | 1.76 | 0.049 |
| Paternal educational status | 1.90 | 0.031 |
| Family income group | 3.21 | 0.001 |

# MANOVA test

Table 4 shows the multivariate analysis of variance (MANOVA) used to examine the difference of mean cognitive tests scores between exposed and non exposed group. At alpha 0.05, the overall multivariate analysis shows no significant difference of the mean cognitive test scores between exposed and unexposed children (p = 0.739).

**Discussion**

This study showed that 55.6% of the primary school children in Kota Bharu exposed to secondhand smoke at home especially from smoking father. However the use of paternal smoking as a proxy for secondhand smoke exposure of children can be problematic, as fathers were generally less likely to be the main caregiver of these children. The prevalence of secondhand smoke exposure among children in this study was comparable to other studies in other countries. For example, WHO estimated that almost half of the world's children breathe air polluted by tobacco smoke, particularly at home. A study by Pirkle *et al.* (1996), in order to estimate the extent of exposure to secondhand smoke in the US population on the basis of questionnaire data and of serum cotinine measurement showed that 43% of US children were exposed to smoking by household members. Lam *et al.* (1999) in Hong Kong also observed about 47% of the children exposed to secondhand smoke particularly at home. A study on 8-10 year of age Croatia children gave the higher prevalence of children who exposed to at least one

smoking parents i.e. 64% (Gomzi, 1999). It is suggested that many children are exposed to secondhand smoke because of parental smoking because in most countries, particularly in those where people were generally not aware of tobacco smoke's harmful effects on children's health, parental smoking status will reflect children's exposure, as smoking parents were unlikely to minimize their children's exposure by not smoking in their [illegible] (WHO, 1999).

In this study, peak expiratory flow rate measurement was used as an estimation of the lung function. The result showed that exposed children have slightly lower PEFR but the difference was not statistically significant. The lack of association observed in this study may be due to the selection of PEFR as a measurement for pulmonary function may not be adequately sensitive to small changes in mild disease states. But in some studies PEFR measurement showed some variation between exposed and unexposed children. For example, a study of 40 children aged 10-11 years in Italy reported lower average levels but greater variability in peak expiratory flow rate in the 20 children exposed to secondhand smoke (Casale *et al.*, 1992). The sample excluded asthmatics and those with acute respiratory problems. Frischer *et al.* (1993) measured PEFR daily over five days in 991 subjects in Germany, they found greater variability among children whose mother smoked but no difference in the level of PEFR between exposed children and those not exposed to maternal smoking. Variability in PEFR was also observed in asthmatic patients. For example, Schwartz *et al.* (2000) did a prospective study for 3 months on asthmatic subjects aged between 7 to 12 years, by measuring their PEFR rate every morning and evening and keeping daily diary of respiratory symptoms. The result showed that exposure to secondhand smoke was associated with a PEFR reduction of 42 L/min in morning and 41 L/min in evening among asthmatic children.

Many studies suggest that pulmonary function decrement in school-aged children is a result of combined early life (including in utero) and current exposures to maternal smoking (Wang *et al.*, 1994). Postnatal secondhand smoke exposure only has also been associated with small declines in pulmonary function however the mechanism of damage has not been identified (Wang *et al.*, 1994).

Experimental and human studies have linked secondhand smoke exposure with decreased performance in tests of reasoning ability and language development (Bauman *et al.*1991; Eskenazi and Bergmann 1995), tests of intelligence (Johnson, *et al.* 1999), and an increased risk for grade retention (Byrd & Weitzman 1994). These findings suggested that secondhand smoke exposure may be causally associated with impairments in cognitive skills. Reading ability was especially sensitive to this exposure. On the other hand, this study failed to observe the association between secondhand smoke exposure and cognitive performance in terms of mathematical knowledge, mental computations and concentrations, short-term memory, motor coordination and speed of mental operation as measured by the subtests. Yolton *et al.* (2004) utilized serum cotinine, a biomarker of secondhand smoke exposure, to examine the relationship between the exposure and cognitive abilities and found that there was a significant inverse relationship between serum cotinine and scores on reading, math, and block design, but not digit span. In a longitudinal study by Fried *et al.* (1997), a significant negative dose-response relationship with prenatal secondhand smoke exposure and specific reading functions was reported but no relationship between prenatal tobacco smoke exposure and math skills (Fried *et al.*, 1998).

The mechanisms by which secondhand smoke exert its effects on cognitive function are not known. Research into the effects of nicotine and cotinine (Audesirk & Cabell, 1999) on neurite length suggest that exposure to these substances during prenatal development, may impact both the survival and growth of essential nervous system components even at very low levels of exposure. More research is needed to explore the mechanism by which postnatal secondhand smoke affects cognitive ability and whether this was similar or different mechanism from the effects during prenatal development.

These exposure data were obtained by parental report and may result in an underestimate of the intensity of secondhand smoke exposure. It would be an advantage if the study assessed exposure by measuring cotinine levels. This would take account of changes in exposure to secondhand smoke which occurs as children grow older and spend less time with their parents resulting in a reduction in their exposure. However measuring the cotinine will be very costly because of large number of the sample size. Jennifer A. Seifert *et al.* (2002) has proved that a questionnaire survey reflected the child's exposure to secondhand smoke and the survey was sensitive to varying levels of exposure. Regarding the lung function test, the used of peak expiratory flow meter to assess the lung function of the children may not be sensitive enough to detect small changes. Spirometry would be better but it was an effort dependent test that required careful instruction and cooperation of the test subjects and studying the primary school children will encounter this problem. Furthermore, additional studies are needed to validate our findings with regards to the association of secondhand smoke and cognitive performance especially in Malaysia.

## Conclusion

From this study it was concluded that there was no association between secondhand smoke exposure and lung function or cognitive performance of the primary school in Kelantan and further studies are needed in this area.


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Dengan ini merakamkan ucapan terima kasih dan setinggi-tinggi penghargaan kepada

**DR. SHARINA DIR**

kerana telah mengambil bahagian sebagai

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# RESPIRATORY SYMPTOMS, LUNG FUNCTION AND COGNITIVE FUNCTIONING OF PRIMARY SCHOOL CHILDREN EXPOSED TO SECONDHAND SMOKE AT HOME IN KOTA BHARU KELANTAN

BY
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# LISTS OF ABBREVIATIONS

ANCOVA Analysis of Covariance

| | |
|---|---|
| **CDC** | Center for Disease Control |
| **CI** | Confidence Interval |
| **FEF 25-75** | Mean forced expiratory flow during the middle half of the FVC |
| **FEV1** | Forced expiratory volume in one second |
| **FVC** | Forced vital capacity |
| **MANOVA** | Multivariate Analysis of Variance |
| **MOH** | Ministry of Health |
| **NHANES** | National Health and Nutritional Examination Survey |
| **OR** | Odds ratio |
| **PEFR** | Peak expiratory flow rate |
| **ROC** | Receiver Operating Characteristic |
| **SIDS** | Sudden infant death syndromes |
| **SPSS** | Statistical Package for Social Science |
| **US DHHS** | United States Department of Health and Human Services |
| **US EPA** | United States Environmental Protection Agency |
| **WISC III** | Wechsler Intelligence Score for Children III |
| **WHO** | World Health Organization |



# CHAPTER 1

# INTRODUCTION AND LITERATURE REVIEW

## 1.1 Tobacco smoke

Tobacco smoke contains over 4500 chemicals in the form of particles and gases. The particulate phase includes tar (itself composed of many chemicals), nicotine, benzene and benzo(a)pyrene. The gas phase includes carbon monoxide, ammonia, dimethylnitrosamine, formaldehyde, hydrogen cyanide and acrolein. Some of these have marked irritant properties and some 60 are known or suspected carcinogens (US Environmental Protection Agency, 1992). The Environmental Protection Agency USA classified secondhand smoke as a class A (known human) carcinogen along with asbestos, arsenic, benzene and radon gas (US Environmental Protection Agency, 1992).

## 1.2 What is secondhand smoke

Secondhand smoke is also called "environmental tobacco smoke" and secondhand smoke exposure is frequently used interchangeably with "involuntary smoking" and "passive smoking" (National Cancer Institute, 1999). Secondhand smoke is derived from a mixture of side-stream smoke and mainstream smoke. Mainstream smoke is tobacco smoke generated during puff-drawing in the burning cone of a tobacco product, which is inhaled directly by the smoker before it is released into the surrounding air (Spitzer *et al.*, 1990). Side-stream smoke is

defined as a combination of: smoke emitted into the air during burning of a tobacco product between puffs; smoke escaping into the surrounding air during puffs; and smoke components that diffuse through cigarette paper (Spitzer *et al.*, 1990). Mainstream smoke and side-stream smoke are qualitatively similar in chemical composition, but due to differences in the burning conditions, the quantities of constituents are different. The cigarette burns at a higher temperature during inhalation, leading to more complete combustion in mainstream smoke. Thus, side-stream smoke contains considerably higher concentrations of many carcinogenic and toxic substances than the mainstream smoke (US Environmental Protection Agency, 1992). A filtered cigarette can produce substantially reduced mainstream smoke emissions compared to filter-less cigarettes, while the side-stream smoke emissions show little variability between the two types (US Environmental Protection Agency, 1992).

Secondhand smoke is a major source of indoor air pollution, contributing to a noxious environment, eye irritation and unpleasant odour. Nearly 85 % of smoke in a room results from side-stream smoke (Fielding & Phenow, 1988). Cigarette smoking is the most important factor determining the level of suspended particulate matter and respirable sulfates and particles in indoor air. Concentrations of respirable suspended particulate matter (particulates of < 2.5 μm) can be 2-3 times higher in homes with smokers than in homes with no smokers (American Academy of Pediatrics, 1997).



### 1.3 Smoking prevalence

Globally, in 1995, about 1.1 billion or 29% of the population aged 15 years and above smoked daily (World Bank, 1999). The WHO estimated that 47% of men and 12% of women smoke. Low-income and middle-income countries, whose populations account for four-fifth of the global adult population, accounted for 82% of the world's smokers. Cigarette smoking has risen over the past two decades in these countries in contrast to declines in overall consumption in high-income countries. East Asia and the Pacific, which include China, accounted for 36% of all smokers, but only 32% of the population aged 15 years and over. Overall, smoking prevalence was highest in Europe and Central Asia at 40% and lowest in Sub – Saharan Africa at 18%. Though fewer women than men are smokers, an increasing number of young women are taking up smoking (World Health Organization, 1997). Partly because of growth in the adult population, and partly because of increased consumption, the total numbers of smokers is expected to reach about 1.6 billion by 2025 (World Bank, 1999).

In Malaysia, as it is in most developing countries, incidence of smoking is on the rise. Based on the Second National Health and Morbidity Survey 1996, the national smoking prevalence among adults aged 18 years and above was 24.8%. The prevalence was significantly higher among males at 49.2% compared to females, which was only 3.5%. The prevalence of smoking among adolescents aged 12 to 18 years was 16.7%; it was significantly higher in a male that was 30.7% than in females which was 4.8% (Ministry of Health, 1998). In 2000, there

were 4.6 million smokers in Malaysia smoking a total of 23.7 billion cigarettes (Nazmi, 2004). A study done in 2002 showed that there were more than 5 million chronic smokers in this country, involving 80% men aged more than 19 years , 10% male adolescents, 8% women and 2% female adolescent (Sharifah Salwa, 2004).

### 1.4 Secondhand smoke exposure among children

The vast majority of children exposed to secondhand smoke do not choose to be exposed. Children's exposure is involuntary, arising from smoking, mainly by adults, in the places where children live, work and play (World Health Organization, 1999). Given that more than a thousand million adults smoke worldwide, WHO estimated that around 700 million, or almost half of the world's children breathe air polluted by tobacco smoke, particularly at home (World Health Organization, 1997). The Centers for Disease Control and Prevention (CDC) reported prevalence of children's secondhand smoke exposure in the home ranging from 11.7% to 34.2% by state, based upon numbers of homes with an adult smoker where smoking was reportedly allowed in some or all areas (Centers for Disease Control, 1997). According to the Third National Health and Nutrition Examination Survey (NHANES III), between 1988 and 1991, 43% of children aged 2 months to 11 years live in homes with at least one smoker (Pirkle *et al.*, 1996).

Burchfiel *et al.* (1986) estimated the prevalence of passive exposure to cigarette smoke using two-parent households where both parents were



interviewed. The result showed that a total of 61.7% of all subjects 0-19 years of age had at least one currently smoking parent; 31.5% had both parents who currently smoked. Another study by Lam *et al.* (1999) in Hong Kong found that 32.9% of the children were living with one smoker, 8.6% with two smokers, 2.5% with three smokers, 1.3% with 4 smokers and 2.1% with 5 or more smokers. Based on the assumption that the smoking family members also smoked at home, the authors estimated about 47% children were exposed to secondhand smoke. A study by Cook *et al.* (1994) in examining the importance of parental smoking on passive exposure to tobacco smoke in children and the social and geographical patterns of exposure found that 53% of children were exposed to secondhand smoke from at least one smoker.

In Hong Kong, the most important place of secondhand smoke exposure is the home while the main source of secondhand smoke were fathers and grandparents, followed by mothers, other relatives and brothers (Lam *et al.*, 1999). Having a father as the only parental smoker was far more common than having a mother as the only parental smoker (Burchfiel *et al.*, 1986). The number of additional household members who smoked also contributes to the exposure. The intensity of exposure may be modified further by demographic and socioeconomic factors such as household crowding, level of education and income (Cook *et al.*, 1994).

Smoking by the mother was consistently associated with higher secondhand smoke exposure to children than paternal smoking. This reflects the longer amount

of time the child spends with the mother (Cook *et al.*, 1994). Secondhand smoke exposure tends to decrease as the child grows older. This may be due to the increasing ability of the child to avoid being around the mother or others when they are smoking (Irvine *et al.*, 1997).

Although in-house exposure remains a primary source of secondhand smoke exposure for children, out of home exposures should not be forgotten. Recurrent secondhand smoke exposure outside the home may occur at the homes of relatives, for example grandparents (Hopper & Craig, 2000), or by a childcare provider in a residential daycare (Holberg *et al.*, 1993). The younger children spend 60-80% of their time indoors on an average school day and may be heavily exposed to indoor pollutants especially secondhand smoke (Gomzi, 1999). The large number of exposed children, coupled with evidence that secondhand smoke causes illness in children, constitutes a substantial public health threat.

### 1.5 Measurement of exposure

Exposure to secondhand smoke is defined as the exposure of a person to tobacco combustion products from smoking by others (US Departmental of Health and Human Services, 1984). Exposure to secondhand smoke is also used to describe exposure of a fetus to tobacco combustion products and/or their metabolites from an actively or passively smoking mother (Spitzer *et al.*, 1990). A major difficulty in studying the ill-health effects of secondhand smoke has been assessing exposure, since this may occur in multiple settings with highly variable



concentrations and exposure profiles may very considerably during different age period. Appropriate exposure assessment is also needed for inferring causality and for risk assessment (Jaakkola & Jaakkola, 1997).

Children's involuntary exposure to secondhand smoke can be measured in several ways: air sampling, uses of biomarkers, and application of a questionnaire. Air sampling involves measuring concentrations of such markers as respirable suspended particulates or nicotine in the air. Biomarkers involve measuring concentrations of smoke components in biological materials, most commonly in saliva or urine (US Environmental Protection Agency, 1992). Both cotinine measurement and air sampling are limited to describing current exposure (Jaakkola & Jaakkola, 1997). Biomarkers may also be valuable to validate questionnaire responses. Several potential biomarkers of secondhand smoke have been explored, including carboxyhaemoglobin, thiocyanate, nicotine and cotinine, DNA adducts, and protein adducts. Thiocyanate concentrations in body fluids, carbon monoxide in expired air, and carboxyhaemoglobin are not specific and sensitive enough for secondhand smoke although they have been useful in distinguishing active smoking from nonsmoking (Leaderer *et al.*, 1993).

Nicotine and its metabolite cotinine, measured in plasma, urine, or saliva are the most widely used biomarkers of secondhand smoke but there are also several problems related to their use. Urine cotinine levels have been suggested as the gold standard for secondhand smoke exposure measurement, currently one of the most widely used biomarker but it is affected by inter-individual variability in

cotinine excretion levels for similar exposures and a relatively short half-life of 20 hours (Al-Delaimy *et al.*, 2002). Cotinine in saliva is subject to similar disadvantages in addition to the artificially high estimates of cotinine in saliva compared with serum levels because of the ability of the salivary glands to concentrate this metabolite (Sepkovic & Haley, 1995). Among children, salivary and urinary cotinine levels have been shown to be rise with the number of smoking parents in the home (Marbury *et al.*, 1993) and in infants, urinary cotinine levels increased with the number of cigarettes smoked by the mother during the previous 24 hours (Greenberg *et al.*, 1984).

Hair nicotine content is a new biomarker with some advantages over the previous ones (Jaakkola & Jaakkola, 1997). In a study by Al-Delaimy *et al.* (2002) to compare the urine cotinine and hair cotinine using questionnaire as the standard they found that hair cotinine method was more precise than the ELISA urine cotinine method for the same individuals.

Questionnaires and interviews are the most commonly used exposure assessment method in studies of health effects of secondhand smoke exposure. They are the least expensive method to obtain information on secondhand smoke exposure and are, thus, suitable for studies with large sample sizes (Jaakkola & Jaakkola, 1997). On the other hand, there are also many concerns about questionnaire assessment, including lack of a gold standard with which to validate questionnaires, lack of commonly accepted standardized questionnaires, possibility of misclassification of exposure for several reasons (US Environmental Protection



Agency, 1992), and possibility of deceptive underreporting of exposure in children by smoking parents (Willers *et al.*, 2000).

Different strategies have been used in an attempt to validate questionnaires for secondhand smoke exposure assessment, but as mentioned above, there is no gold standard. Jennifer A. Seifert *et al.* (2002) evaluated the validity of a five-question survey administered to parents to assess their child's exposure to secondhand smoke. Urinary cotinine was used as the measurement of exposure to secondhand smoke for comparison with the questionnaire data. Using a cut-point of 30 ng/mg of cotinine to differentiate unexposed and exposed to secondhand smoke, they found 80% agreement with their survey. A Spearman's ranked correlation coefficient of 0.62 indicated a direct relationship between cotinine and secondhand smoke exposure intensity score. They concluded that the 5-question survey reflected the child's exposure to secondhand smoke and that the survey was sensitive to varying levels of exposure.

In a study by O'Connor *et al.* (1995), three methods to measure secondhand smoke exposure were compared in 415 pregnant women: personal monitoring of air nicotine, urine cotinine and questionnaire. Women reporting secondhand smoke exposure had significantly higher levels of air nicotine compared with women reporting no exposure, whereas urine cotinine did not differ between these groups. Agreement was deemed fair (kappa=0.29) between self-reported exposure and personal monitoring of air nicotine, but poor between urine cotinine and both self-report (kappa=0.08) and air monitoring (kappa=0.10).

## 1.6 Health effects of exposure to secondhand smoke

Tobacco smoking has long been recognized as a major cause of death and disease, responsible for an estimated 434,000 deaths per year in the United States. Tobacco use is known to cause lung cancer in humans, and is a major risk factor for heart disease. In recent years, there has been concern that non-smokers may also be at risk for some of these health effects resulting from secondhand smoke exposure (US Environmental Protection Agency, 1993). Exposure to secondhand smoke has been associated with acute and chronic health effects among non-smokers (Jaakkola & Jaakkola, 1997).

Among the harmful effects of secondhand smoke exposure are respiratory conditions in children, which have been investigated in many studies. Children exposed to secondhand smoke have higher rates of lower respiratory illness such as bronchitis and pneumonia during their first year of life. In children of all ages, secondhand smoke exposure has been found to be associated with increased respiratory symptoms such as wheeze and cough (Somerville *et al.*, 1988). Secondhand smoke is usually associated with increased prevalence of fluids in the middle ear, upper respiratory tract irritation, and reduced lung function. It is also associated with increased severity of asthma in children; the asthma of an estimated 200,000-1000,000 children in the US is worsened by secondhand smoke. Secondhand smoke is a risk factor for new cases of asthma for children in whom the condition was not previously diagnosed (Murphy, 2004). Sudden infant death syndrome, behavioral problems, neurocognitive decrements, and increased



rates of adolescent smoking also are associated with secondhand smoke exposures (World Health Organization, 1999).

### 1.6.1 Secondhand smoke exposure and respiratory symptoms

Respiratory diseases are a major health burden in children. An estimated 150,000-300,000 case of lower respiratory tract infections in children younger than 18 months are annually attributed to secondhand smoke (US Environmental Protection Agency, 1992). In 1995-1996, diseases of the respiratory tract contributed 7 of the top 15 reasons for visits to physician offices among children below 15 years of age in the United States (Gergen, 2001). In Malaysia, symptoms of upper respiratory tract infections represented about 35% of medical problems among adolescents who seek treatment from health clinics in certain districts (Ministry Of Health, 2000a). However, no study of acute respiratory infections attributed to smoking has been carried out in Malaysia.

A number of factors have been identified as risks for respiratory disease. Among the risk factors for recurrent upper respiratory tract infections are allergy, hypertrophy and inflammation of adenoid and tonsils, socio-economic and environmental conditions and secondhand smoke (Gryezyska *et al.*, 1999). Prominent among these factors is secondhand smoke (Gergen, 2001). One study found that in households where both parents smoked, young children have a 72 % increased risk of respiratory illnesses (Strachan & Cook, 1997).

Direct exposure to secondhand smoke affects the physiology of the respiratory tract, with symptoms of disease depending on which specific mechanism predominates and which anatomic area is most affected most. The physiologic response to secondhand smoke is generally the same as that of the smoker but with a diminished effect. Such changes include increased mucus production (up to 7-fold); decreased cilliary movement, beat frequency, and transport; increased white blood cell production and movement to the airway lumen; and increased mucosal permeability to allergens, associated with increased total and specific immunoglobulin E levels and increased blood eosinophils counts (Murphy, 2004). It has been suggested also that parental smoking might be associated with respiratory infections in children because the parents themselves are more likely to bring home a respiratory infection (DiFranza *et al.*, 2004). When the members of household smoke a lot and ventilation is poor, secondhand smoke can heavily affect respiratory system of children (Forastiere *et al.*, 1992, Cook & Strachan, 1997).

Gomzi (1999) found 64% of the 223 interviewed children were exposed to parental tobacco smoke and the prevalence of respiratory illness was 24%. Current parental cigarette smoking was associated with 38% increased risk of respiratory illness in children in the past six-month period. Lam *et al.* (1999) found that in never smokers who were exposed to secondhand smoke, there was an increased risk of throat problems, any cough, any phlegm, ever wheezing and nose problems. The excess risks ranged from 15 to 46%. The odds ratios for the symptoms increased with increasing number of smokers at home. These results



suggested a 'dose-response relationship' and provided strong evidence that the association between respiratory ill health and secondhand smoke exposure was likely to be causal. The same study also examined the effect of exposure from specific smoking family members and it showed that the odds ratios were the highest for exposure to smoking from grandparents, followed by siblings and then father. These results probably were due to the closer contacts of the children with their grandparents.

The relationship of secondhand smoke to respiratory conditions and pulmonary function was assessed using a cross-sectional design in the defined population of Tecumseh, Michigan. Secondhand smoke exposure was associated with an elevated prevalence of phlegm, wheeze, asthma, and chest colds among males and wheeze, bronchitis and chest colds among females. Offspring were shown to be 1.5 to 2.0 times more likely to have a respiratory condition if both their parents currently smoked than if both parents never smoked (Burchfiel *et al.*, 1986).

Charlton (1984) did a study to see the association between cough and parental smoking. The result showed that 35% of boys below 11 years who had never smoked and whose parents did smoke reported 'frequent cough'; with one parent smoking, this increased to 42%, and when both parents smoked the proportion was 48%. Girls below 11 years showed the same pattern. The same study suggested that maternal smoking had more influence on children's cough than paternal smoking. Cook & Strachan (1999) showed a very consistent picture

with odds ratios for respiratory illnesses and symptoms of between 1.2 and 1.6 for either parent smoking.

The Respiratory Health Study in Hong Kong showed that secondhand smoke exposure was strongly associated with cough, phlegm and wheezing in primary school children aged 8 – 12 years. The risk was independent of and higher than that due to air pollution, and increased with increasing numbers of smoker categories at home. When the presence of individual smoking family members was taken into account, exposure to smoking by fathers, siblings and others was associated with any cough or sore throat or any phlegm (Peters *et al.*, 1996).

In 1998, a study on grade 1-3 students, mostly aged 8-12 years showed a significant trend found for the prevalence in eight items such as sore throat, cough in the morning, cough in the evening, doctor consultation for cough, phlegm in the morning, phlegm day or night, phlegm for 3 months and wheezing in the past 3 months with increasing numbers in the household of the children who had never smoked (Lam *et al.*, 1998). There was a dose response relationship between the number of categories of smokers in the home and respiratory symptoms with the strongest effect on cough or sore throat and phlegm. Exposed children were especially more likely to remain symptomatic than were unexposed (Dijkstra *et al.*, 1990).

Gryezyska *et al.* (1999) did a study among Polish preschool and school children in order to evaluate the factors playing a role in recurrent upper respiratory



tract infections and otitis media in children. Histopathological evaluation of adenoid tissue in children who exposed to secondhand smoke indicates significant differences in children not exposed to secondhand smoke.

A study by Forastiere *et al.* (1992) on the effects of environment and passive smoking on the respiratory health of children showed that most symptoms and illnesses were higher in children when any of the parents smoked, the exception being chest illness, pneumonia and otitis. The significant associations found were night cough, snoring, and early respiratory infections. When children were classified by paternal and maternal smoking status separately, odds ratio tended to be higher for children from households where only the mother smoked than for those where fathers were the only smoker. When the effects of air pollution and secondhand smoke on the health were examined, it showed that both of them separately affect respiratory illness but that the combination of the two factors did not produce a synergistic effect.

Azizi & Henry (1991) did a cross-sectional study to examine the effects of exposure to mosquito coil smoke, secondhand smoke and other sources of indoor pollutants on the respiratory health of children in Kuala Lumpur. They found that higher prevalence of respiratory symptoms and illnesses were observed almost uniformly in children exposed to mosquito coil smoke and secondhand smoke. A similar pattern was not observed in children exposed to other environmental factors. Secondhand smoke was also confirmed to be independently associated

with chest illness. In addition, children with reported chronic cough and/or phlegm had significantly lower peak expiratory flow rate than those without this symptoms.

A survey of respiratory symptoms in children aged 12-14 years was conducted throughout Great Britain as part of the International Study of Asthma and Allergies in Childhood (ISAAC). The survey showed that wheeze was reported more often in non-metropolitan areas and in association with active smoking, passive smoking, the presence of a furry pet, bottled gas, paraffin and other unusual heating fuels. Current smoking, previous smoking, and passive smoking accounted for 10.4%, 6.8% and 6.5% respectively, of wheezing in the past 12 months. Cough and phlegm were associated with active and passive smoking and with the miscellaneous fuels; similar associations were found for rhinitis (Burr *et al.*, 1999).

Austin & Russell (1997) found that cough was associated with parental smoking, particularly maternal smoking. However parental smoking did not influence the prevalence of current wheeze or eczema. A significant but inexplicable finding was the reduced risk of hay fever in children whose mothers smoked.

Cuijpers *et al.* (1995) did a study on the adverse effects of indoor environment on respiratory health and lung function in 470 Dutch primary school children. Secondhand smoke was significantly related to symptoms and lung function impairment, and more so in boys than in girls. The effects seemed to be



related to duration of exposure, since the largest impairment in lung function were observed in children exposed during their entire life. Although often non-significant, the odds ratios suggest a dose-response relationship between the asthma-like symptoms and maternal (but not paternal) smoking in boys, but not in girls. The result also strongly suggestive of a gender difference in airway sensitivity to secondhand smoke, with boys being at a disadvantage.

### 1.6.2 Secondhand smoke exposure and asthma

Asthma is the most common chronic disease of childhood, and environmental factors play an important role in determining both onset and severity. Eleven percent of the asthmatic symptoms were due to exposure to secondhand smoke (Schwartz *et al.*, 2000). There have been numerous claims that exposure to secondhand smoke in children may induce asthma or increase the frequency or severity of attacks in asthmatic subjects (Strachan & Cook, 1998). In a meta analysis, the risk of developing asthma was 1.37 if either parent smoked (Strachan & Cook, 1998). Exposure to secondhand smoke, especially from maternal smoking, has been shown to be a risk factor for asthma and wheezing in children (Forastiere *et al.*, 1992). It has been estimated that in the United States, maternal smoking was responsible for approximately 7.5% of the total number of cases of childhood asthma or lower respiratory illness marked by wheezing (Stoddard & Gray, 1997). The report estimated that 200,000 to 1,000,000 asthmatic children have their condition worsened by exposure to secondhand smoke. It is suggested that the evidence relating exposure to secondhand smoke

with asthma and wheezing was more consistent with the secondhand smoke acting as a trigger than as an underlying cause of the asthmatic tendency (Strachan & Cook, 1998)

Schwartz *et al.* (2000) found that exposure to secondhand smoke was associated with a decline in peak flow, increase in respiratory symptoms and the use of bronchodilator drugs among asthmatic children. These changes showed evidence of a dose-dependent effect with children who were exposed for a greater proportion of time having greater reduction in PEFR. Significant increases in the frequency of acute exacerbations of asthma were found whether exposure to secondhand smoke was identified on the basis of parental reports or urine cotinine levels, and dose-response patterns were evident with both methods. The linear dose-response patterns provided further evidence of a causal relation between exposure to secondhand smoke and pulmonary morbidity in children with asthma (Chilmonczyk *et al.*, 1993).

The primary findings from a study by Mannino *et al.* (2002) were that children in whom asthma has been diagnosed by a physician have increased severity associated with secondhand smoke exposure. These children were significantly more likely to have more severe asthma, as indicated by increased symptoms of cough and wheeze, by an increased number of respiratory illnesses, and by lower levels of lung function. They were also more likely to have visited a physician more than once in the previous year, although this increase was not statistically significant.



### 1.6.3 Secondhand smoke exposure and lung function

During childhood, the lung grows as height increases. Damage to the lung during its development may have lasting effect and reduce the lung's reserve capacity. There is substantial evidence that maternal smoking during pregnancy cause sizeable adverse effects on neonatal lung mechanics (World Health Organization, 1999). One large cross-sectional study done by Venners *et al.* (2001) in rural Chinese communities demonstrated that paternal smoking was associated with deficits in FEV1 and FVC in the children. Children whose fathers smoked more cigarettes had larger deficits in both FEV1 and FVC than either children whose fathers smoked less or were non-smoker. Chilmonczyk *et al.* (1993) reported that pulmonary function was impaired and acute exacerbation of asthma increased as secondhand smoke exposure increased. Studies suggested that pulmonary function decrement in school-aged children is a result of combined early life (including in utero) and current exposure to maternal smoking (Wang *et al.*, 1994). However, distinguishing between residual effects of maternal smoking during pregnancy and childhood secondhand smoke exposure to explain these deficits was difficult (Chilmonczyk *et al.*, 1993). FEV1 and FVC among males were significantly lower by 5% in non-smokers 10-19 year of age whose parents were current smokers compared with similar offspring of never smoking parents (Burchfiel *et al.*, 1986). There was a significant lower value of FEV1 / FVC, FEF 25-75 and PEFR in those children with reported persistent wheeze and doctor diagnosed asthma. Lung function, as indicated by the $FEV_1$ and FVC was significantly decreased by 8.1% and 5.6%, respectively, in children with high levels

of secondhand smoke exposure compared with those children with low levels of exposure (Mannino *et al.*, 2002).

Gharaibeh (1996) reported a 13.4 % decrease in FVC in children who lived with at least one adult who smoked more than 1 pack per day. Another meta-analysis of 21 studies found a reduction in forced expiratory volume in 1 second of 1.4%, mid-expiratory flow rate of 5% and end-expiratory flow rates of 4.3% among children who exposed to secondhand smoke (Cook & Strachan, 1998).

### 1.6.4 Secondhand smoke exposure and middle ear disease

Secondhand smoke can lead to a build-up of fluid in the middle ear, the most common cause of hospitalization for an operation in children. The risk of of getting persistent middle ear effusions in children who lived in households where more than three packs of cigarettes were smoked per day, is more than four times at risk compared to children whose parents did not smoke (Kraemer *et al.*, 1983).

Etzel *et al.* (1992) studied 132 children in a day care center to determine whether secondhand smoke exposure was associated with an increased risk of middle ear effusion during the 18-month period between 6 and 24 months of age. In this study, the children were classified as exposed or not exposed to cigarette smoke on the basis of serum cotinine concentrations at 1 year of age. Middle ear effusion was diagnosed with the use of pneumatic otoscopy. The 45 children exposed to secondhand smoke had an average of 7.1 episodes of middle ear



effusion between 6 and 24 months of age, whereas the 87 children unexposed to secondhand smoke had 5.8 episodes during that period. The average duration of middle ear effusion was 28 days among those in the exposed group and 19 days among those in unexposed group. An estimated 8% of the middle ear effusions were attributed to exposure to secondhand smoke.

### 1.6.5. Secondhand smoke exposure and cognitive performance

Numerous tests for assessing intelligence in children exist, each with unique strengths and weaknesses. The most popular intelligence scale in use today is the Wechler Intelligence Scale for Children–III (WISC-III), the most recent version of a test that was introduced about 50 years ago (Murphy & Davidshofer, 1991). The WISC-III is made up of ten mandatory and three supplementary subtests, all of which span the age range of 6 to 16 years. The WISC-III is individually administered to the child by a highly trained examiner who follows specific procedures (Murphy & Davidshofer, 1991).

Other tests assess intelligence in younger children, including the Wechler Preschool and Primary Scale of Intelligence–Revised (WPPSI-R), Stanford-Binet Fourth Edition (Binet-4) and Kaufmann Assessment Battery For Children (K-ABC) (Murphy & Davidshofer, 1991). The Binet-4 samples a wide variety of tasks that involve the processing of information, and measures an individual's intelligence by comparing his or her performance on these tasks to the performance of an appropriate norm group. Each of the subtests of the Binet-4 is made up of open-ended questions or tasks that become progressively more difficult. A child

responds to only that part of the test that is appropriate for his or her developmental level. A child taking the test may respond only to a few sets of items on each subtest (Murphy & Davidshofer, 1991).

The WPPSI-R is a measurement of the intelligence of children between the ages of 3 to 7. It is composed of a number of subtests grouped into a Verbal scale and a Performance scale. The administration and scoring of the WPPSI-R is highly similar to WISC-III in that a child alternately completes Verbal and Performance subtests. It is differs from the WISC-III primarily in the nature and demands of the examiner's role. Using the WPPSI-R the examiner must actively maintain a very young child's interest in a series of challenging and potentially frustrating tasks (Murphy & Davidshofer, 1991).

The K-ABC is designed for assessing children ages 2 ½ to 12 ½. The test consists mostly of nonverbal items (e.g., pictorial diagrams) that require children to perform a variety of information processing tasks. The battery is divided into a Mental Processing section designed to measure fluid intelligence and an Achievement section designed to measure crystallized intelligence, or acquired knowledge. The Mental Processing scales are divided into tests of two fundamentally different types of information processing, Sequential Processing and Simultaneous processing. Sequential processing occurs when problems are solved in a step-by-step fashion. Simultaneous processing occurs when multiple pieces of information must be organized and integrated to solve a problem. The



Achievement scales measure vocabulary, reading comprehension, general knowledge and knowledge of arithmetic (Murphy & Davidshofer, 1991).

Evaluation of educational achievement also plays an important role in psycho educational assessments carried out for mental retardation, learning disorders, or behavior disorders. A popular screening test of academic achievement is the Wide Range-Achievement Test (WRAT-3) which consists of Reading, Spelling and Arithmetic subtests (Mash & Wolfe, 1999).

Both animal model and human epidemiologic studies strongly suggested that prenatal and early passive exposure to tobacco smoke led to negative behavioral and neurocognitive effects in children, and there were plausible biologic mechanisms through which this may occur (Weitzman *et al.*, 2002). It was possible that secondhand smoke exposure during childhood may be hazardous, and potentially more hazardous, to neurodevelopmental than in-utero exposure to maternal smoking. The routes of exposure to prenatal and postnatal maternal smoking differed. The fetus was exposed transplacentally to compounds absorbed by the mother, whereas the child was exposed primarily through inhalation. Also, the chemical constituents and their levels differ, to some extent, in secondhand smoke and mainstream smoke. Childhood may be the critical period for neurodevelopment effects of smoking. Furthermore, exposure during childhood may be longer than 9 months in-utero (Eskenazi & Castorina, 1999). These differences could explain why those exposed in the postnatal period performed worse than children of nonsmokers.

A number of studies have provided evidence suggesting long-term behavioral, intellectual, and educational problems associated with children's prenatal and passive exposure to tobacco smoke. Rantakallio (1983) reported data from a 1966 birth cohort of 1819 Finnish children demonstrating that parental smoking was associated with lower mean scores on 'theoretical subjects' based on school reports. Using the US National Health Interview Survey, Byrd & Weitzman (1994) demonstrated that children of smoking parents were more likely to repeat kindergarten or first grade. This study however, was a cross-sectional study and cannot distinguish prenatal from postnatal exposure. A study by Sexton *et al.* (1990) in which 3-year-old children born to mothers who quit smoking early in pregnancy were compared to the offspring of mothers who continued to smoke throughout pregnancy. The authors reported that the children of the former group performed at a higher level of intellectual functioning than the children of the latter group.

Eskenazi & Castorina (1999) reviewed the potential neurodevelopmental and behavioral effects of children's prenatal and/or postnatal exposure to environmental tobacco smoke. They found that the children of smokers performed more poorly in school than the children of non-smokers. In addition, this association was dose related after adjusting for a number of potential confounders.



### 1.6.6. Other health effects of secondhand smoke exposure

A growing body of evidence has linked exposure to secondhand smoke to sudden infant death syndrome (SIDS). A review of 39 studies, including 10 cohort studies and 29 case-control studies concluded that maternal smoking doubles the risk of sudden infant death syndrome (Anderson & Cook, 1997). The epidemiologic evidence pointed to a causal relationship between SIDS and postnatal exposure to secondhand smoke.

Cigarette smoking was the single most important factor affecting birth weight in developed countries (Kramer, 1987). Maternal and paternal smoking both were associated with lower birth weight, with maternal smoking having a greater effect (Matsubara *et al.*, 2000). Meyer & Comstock (1972) reported that the effect of maternal cigarette was an average reduction of 150-300 grams in birth weight. A randomized controlled intervention study demonstrated that reduction of smoking during pregnancy improved infant birth weight (Sexton & Hebel, 1984).

These results are a clear evidence of a definite link between smoking in the home, respiratory ill-health and cognitive performance in young children, which not only may cause immediate health problems, but may also, lead to chronic illnesses in future.

## 1.7 Tobacco control in Malaysia

The Division of Disease Control, Ministry of Health (MOH) is the government focal point in charge of tobacco control action. Enforcement of 'The Control of Tobacco Products Regulation 1993' which was enacted in 1993, remain to be the most important activities carried out. In 1972 the MOH and the Malaysian Medical Association jointly established Action on Smoking or Health Committee (ASH) (Ministry Of Health, 2000b).

### 1.7.1. Tobacco production

In 1997, 10,790 hectares of land area were harvested for tobacco, down from 14,000 hectares in 1990. In 1997 10,825 million kilogram of unmanufactured tobacco were produced in Malaysia. Malaysia imported 4,894 million kilogram unmanufactured tobacco. Thus, Malaysia produce 70% unmanufactured tobacco for tobacco manufactures and import 30% of tobacco needed by the manufactures. In 1997, it was estimated that Malaysian government received about RM 1.28 billion from various types of tobacco tax (Ministry Of Health, 2000b).

### 1.7.2. Control on tobacco products

The Control of Tobacco Products Regulations 1993 had been enforced since May 1994, prohibits all direct advertising, but brand name stretching is still allowed. However recently, the Government of Malaysia has decided to ban all forms of promotion on cigarette brand names in Malaysia. Cigarette packets bear a



single, fixed health warning on the side of the pack which reads 'Warning by the Government of Malaysia: Smoking is dangerous to your health'. Tar and nicotine must not exceed 20 mg and 1.5 mg respectively and the level must be displayed on the packet. Tobacco sale to any person under 18 years old is prohibited. In 1998, the taxation on cigarette was increased as follows: 1) the import duties on cigar, cheroots and cigarillos containing tobacco have been increased from RM 138 per kg to RM180 per kg. On cigarettes containing tobacco, it had been increased from RM162 per kg to RM180 per kg: 2) the excise duty on cigarette had been increased from RM28.60 per kg to RM40 per kg (Ministry Of Health, 2000b).

### 1.7.3 Protection for non-smokers

Under Regulation 10 of the Control of Tobacco Products Regulation 1993, a few places had been included as smoking prohibited areas. However in 1996, Ministry of Health has included many more places as smoking prohibited areas. The areas are:

1. Any amusement center or theatre when such place is open to public.
2. Any hospital or clinic.
3. Any public lift.
4. Any air conditioned eating house (up to half of which can be allowed for smoking provided ventilation fans are installed)
5. Any public transport
6. Banks and financial institutions.
7. Sport complexes including stadium (whether closed or open)

8. Shopping complexes
9. Air-conditioned shops
10. Government offices
11. Transport terminals
12. Airports except some designated areas as approved by the Ministry of Health
13. Schools (including kindergartens and nursery)
14. Institutions of higher learning (excluding hostels and open spaces)
15. Service counters of Tenaga Nasional Berhad, Telekom and Pos Malaysia.
16. Public halls (while in use by the public)
17. Petrol kiosks

Apart from the public places mentioned above, The Minister of Health also welcomes any organization and owner of any buildings to request to the Minister of Health to have their properties declared as smoke-free premises (Ministry Of Health, 2000b).

### 1.7.4 Health education

Intensive health education activities were also being carried out to increase public awareness and motivate smokers to quit smoking. Since 1970, regular anti-smoking campaigns have been organized by schools, the Ministry of Health and the non-governmental organizations such as the Malaysian Medical Association and consumer associations. Information on the dangers of passive smoking to mothers is distributed through pamphlets and posters and well as health talks.



Articles on smoking and health appear regularly in the media. The World No Tobacco Day was observed every year. Various activities in conjunction with that day were carried out. Training of trainers on the technique of quiting smoking has been carried out. Quit smoking clinics for smokers who are motivated and plan to quit smoking were provided. Smokers will be provided with free nicotine replacement therapy for the first 3 months of the quitting process (Ministry Of Health, 2000a).

## 1.8 Rationale of the study

In Malaysia there is an increasing trend of smoking among male and female adult and also among adolescents. The prevalence of smoking among Malaysian adult has increased from 39% in 1986 to 49% in 1996 and the prevalence of smoking among adolescents was from 9.8% to 41.4% (Ministry of Health, 1998). The implications of children exposed to secondhand smoke and the resulting ill health of these children to the health care services will be a great burden. As these children will likely grow to become adult smokers there will be future implications for their health, mortality rates and health care costs in Malaysia. For this reason, reduction of parental smoking throughout a child's upbringing may pay substantial future dividends in the prevention of respiratory diseases. Policies need to be developed which reduce smoking amongst parents and protect infants and young children from exposure to secondhand smoke. Therefore, it is hoped that this study can provide more evidence on the health effect of secondhand smoke on children. This will lead to stronger tobacco control policies in this country.

## CHAPTER 2

## OBJECTIVES AND RESEARCH HYPOTHESIS

### 2.1 General Objective

To study whether exposure to secondhand smoke at home is associated with respiratory symptoms, lung function and cognitive performance of primary school children in Kota Bharu, Kelantan.

### 2.2. Specific Objectives

1. To determine the prevalence of secondhand smoke exposure at home among primary school children in Kota Bharu, Kelantan.

2. To determine the association between secondhand smoke exposure and respiratory symptoms among primary school children in Kota Bharu Kelantan with reference to:

i. Cough in the morning

ii. Cough at night

iii. Cough most days for the previous 3 months

iv. Phlegm in the morning

v. Phlegm daytime or at night

vi. Ever wheeze or diagnosed asthma by doctor

vii. Nose problems in the morning



viii. Nose problems during daytime

ix. Nose problems at night

x. Throat problems in the morning

xi. Throat problems during daytime

xii. Throat problems at night

3. To determine the association between secondhand smoke exposure and peak expiratory flow rate among the primary school children in Kota Bharu Kelantan.

4. To determine the association between secondhand smoke exposure and cognitive performance among the primary school children in Kota Bharu Kelantan.

### 2.3. Research hypothesis

1. Children who are exposed to secondhand smoke at home have a higher risk of respiratory symptoms than those not exposed.

2. Children are who exposed to secondhand smoke at home have lower peak expiratory flow rate than those not exposed.

3. Children who are exposed to secondhand smoke at home have lower scores in cognitive performance tests than those not exposed.

# CHAPTER 3

# METHODOLOGY

## 3.1 Study design

A comparative cross-sectional study was conducted to determine the association between secondhand smoke exposure at home and respiratory symptoms, difference in peak expiratory flow rate (PEFR) and cognitive tests scores of primary school children in Kota Bharu Kelantan. The reference population in this study was primary school children in Kota Bharu Kelantan while the source population was the primary 4, primary 5 and primary 6 school children from ten randomly selected government primary schools in the district of Kota Bharu, Kelantan. Our study population was all primary 4, primary 5 and primary 6 children from randomly selected classes whose parents or guardians consented to them participating in the study. The children were excluded from the study if:

I. They have any medical illness other than asthma.

ii. They were identified by their teacher to be slow learners.

iii. They were absent from school on the day of survey.

iv. One of their siblings has been included in the study.

## 3.2 Sampling method

The researcher obtained permission to conduct the study from the Ministry of Education and the respective school headmasters before starting the study in the selected schools. A cluster sampling method was used in selecting the study



population. This type of sampling method was chosen because it was the most practical method in studying school children. The primary sampling unit was a list of all 95 government primary schools in Kota Bharu. Ten out of ninety five government primary schools in Kota Bharu were selected by simple random sampling. The secondary sampling units were all primary four, five and six in each selected schools. For each school, two classes were randomly selected from each primary four, five and six. All children in the selected classes were given a consent form to be completed by either their parents or guardian.

## 3.3 Sample size

a. Objective 1; to determine the prevalence of secondhand smoke exposure at home among the primary school children in Kota Bharu, Kelantan.

For the expected prevalence of secondhand smoke exposure at home of 47% (Lam *et al.*, 1999) with the precision of 5%, 95% confidence interval and design effect of 2, the calculated sample size was 766 (383 X design effect). After considering 10% non-response rate the sample size was 842. The calculation was done using the following formula:

$$n = \frac{z^2}{\Delta^2} p\,(1-p)$$

b. Objective 2; to determine the association between secondhand smoke exposure and respiratory symptoms.

The calculation was done using PS software for sample size calculation. In order to achieve the detectable odds ratio of 2.0 with 80% power and 95% confidence interval, the calculated sample size was 356 (89 + (89 x 3)), In this calculation, $p_0$ (proportion of secondhand smoke exposure in children) was estimated as 0.47 (Lam *et al.*, 1999) and ratio between respiratory symptoms : no respiratory symptoms was 1: 3 because the prevalence of respiratory symptoms was estimated as 25% (Ministry Of Health,1999). Therefore, the sample size was 783 (considering 10% non response rate and design effect of 2.0).

c. Objective 3 and 4; to determine the association between secondhand smoke exposure and PEFR and association between secondhand smoke exposure and cognitive tests score.

Since the dependent variables PEFR and cognitive tests scores were all continuous variables, the sample size for Objective 2, which was calculated based on the comparison of two proportions will be adequate. It was decided to use the largest sample size that was obtained for Objective 1 for this study.

Ethical approval was obtained from Research and Ethics Committee in August 2003 and the study was funded by Universiti Sains Malaysia short term grant (304/PPSP/6131317).



## 3.4 Research tools

The methods of data collection were via:

### 3.4.1 Questionnaire

A self-administered questionnaire on demography, respiratory symptoms and secondhand smoke exposure at home was prepared. There were two sections in the questionnaire.

**Section 1**

This section was answered by the children. It required responses on name, sex, race, class and school, respiratory symptoms and secondhand smoke exposure of the children. Questions on respiratory symptoms were adapted and translated from the Medical Research Council Respiratory Questionnaire 1986. The questionnaire was used by Lam *et al.*, (1999) in Hong Kong to study the association between passive smoking and respiratory symptoms in primary school children. Minor changes were made to several questions in the questionnaire to suit the local situation. The questionnaire has been tested for content validity by seeking the opinions from experts from relevant field and was piloted on the 30 children in primary 4, 5 and 5 from one of the selected schools in order to assess the response and understanding of the children towards the questions. Questions on secondhand smoke exposure were parental smoking status, number of smokers in the household and estimated total number of cigarettes smoked per day in the house.

**Section 2**

This section was answered by parents or guardian. It required responses on sociodemographic data such as parental educational status, occupation and total monthly family income, medical history of the children and household smoking status.

### 3.4.2 Peak expiratory flow meter

The procedure was performed by a trained assistant on each child. Standing height was measured in centimeters in stockinged feet and no shoes. Weight was measured fully clothed with the pockets empty (Azizi & Henry, 1991). A child Mini Wright peak expiratory flow meter was used to measure the PEFR. It was measured with the child standing and the measurement taken was the best of three attempts of forceful expiration. The predicted "normal" peak flow is determined by height, age and sex of the subject (Murphy & Kelly, 1999).

### 3.4.3 Cognitive tests.

The WISC-III comprises 5 mandatory subtests on the Verbal Scale include Information, Similarities, Arithmetic, Vocabulary and Comprehension and one supplementary test that is Digit Span. Similarly, the Performance scale of the WISC-III comprises five mandatory subtests: Picture Completion, Picture Arrangement, Block Design, Object Assembly and Coding and three supplementary tests that are Mazes and Symbol Search (Kamphaus, 1993). The



subtests used in this study were Arithmetic, Coding, Digit Span Forward and Digit Span Backward. They measure a factor called Freedom From Distractibility (FFD) which refers to attention and concentration (Kamphaus, 1993).

The Arithmetic subtest required the child to answer applied mathematical questions that were, for the most part, and presented orally by the examiner. It measured mathematical knowledge, mental computations and concentrations. The Digit Span Forward and Backward subtests required student to orally reproduce a string of numbers that are dictated by the examiner. They measure attention span and short-term memory. The Coding subtest requires a child to copy letter and number-like symbols according to a specified pattern as quickly as possible. The test measured motor coordination, speed of mental operation and short term memory (Kamphaus, 1993).

Hadidjaja *et al.* (1998) used the similar subtests to study the effect of intervention methods on cognitive function of primary school children infected with *Ascaris Lumbricoides* in Indonesia. The WISC-III subtests were performed on each of the children.

A number of psychological, social, and medical factors are either related to or have an effect on intelligence test scores. These variables include socio-economic status, dominant language, low birth weight, head trauma and others and the examiners must collect information regarding these variables when gathering background information (Kamphus, 1993).

### 3.5 Data collection

During the second visit to the schools the researcher collected the data [illegible] of a trained [illegible] in the classroom by the researcher on the purpose and methods of the study. It was emphasized that the questionnaire was anonymous and that individual responses will not be disclosed to teachers or parents. Teachers were requested to leave the classroom during the study. The researcher gave explanation on the questions, terms in the questionnaire such as "asthma" and demonstrated "wheezing". The students were asked to answer questions based on their own experience and not to copy their friends. The researcher and the assistant were in the classroom to facilitate the process of the survey. The questionnaires were collected once they were completed and each child was then given another set of questionnaire to be brought home for their parents or guardians to complete. All completed questionnaires were collected during the third visit.

During the third visit, WISC-III subtests i.e. Digit Span Forward, Digit Span Backward, Coding and Arithmetic were performed for each child. The trained assistant measured the height, weight and PEFR for each child. Data collection commenced in September 2003 and data collection was completed in March 2004.



### 3.6 Data entry and analysis

Data entry was done using SPSS version 11.0 software and was transferred to Stata Intercooled 7.0 format using Stat Transfer software. Data were then checked and cleaned. First editing process was done, which include preliminary data screening (missing values), adding or deleting variables, adding or deleting observations and correcting data points. The original data were reviewed again to complete the data set. Then, the data set was updated and changes made during the editing phase.

The data set then was evaluated for normality and outliers. Outliers were identified by plotting histogram and box plot. The outliers were checked for possibility of data recording errors, data entry errors or true outliers. Decision to remove the outliers was made.

The distributions and frequencies were examined. All continuous variables were expressed as mean and standard deviation. Frequency and percentages for categorical variables were calculated. Categories with small sample size and skewed distributions were noted. Meaningful combination of categories was done when it was indicated.

#### Objective 1

Children were classified as exposed to secondhand smoke at home when at least one household member smoked (Lam *et al.*, 1999). The prevalence of

children exposed to secondhand smoke at home was calculated based on that definition in this study.

**Objective 2**

To determine the association between secondhand smoke exposure and respiratory symptoms among school children.

The dependent variables for this objective were the following respiratory symptoms and the children have to answer 'yes' or 'no' to the questions:

i. Cough in the morning
ii. Cough at night
iii. Cough most days for the past 3 months
iv. Phlegm in the morning
v. Phlegm during daytime or night time
vi. Ever wheeze or diagnosed asthma by the doctor
vii. Nose problems in the morning
viii. Nose problems during daytime
ix. Nose problems at night
x. Throat problems in the morning
xi. Throat problems during daytime
xii. Throat problems at night.



The independents variables were:

i. Secondhand smoke exposure
   a. Unexposed
   b. Exposed
ii. Number of household smokers categorized into:
   a. No household smoker
   b. 1 household smoker
   c. 2 or more household smokers
iii. Parental educational status which was categorized into 4:
   a. No formal education
   b. Primary school level
   c. Secondary school level
   d. University level
iv. Sex
   a. Boy
   b. Girl
v. Class
   a. Primary 4
   b. Primary 5
   c. Primary 6
vi. Family history of asthma
   a. Yes
   b. No

vii. Based on the poverty level income in the 8th Malaysia Plan the income was categorized into 3 categories:

a. Below RM 500 / month ( below poverty level)

b. RM 501 – RM 1300/ month (above poverty below average)

c. More than RM 1300 / month (above average)

Since there was only 1 Indian student in the study, the variable 'race' was not considered in the analysis.

The analysis done comprised of:

1. Univariate analysis:

   Simple logistic regression was used to determine the association between secondhand smoke exposure and respiratory symptoms.

2. Multivariate analysis using a multiple logistic regression to determine the association between respiratory symptoms and secondhand smoke exposure after considering all possible confounders and interactions.

### 3.6.1 Multiple logistic regression analysis

Each of the dependent variables was analyzed separately. The independent variables were the exposure to secondhand smoke and other potential confounders. All of them were analyzed by using backward stepwise variable selection methods to obtain preliminary model. The independent variables were fitted into multiple linear regression and variance-inflation-factors were obtained to check for multicollinearity. All possible 2-ways or first order interactions were



checked by LR test. Significant and meaningful interactions were included in the model. Fitness of model was tested by Hosmer-Lemeshow goodness-of-fit test. The model was perfect fit if the p value approached one. The Receiver Operator Characteristics (ROC) curve was also used to determine the fitness of model. Area under the curve towards one in ROC curve showed that the model was fit. After the above analysis, the same analysis was repeated with the 'number of smokers in the house' as the exposure and other potential confounders remained in the analysis.

**Objective 3**

To determine the association between secondhand smoke exposure at home and peak expiratory flow rate (PEFR)

**The independent variable**

The fixed factor or main effect was secondhand smoke exposure whereas the confounders were sex and family history of asthma. Covariates were height and weight. Later, the fixed factor was changed with 'number of smoker in the house'.

**The dependent variables**

The dependent variable was peak expiratory flow rate (PEFR).

The analysis done comprised of:

1. Descriptive analysis of the sample.

2. Univariate analysis of the dependent variable using an independent t-test to determine whether there were significant differences between exposed and non exposed children.

3. A univariate analysis of covariance (ANCOVA) was done to determine any significant difference of the PEFR in exposed and non exposed children while controlling for other confounders in the model.

### 3.6.2 Univariate Analysis of Covariance (ANCOVA)

The distributions and frequencies of the variables were examined. Skewed distributions of continuous variables were noted. Univariate analysis of the covariates as well as dependent variables between exposed and non-exposed groups by independent t-test or chi square tests was done.

The analysis was continued with a univariate analysis of covariance (ANCOVA). The fixed factor was secondhand smoke exposure. Sex, family history of asthma, height and weight were the factors and covariates and PEFR was the dependent variable. The alpha was set at 0.05. The 'Preliminary overall model' was obtained. The multicollinearity between the factor and covariates were checked by looking at their respective standard error of parameter estimates. All possible two-ways interactions were checked one by one in the model between the factor and covariates by F test



**Objective 4**

To determine the association between secondhand smoke exposure and cognitive performance.

**The dependent variables**

The dependent variables were the scores obtained for the WISC-III subtests:

i. Digit Span Forward
ii. Digit Span Backward
iii. Coding
iv. Arithmetic

The analysis done comprised of:

1. Descriptive analysis of the data
2. Univariate analysis of the dependent variables using an independent t-test to determine whether there were any significant different between the exposed and non-exposed children.
3. A multivariate analysis of variance (MANOVA) was done to determine any significant different of the cognitive tests scores in exposed and non-exposed children while other confounders in the model.

### 3.6.3 Multivariate analysis of variance (MANOVA)

The distributions and frequencies of the variables were examined. Skewed distributions of continuous variables were noted. Univariate analysis of the

covariates as well as dependent variables between exposed and non exposed groups by independent t-test or chi square tests was done.

The analysis was continued with MANOVA. The fixed factor was secondhand smoke exposure. Sex, year of study, parental educational status and family income were the confounding factors. All the cognitive tests scores were the dependent variables. The alpha was set at 0.05. The 'Preliminary overall model' was obtained. The multicollinearity between the factor and covariates were checked by looking at their respective standard error of parameter estimates. All possible two-ways interactions were checked one by one in the model between the factor and covariates by F test.



# CHAPTER 4

# RESULTS

## 4.1 Demographic characteristics

A total of 795 children from ten selected government primary schools in Kota Bharu were included in this study. A total of 386 of children (48.6%) were boys and 409 children (51.4%) were girls. The distribution by class was: Primary 4; 35.3%; Primary 5; 29.9% and Primary 6; 34.7%. Most of the children were Malay (99.9%) with only 1 Indian child who was included in this study. There was no Chinese child. Figure 4.1 shows the distribution of the children according to the class.

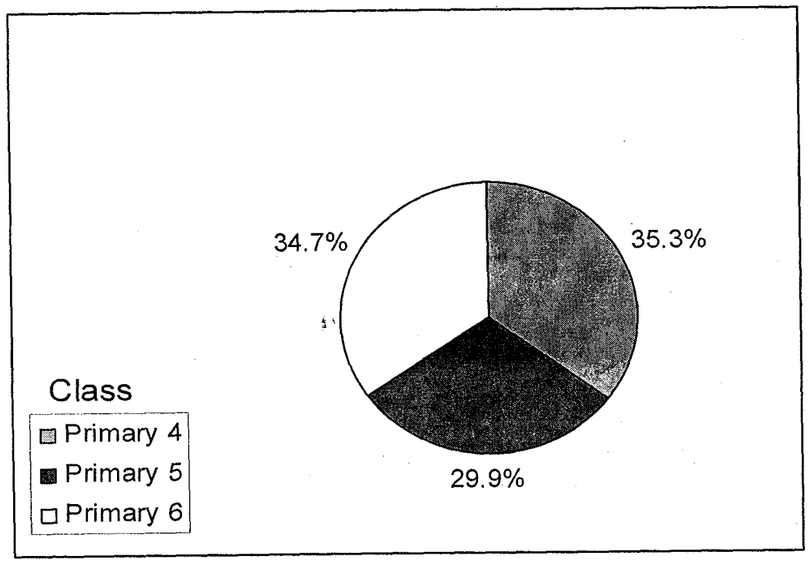


**Figure 4.1 Distribution of Primary 4, Primary 5 and Primary 6 school children participating in the study**

### 4.2 Prevalence of secondhand smoke exposure among primary school children

There were 358 (45%) children who lived with 1 smoker, 73 (9.2%) lived with 2 smokers, 9 (1.1%) lived with 3 smokers and 2 (0.3%) lived with 4 smokers in the household. A total of 442 (55.6%) children lived with at least 1 smoker in the house. Figure 4.2 shows the distribution of number of smokers in the household.

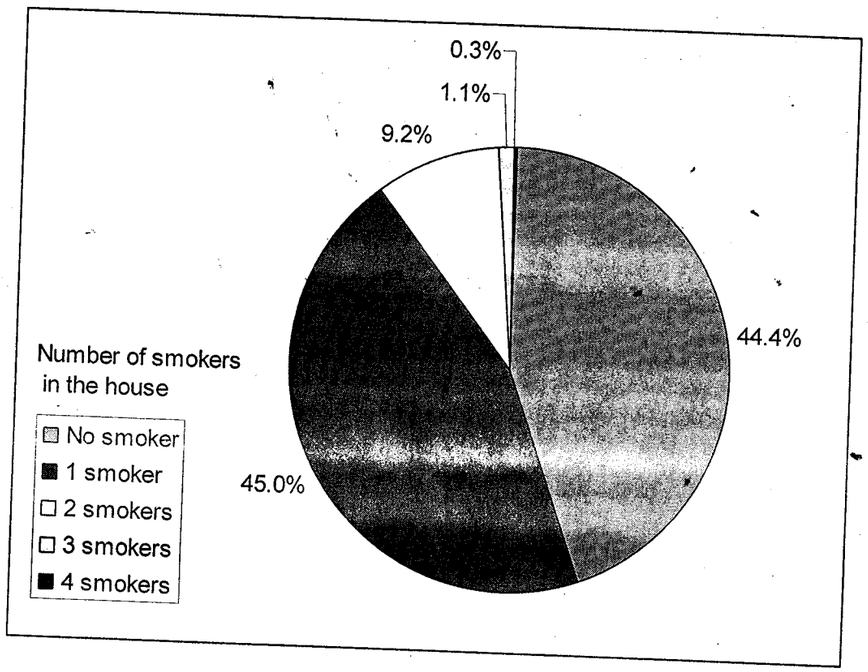


**Figure 4.2 – Distribution of number of smokers in the household**

There were 389 (48.9%) children having currently smoking fathers. None of the mothers smoked. There were 132 (16.6%) children who have other household members who were smokers. The number of children with smoking by other siblings was 92 (69.8%), 6 (4.5%) was among grandmothers, 16 (12.1%) was among grandfathers and 18 (13.6%) among uncles. Figure 4.3 shows the distribution of the other household members who were smokers.



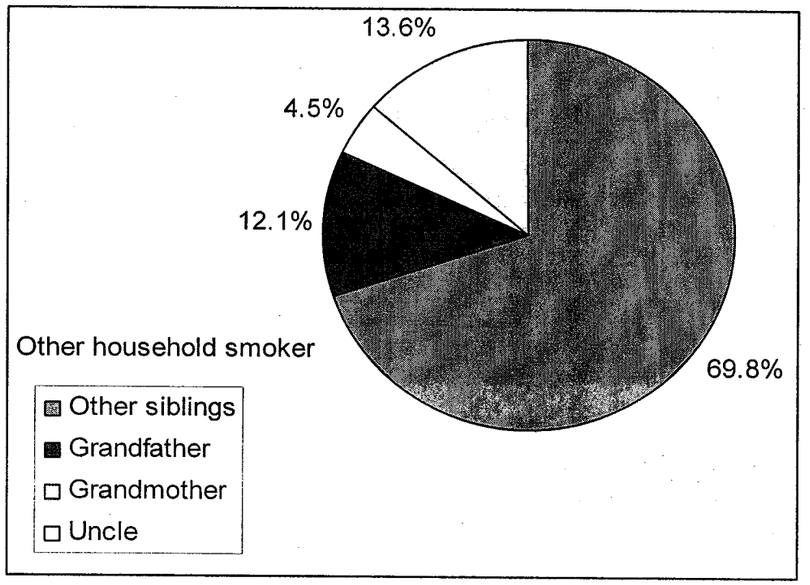


**Figure 4.3 Distribution of the other household smoker**

### 4.3 Differences in sociodemographic characteristics between exposed and unexposed children

Table 4.1 show the different sociodemographic characteristic between exposed and non-exposed children. There was no significant difference in sex, class, and family history of asthma between exposed and non-exposed children. Significant differences were observed for level of parental educational status and family income. Children whose father had no formal education or with primary school level educational status were more exposed to secondhand smoke. Children whose mother had no formal education or with primary school level

educational status were also more exposed to secondhand smoke. Children from a family with low family income were also more exposed to secondhand smoke.

**Table 4.1 Sociodemographic differences between exposed and unexposed children to secondhand smoke**

| Variables | Non exposed No (%) | Exposed No (%) | P value |
|---|---|---|---|
| 1. Sex | | | |
| Boy | 178 (50.40) | 208 (47.1) | 0.345 |
| Girl | 175 (49.6) | 234 (52.9) | |
| 2. Class | | | |
| Primary 4 | 138 (39.1) | 143 (32.4) | 0.118 |
| Primary 5 | 103 (29.2) | 135 (30.5) | |
| Primary 6 | 112 (31.7) | 164 (37.1) | |
| 3. Paternal educational status | | | |
| Not schooling | 5 (1.5) | 24 (5.6) | <0.001 |
| Primary school | 57 (17.5) | 126(29.6) | |
| Secondary school | 207 (63.7) | 236 (55.4) | |
| STP/University | 56 (17.2) | 40 (9.4) | |
| 4. Maternal educational status | | | |
| Not schooling | 10 (2.9) | 32 (7.5) | 0.001 |
| Primary school | 57 (16.8) | 105 (24.6) | |
| Secondary school | 223 (65.6) | 249 (58.3) | |
| STP/University | 50 (14.7) | 41 (9.6) | |
| 5. Family history of asthma | | | |
| Yes | 65 (18.4) | 94 (21.3) | 0.318 |
| No | 288 (81.6) | 348 (78.7) | |
| 6. Family income | | | |
| <RM 500 | 179 (50.7) | 289 (65.4) | <0.001 |
| RM 501- RM 1300 | 75 (21.2) | 74 (16.7) | |
| > RM 1300 | 99 (28.0) | 79 (17.9) | |



### 4.4. Prevalence of respiratory symptoms

Table 4.2 shows the prevalence and risks of respiratory symptoms in exposed and non-exposed children to secondhand smoke at home. The most prevalent symptom among the exposed group was nose problems in the morning (48.2%). The least prevalent symptom among the same group was throat problems during daytime (15.8%). For the unexposed children, the most prevalent symptom was also nose problems in the morning (41.1%) and the least prevalent symptom was also throat problems during daytime (9.1%).

**Table 4.2 Prevalence and risks of respiratory symptoms among exposed and unexposed children to secondhand smoke**

| Symptoms | Exposed No (%) | Non exposed No (%) | Crude OR 95% CI | Adjusted OR 95% CI |
|---|---|---|---|---|
| Yes | 119 (26.9) | 66 (18.7) | 1.60 | 1.67 |
| No | 323 (73.1) | 287 (81.3) | (1.14, 2.25) | ( 1.18, 2.39) |
| 2. Cough night | | | | |
| Yes | 117 (26.5) | 66 (18.7) | 1.56 | 1.59 |
| No | 325 (73.5) | 287 (81.3) | (1.11, 2.20) | (1.10, 2.30) |
| 3. Cough 3 months | | | | |
| Yes | 99 (22.4) | 46 (13.0) | 1.93 | 1.76 |
| No | 343 (77.6) | 307 (87.0) | (1.32, 2.82) | (1.16 2.65) |
| 4. Phlegm morning | | | | |
| Yes | 152 (34.4) | 85 (24.1) | 1.65 | 1.57 |
| No | 290 (65.6) | 268(75.9) | (1.21, 2.26) | (1.14 2.17) |
| 5. Phlegm day or night | | | | |
| Yes | 130 (29.4) | 77 (21.8) | 1.49 | 1.49 |
| No | 312 (70.6) | 276 (78.2) | (1.08, 2.07) | (1.08, 2.07) |
| 6.Ever wheeze or diagnosed asthma | | | | |
| Yes | 93 (21.0) | 51 (14.4) | 1.58 | 1.55 |
| No | 349 (79.0) | 302 (85.6) | (1.08, 2.95) | (1.06, 2.26) |
| 7. Nose problems morning | | | | |
| Yes | 213 (48.2) | 145 (41.1) | 1.33 | 1.38 |
| No | 229 (51.8) | 208 (58.9) | (1.00, 1.77) | (1.03, 1.86) |
| 8. Nose problems daytime | | | | |
| Yes | 168 (38.0) | 111 (31.4) | 1.34 | 1.34 |
| No | 274 (62.0) | 242 (68.6) | (0.99, 1.80) | (0.99, 1.80) |
| 9. Nose problems night | | | | |
| Yes | 182 (41.2) | 120 (34.0) | 1.36 | 1.40 |
| No | 260 (58.8) | 233 (66.0) | (1.02, 1.82) | (1.03, 1.90) |
| 10. Throat problems morning | | | | |
| Yes | 80 (18.1) | 45 (12.7) | 1.51 | 1.57 |
| No | 362 (81.9) | 308 (87.3) | (1.02, 2.25) | (1.05, 2.36) |
| 11. Throat problems daytime | | | | |
| Yes | 70 (15.8) | 32 (9.1) | 1.89 | 1.81 |
| No | 372 (84.2) | 321 (90.0) | (1.21, 2.94) | (1.15, 2.85) |
| 12. Throat problems at night | | | | |
| Yes | 75 (17.0) | 35 (9.9) | 1.86 | 1.78 |
| No | 367 (83.0) | 318 (90.1) | (1.21, 2.88) | (1.14, 2.78) |



## 4.5. The association between secondhand smoke exposure and respiratory symptoms

### 4.5.1. Univariate analysis

Analysis of the individual symptoms and exposure to the secondhand smoke using simple logistic regression found that the difference in proportion of symptoms between exposed and unexposed children were all significant except for the nose problems in the morning and nose problems during daytime The odds ratio (95% confidence interval) for the symptoms were 1.60 (1.14. 2.25) for cough in the morning, 1.56 (1.11, 2.20) for cough at night, 1.93 (1.32, 2.82) for cough for 3 months, 1.65 (1.21, 2.26) for phlegm in the morning, 1.49 (1.08, 2.07) for phlegm during daytime or at night, 1.58 (1.08, 2.95) for ever wheeze or diagnosed asthma by doctor, 1.36 (1.02, 1.82) for nose problems at night, 1.51 (1.02, 2.25) for throat problems in the morning, 1.89 (1.21, 2.94) for throat problems during daytime and 1.86 (1.21,2.88) for throat problems at night. Only the odds ratios for nose problems in the morning and nose problems during daytime were not significantly different between exposed and unexposed children (Table 4.2).

### 4.5.2. Multivariate analysis

Multiple logistic regression analysis was used in multivariate analysis to determine the association between respiratory symptoms and secondhand smoke exposure at home among the children while controlling for confounders. The dependent variables in the model were all 12 respiratory symptoms analyzed one at a time while the exposure variable was exposure to secondhand smoke. The

confounders selected were sex, class, family history of asthma, parental smoking status, parental educational status and family income. A backward stepwise logistic regression was done and all independent variables in the study were included. All possible two-way interaction terms were tested one by one together with the main effects and it was found that there was no significant interaction of the independent variables. Table 4.2 shows the summary of the univariate as well as the multivariate analysis.

At multivariate level, 11 respiratory symptoms were significantly associated with secondhand smoke exposure. Only nose problems during daytime were not associated with the exposure. The odds ratios (95% confidence interval) were 1.67 (1.18, 2.39) for cough in the morning, 1.59 (1.10, 2.30) for cough at night, 1.76 (1.16, 2.65) for cough most days for the previous 3 months, 1.57 (1.14, 2.17) for phlegm in the morning, 1.49 (1.08, 2.07) for phlegm during daytime or at night, 1.38 (1.03, 1.86) for nose problems in the morning, 1.40 (1.03, 1.90) for nose problems at night and 1.78 (1.14, 2.78) for throat problems at night, 1.55 (1.06, 2.26) for ever wheeze or diagnosed asthma by doctor, 1.57 (1.05, 2.36) for throat problems in the morning and 1.81 (1.15, 2.85) for throat problems during daytime.

Model fitness was checked for each dependent variable. Table 4.3 shows the summary of the Hosmer-Lemeshow goodness of fit test and area under the ROC curve. The models for each dependent variable were reasonably fit with the Hosmer–Lemeshow goodness of fit revealed not significant.



**Table 4.3 Summary of the Hosmer-Lemeshow goodness of fit test and area under the ROC curve**

| Dependent variables | Hosmer-Lemeshow | | Area under ROC curve |
|---|---|---|---|
| | Chi-square | p value | |
| 1. Cough in the morning | 0.43 | 0.81 | 0.58 |
| 2. Cough at night | 12.18 | 0.14 | 0.62 |
| 3. Cough 3 months | 7.85 | 0.35 | 0.69 |
| 4. Ever wheeze or diagnosed asthma | 0.00 | 0.94 | 0.69 |
| 5. Phlegm in the morning | 3.5 | 0.90 | 0.61 |
| 6. Phlegm daytime or night | 0.00 | 1.00 | 0.55 |
| 7. Nose problems in the morning | 10.39 | 0.17 | 0.58 |
| 8. Nose problems during daytime | 6.04 | 0.64 | 0.55 |
| 9. Nose problems at night | 2.53 | 0.96 | 0.58 |
| 10. Throat problems in the morning | 5.96 | 0.54 | 0.61 |
| 11. Throat problems daytime | 2.06 | 0.91 | 0.63 |
| 12. Throat problems at night | 7.69 | 0.46 | 0.66 |

Further analysis was done to determine the association between respiratory symptoms and number of smokers in the home. The number of smokers was categorized into 3 categories i.e. no smoker, 1 smoker and 2 or more smokers in the home. Table 4.4 shows the adjusted odds ratios of respiratory symptoms by number of smokers at home. It showed that adjusted odds ratios increased with increasing number of smokers at home for cough in the morning, cough most days

for the previous 3 months, phlegm in the morning, ever wheeze or diagnosed asthma by doctor, throat problems in the morning, throat problems during daytime and throat problems at night. No increased in odds ratio observed for cough at night, phlegm during daytime or at night, nose problems at any time.

**Table 4.4 Adjusted odds ratios (OR) for respiratory symptoms by number of smokers at home**

| Symptoms | 0 smoker | 1 smoker OR (95% CI) | ≥ smokers OR (95% CI) |
|---|---|---|---|
| Cough, morning | 1.00 | 1.51 (1.06, 2.17) | 2.22 (1.31, 3.76) |
| Cough, night | 1.00 | 1.62 (1.11, 2.36) | 1.48 (0.80, 2.71) |
| Cough for 3 months | 1.00 | 1.76 (1.15, 2.70) | 2.34 (1.18, 4.23) |
| Phlegm, morning | 1.00 | 1.48 (1.06, 2.07) | 2.04 (1.23, 3.41) |
| Phlegm, day or night | 1.00 | 1.49 (1.06, 2.09) | 1.52 (0.90, 2.58) |
| Ever wheeze or diagnosed asthma | 1.00 | 1.48 (0.99, 2.20) | 1.88(1.05, 3.36) |
| Nose problem, morning | 1.00 | 1.47 (1.08, 2.00) | 1.02 (0.61, 1.71) |
| Nose problem, daytime | 1.00 | 1.34 (0.98, 1.83) | 1.31(0.80, 2.17) |
| Nose problem, night | 1.00 | 1.38 (1.02, 1.87) | 1.23 (0.75, 2.01) |
| Throat problem, morning | 1.00 | 1.45 (0.95, 2.22) | 2.20 (1.18, 4.08) |
| Throat problem, daytime | 1.00 | 1.74 (1.09, 2.79) | 2.11 (1.08, 4.11) |
| Throat problem, night | 1.00 | 1.71 (1.07, 2.71) | 2.17 (1.10, 4.27) |

Model fitnesses were checked for each dependent variable. Table 4.5 shows the summary of the Hosmer-Lemeshow goodness of fit test and area under the ROC curve. The models for each dependent variables were reasonably fit with the Hosmer–Lemeshow goodness of fit revealed not significant.



**Table 4.5 Summary of the Hosmer-Lemeshow goodness of fit test and area under the ROC curve**

| Dependent variables | Hosmer-Lemeshow | | Area under |
|---|---|---|---|
| | Chi square | p value | ROC curve |
| 1. Cough in the morning | 2.29 | 0.97 | 0.58 |
| 2. Cough at night | 8.39 | 0.40 | 0.62 |
| 3. Cough for 3 months | 4.95 | 0.55 | 0.68 |
| 4. Phlegm in the morning | 3.38 | 0.91 | 0.61 |
| 5. Phlegm daytime or night | 1.48 | 0.96 | 0.56 |
| 6. Ever wheeze or diagnosed asthma | 0.20 | 0.98 | 0.60 |
| 7. Nose problems in the morning | 9.23 | 0.32 | 0.60 |
| 8. Nose problems daytime | 6.04 | 0.64 | 0.55 |
| 9. Nose problems at night | 1.00 | 0.91 | 0.55 |
| 10. Throat problems in the morning | 3.63 | 0.82 | 0.61 |
| 11. Throat problems daytime | 3.78 | 0.71 | 0.63 |
| 12. Throat problems at night | 5.29 | 0.73 | 0.67 |

## 4.6 The association between secondhand smoke exposure and peak expiratory flow rate (PEFR)

Peak expiratory flow rate was measured for all children in order to determine the association between PEFR and secondhand smoke exposure at home.

### 4.6.1. Univariate analysis

In studying the difference of PEFR between exposed and unexposed [illegible] and smoke, height, weight and family history [illegible] considered to be potential confounders and were included as covariates in the analysis. Independent t-tests were applied between exposure variable and PEFR and to each of covariates to identify whether they were significantly different between the exposed and unexposed children. At alpha 0.05, there was significant difference in height and weight between exposed and unexposed children. The exposed children were taller and heavier than unexposed children. However there was no significant difference in PEFR between the exposed and non-exposed children (table 4.6).

**Table 4.6 – Differences of the PEFR and covariates between exposed and non-exposed children to secondhand smoke at home**

| Variables | Non exposed | Exposed | # p value |
|---|---|---|---|
| | Mean (SD) | Mean (SD) | |
| 1. Height | 136.24 (7.74) | 137.25 (7.54) | 0.017 |
| 2. Weight | 35.44 (5.91) | 36.59 (6.00) | 0.006 |
| 3. PEFR | 266.18 (60.80) | 266.06 (57.70) | 0.978 |

# Independent t-test

Further analysis using ANOVA test was done to determine the mean difference of PEFR according to number of smokers in the house. Mean PEFR of



the children exposed to more smokers was slightly lower compared to those exposed to only 1 smoker. However the difference in mean PEFR was not statistically significant. Table 4.7 shows the mean PEFR according to number of smokers at home.

**Table 4.7 Differences of mean PEFR according to number of smokers at home**

| Variable | Number of household smokers Mean (SD) | | | # P value |
|---|---|---|---|---|
| | No smoker | 1 smoker | ≥ 2 smokers | |
| PEFR | 266.18 (60.80) | 267.53 (58.37) | 259.76 (54.64) | 0.555 |

# ANOVA test

### 4.6.2. Multivariate analysis

As this is a confirmatory analysis, no variable selection was done. A univariate analysis of covariance (ANCOVA) was used to examine the difference in PEFR between exposed and unexposed group while potential confounders were controlled. The fixed factor was secondhand smoke exposure, while weight and height of the children were the covariates family history of asthma as a categorical confounder and PEFR was the dependent variable. At alpha 0.05, the overall multivariate analysis shows no significant difference of the PEFR between exposed and unexposed children (p=0.816) when weight, height and family history of

asthma were included in the model. Table 4.8 shows the summary of the overall multivariate analysis.

Table 4.8 Summary of the overall multivariate analysis in explaining PEFR

| Variables | F statistic | p value |
|---|---|---|
| Secondhand smoke exposure | 0.054 | 0.816 |
| Sex | 111.52 | <0.001 |
| Family history of asthma | 10.48 | 0.001 |
| Height | 27.35 | <0.001 |
| Weight | 1.57 | 0.210 |

There was no possible multicollinearity between factors and covariates as well as among the covariates in explaining the outcomes as shown by small standard error of parameter estimates. Therefore the fixed factor and covariates could be maintained in the model. Two-way interaction terms were checked one by one between factor and covariates and none of them was found to be significant.

### 4.7 The association between secondhand smoke exposure and cognitive performance

Four subtests of Wechsler Intelligence Scale for Children (WISC-III) were performed on the schoolchildren to determine the cognitive status. The subtests were:

i. Digit Span Forward

ii. Digit Span Backward



iii. Coding

iv. Arithmetic

#### 4.7.1 Univariate analysis

Table 4.9 shows the mean cognitive tests for secondhand smoke exposure and confounders that were included in the analysis. For Digit Span Forward test, the mean score for non-exposed children was higher than the exposed children, girls have higher score and primary 6 children have the highest score. With regard to parental educational status, the mean score increased with increased maternal educational level and also same for paternal educational level. Children from family with higher income have higher score. For Digit Span Backward subtest, the non-exposed children have the higher score, girls and boys have the same score and primary 6 children have the highest score. The score increased with increased parental educational status. The score also increased with increased family income. For Coding subtest, the mean score was higher in unexposed children, higher among girls, highest among primary 6 children, increased with increased parental educational status and increased with increased family income. On the other hand, for Arithmetic subtest, the score was higher among exposed children, higher in girls, highest among primary 6 children but inconsistent with parental educational status and family income.

**Table 4.9 Mean cognitive tests for secondhand smoke exposure and confounder variables**

| Variables | DSF | DSB | Coding | Arithmetic |
|---|---|---|---|---|
| | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) |
| 1.Exposure | | | | |
| Exposed | 6.73 (1.75) | 4.07 (1.65) | 45.15 (10.84) | 8.13 (1.00) |
| Unexposed | 6.84 (1.80) | 4.30 (1.69) | 45.65 (10.17) | 8.04 (1.04) |
| 2. Sex | | | | |
| Girl | 6.87 (1.71) | 4.17 (1.65) | 47.95 (10.60) | 8.13 (0.99) |
| Boy | 6.70 (1.86) | 4.17 (1.69) | 42.67 (9.83) | 8.05 (1.04) |
| 3. Class | | | | |
| Primary 4 | 6.63 (1.66) | 3.70 (1.47) | 40.53 (8.70) | 6.89 (0.44) |
| Primary 5 | 6.43 (1.78) | 3.99 (1.58) | 42.56 (9.04) | 8.71 (0.57) |
| Primary 6 | 7.23 (1.82) | 4.81 (1.73) | 52.70 (9.47) | 8.79 (0.45) |
| 4. Maternal education | | | | |
| No formal education | 6.26 (1.89) | 4.03 (1.51) | 46.13 (12.10) | 8.21 (0.87) |
| Primary school | 6.56 (1.77) | 4.00 (1.66) | 42.29 (11.10) | 8.05 (0.99) |
| Secondary school | 6.86 (1.76) | 4.18 (1.67) | 45.77 (9.88) | 8.09 (1.04) |
| University | 7.00 (1.79) | 4.48 (1.70) | 47.98 (11.28) | 8.11 (1.01) |
| 5. Paternal education | | | | |
| No formal education | 6.64 (2.04) | 4.07 (2.03) | 44.61 (13.16) | 8.11 (0.99) |
| Primary school | 6.59 (1.59) | 3.88 (1.51) | 43.30 (10.06) | 8.12 (0.96) |
| Secondary school | 6.72 (1.80) | 4.15 (1.63) | 45.58 (10.44) | 8.09 (1.04) |
| University | 7.48 (1.82) | 4.84 (1.85) | 48.40 (10.48) | 8.08 (1.02) |
| 6.Family income | | | | |
| < RM 500/month | 6.68 (1.72) | 3.94 (1.63) | 43.76 (10.54) | 8.07 (1.02) |
| RM 501-RM 1300 | 6.61 (1.78) | 4.46 (1.59) | 47.09 (10.31) | 8.20 (0.94) |
| > RM 1300 | 7.19 (1.89) | 4.51 (1.73) | 47.77 (10.15) | 8.08 (1.06) |

In studying the difference of cognitive tests scores between exposed and unexposed children to secondhand smoke at home, sex, class, parental educational status and family income were considered to be potential confounders and were included in the analysis. Independent t-test was applied to each of



cognitive tests and exposure variable to identify whether they were significantly different between the two groups. The mean score for Digit Span Forward, Digit Span Backward and Coding were higher among unexposed children. However the mean score for Arithmetic was higher among exposed children. At alpha 0.05, there was no significant difference in all cognitive tests scores between the groups. Table 4.10 shows the differences of the cognitive test scores between exposed and unexposed group in the univariate analysis.

**Table 4.10 Differences in mean cognitive test scores between exposed and unexposed children**

| Variables | Non exposed | | Exposed | | #p value |
|---|---|---|---|---|---|
| | Mean | (SD) | Mean | (SD) | |
| 1. Digit Span Forward | 6.84 | (1.80) | 6.73 | (1.77) | 0.364 |
| 2. Digit Span Backward | 4.27 | (1.68) | 4.07 | (1.65) | 0.089 |
| 3. Coding | 45.25 | (9.99) | 45.11 | (11.03) | 0.858 |
| 4. Arithmetic | 8.04 | (1.04) | 8.13 | (1.00) | 0.197 |

# Independent t-test

Further analyses using ANOVA test was done to determine the mean difference of each cognitive tests score according to the number of smokers in the household. The mean score for Digit Span Forward, Digit Span Backward and Coding. The mean score for Arithmetic increased with increasing number of smokers in the house. However the differences in means were not statistically

significant. Table 4.11 shows the differences in mean cognitive test scores according to number of household smokers.

**Table 4.11 Differences in mean cognitive test scores according to number of smokers at home**

| Variables | Number of household smokers Mean (SD) | | | # p value |
|---|---|---|---|---|
| | 0 smoker | 1 smoker | ≥ 2 smokers | |
| Digit Span Forward | 6.84 (1.80) | 6.75 (1.78) | 6.63 (1.72) | 0.567 |
| Digit Span Backward | 4.27 (1.68) | 4.1 (1.86) | 3.94 (1.51) | 0.172 |
| Coding | 45.25 (9.99) | 45.51 (11.06) | 43.40 (10.78) | 0.255 |
| Arithmetic | 8.04 (1.04) | 8.13 (0.99) | 8.14 (1.07) | 0.434 |

# ANOVA test

### 4.7.2. Multivariate analysis

A multivariate analysis of variance (MANOVA) was used to examine the difference of mean cognitive tests scores between exposed and non exposed group. The fixed factor was secondhand smoke exposure, sex, class, parental educational status and group of family income were the confounders. Mean Digit Span Forward test score, mean Digit Span Forward test score, mean Coding test score and mean Arithmetic test score were the dependent variables in the analysis. At alpha 0.05, the overall multivariate analysis shows no significant difference of the mean cognitive test scores between exposed and unexposed children (p = 0.739) when other confounders were in the model. Table 4.12 shows summary of the overall multivariate test.



**Table 4.12 Summary of the overall multivariate analysis in explaining the cognitive tests scores**

| Variables | F statistic | p value |
|---|---|---|
| Secondhand smoke exposure | 0.49 | 0.739 |
| Sex | 16.34 | <0.001 |
| Year of study | 163.47 | <0.001 |
| Maternal educational status | 1.76 | 0.049 |
| Paternal educational status | 1.90 | 0.031 |
| Family income group | 3.21 | 0.001 |

There was no possible multicollinearity between fixed factor and other factors in explaining the outcomes as shown by small standard error of parameter estimates. Therefore the fixed factor and other factors could be maintained in the model. Two-way interaction terms were checked one by one between fixed factor and other factors and none of them was found significant.

# CHAPTER 5

# DISCUSSION

Public concern over health effects of the indoor air quality has risen, since it has been recognized that most people spend 75-90% of their lives indoors (Lebowitz. 1983). Interest has mainly been focused on the potential hazards of tobacco smoke, home dampness, humidifier use and nitrogen dioxide, mainly produced by combustion appliances. In recent years, many studies have focused on the detrimental effects of exposure to secondhand smoke especially among children. However, except for several studies on secondhand smoke in China (Venners *et al.*, 2001) and Hong Kong (Lam *et al.*, 1998, Lam *et al.*, 1999) the existing evidences in the literature on secondhand smoke and children health are mainly derived from Western developed countries (Cook & Strachan, 1997, Gergen 2001, DiFranza *et al.*, 2004).

## 5.1 Prevalence of secondhand smoke exposure

Because cigarette smoking is prevalent among Malaysian adults, the likelihood of passive exposure in children is expected to be high. From the National and Health Morbidity Survey 1996, the smoking prevalence among adults was 24.8% and prevalence among male was 49.2% and female was 3.5%. Assuming that the smoking family members did smoke at home this study found that 55.6% of the children were exposed to at least one smoker at home mainly from the father. When categorized into number of smoking household, 45% students lived



with 1 smoker, 9.2% lived with 2 smokers, 1.1% lived with 3 smokers and 0.3% lived with 4 smokers. For young children, the major source of exposure to tobacco smoke was smoking by parents and other household members. This study showed that the main source of exposure was the father followed by uncle and grandfather. None of the children have a smoking mother. One advantage of not having mothers who smoked was that the problem of determining whether the effects of secondhand smoke exposure were intra or extra uterine can be avoided. However the use of paternal smoking as a proxy for secondhand smoke exposure of children can be problematic, as fathers were generally less likely to be the main caregiver these children. Lam *et al.* (1999), found that in Hong Kong, the main sources of secondhand smoke exposure were fathers and grandfathers, followed by mothers, other relatives and brothers.

The prevalence of secondhand smoke exposure among children in this study was comparable to other studies in other countries. For example, WHO estimated that almost half of the world's children breathe air polluted by tobacco smoke, particularly at home. A study by Pirkle *et al.* (1996), in order to estimate the extent of exposure to secondhand smoke in the US population on the basis of questionnaire data and of serum cotinine measurement showed that 43% of US children were exposed to smoking by household members. Lam *et al.* (1999) in Hong Kong also observed about 47% of the children exposed to secondhand smoke particularly at home. A study on 8-10 year of age Croatia children gave the higher prevalence of children who exposed to at least one smoking parents i.e. 64% (Gomzi, 1999). However, the definition of secondhand smoke exposure varied

from study to study and these comparisons may not be valid. However it is suggested that many children are exposed to secondhand smoke because of parental smoking because in most countries, particularly in those where people were generally not aware of tobacco smoke's harmful effects on children's health, parental smoking status will reflect children's exposure, as smoking parents were unlikely to minimize their children's exposure by not smoking in their presence (World Health Organization, 1999).

Many investigations have used either a dichotomous classification or the number of current household smokers as exposure variables. Only one study defined exposure to parental smoking with reference to the child's lifetime (Tager *et al.*, 1979). A few studies have classified exposure based on the number of cigarettes currently smoked per day (Cuijpers et al., 1995). In this study, the exposure was measured by the current parental smoking status, other household members smoking status and approximate number of cigarettes smoked per day. However number of cigarette smoked per day was not analyzed because of many missing values especially involving other household smokers.

Exposure to secondhand smoke can be measured by either self-report by measuring cotinine levels. The two methods can give different results with respect to the proportion of children exposed to secondhand smoke. There is no clear guidance as to which measure (self-report or cotinine) was the best for documenting secondhand smoke exposure. While cross-sectional studies looking at risk factors have found self-reported secondhand smoke exposure and



measured cotinine levels were highly correlated (Henderson *et al.*, 1989, Chilmonczyk *et al.*, 1990, Hovell *et al.*, 2000)), other types of studies have not always found the same correlation. For example, during a year-long follow-up after an intervention to reduce secondhand smoke exposure in the home, the control group self-reported less secondhand smoke exposure while the measured cotinine value of their children increased (Hovell *et al.*, 2000). In contrast in a year-long study to document the impact of secondhand smoke exposure on lower respiratory infections self-reported secondhand smoke exposure was statistically significantly correlated with lower respiratory infections while measured cotinine was not (Margolis *et al.*, 1997). Therefore, it appears clear that neither measurement will be the best in all circumstances. Validation of secondhand smoke exposure measurement is important and should be used for studies in developing as well as developed countries if at all possible.

### 5.2 Secondhand smoke exposure and respiratory symptoms

Many studies have implicated secondhand smoke as a cause of respiratory illness in young schoolchildren. This study found a number of statistically significant associations between secondhand smoke exposure and respiratory symptoms among children. Significant associations were seen for cough in the morning (OR=1.67), cough at night (OR=1.59), cough most days for the previous 3 months (OR=1.76), phlegm in the morning (OR=1.57), phlegm during daytime or at night (OR=1.49), nose problems in the morning (OR=1.38), nose problems at night (OR=1.40), throat problems at night (OR=1.78), ever wheeze or diagnosed asthma

by doctor (OR=1.55) throat problems in the morning (OR=1.57) and throat problems during daytime (OR=1.81). No significant odds ratios observed for nose problems during daytime

The associations between secondhand smoke exposure and the respiratory symptoms were further compared according to number of household smokers (no smoker, 1 smoker and two or more smokers). The odds ratios increased with increasing number of smokers at home for cough in the morning, cough most days for the previous 3 months, phlegm in the morning, ever wheeze or diagnosed asthma by doctor, throat problems in the morning, throat problems during daytime and throat problems at night. No increased in odds ratio observed for cough at night, phlegm during daytime or at night, nose problems at any time.

Most of studies focused only on the symptom of cough, phlegm and wheeze only. The US EPA review considered cough, phlegm and wheezing particularly in infants and preschool children and the estimated odds ratio were between 1.1-2.0. The EPA review did not consider nose and throat problems separately from other respiratory illnesses. Lam *et al.* (1998) included throat problems (frequent itchy or sore throat of throat discomfort) and nose problems (frequent blocked or runny nose) in secondary school children. This finding provided additional evidence to support a causal relationship between secondhand smoke exposure and throat problems and possibly an association between secondhand smoke exposure and nose problems in older school children. Charlton (1984) studied only on symptom of 'cough' only in relation to parental smoking and showed a significant association



between parental smoking, general family smoking, and self reported frequent cough in children who had never smoked-particularly those aged under 11.

Our study observed a dose response relationship for cough in the morning, coughs most days for the previous 3 months, phlegm in the morning, ever wheeze or diagnosed asthma by doctor, throat problems in the morning, throat problems during daytime and throat problems at night. Many other studies also showed a dose-response relationship. For example, Lam *et al.* (1999) showed that the adjusted odds ratio increased with increasing number of smokers at home for throat problems, cough, phlegm and nose problems. Peters *et al.* (1996) found a dose response relationship between the number of categories of smokers in the home and respiratory symptoms with the strongest effect on cough or sore throat and phlegm. A systematic review on parental smoking and prevalence of respiratory symptoms and asthma in school age children by Cook & Strachan (1997) also showed the clear increased in odds with number of parents smoking which was highly statistically significant for asthma, wheeze, and cough and consistently seen in nearly all studies.

While many studies showed a positive association between secondhand smoke and respiratory symptoms, some studies found no such association. In addition to cough, phlegm, and wheeze, Burchfiel *et al.* (1986) added the symptoms of bronchitis and chest cold in his study among Tecumseh children. They found that secondhand smoke was associated with increased prevalence of phlegm, wheeze, asthma and colds settling in the chest among males and wheeze,

bronchitis and colds settling in the chest among females. Nevertheless, history of cough did not show a significant associaion. Azizi & Henry (1991) also observed lack of significant association between secondhand smoke and chronic cough, phlegm and persistent wheeze or asthma among children in Kuala Lumpur. A study by Ribeira *et al.* (2002) in Sao Paolo also did not find an increase in the incidence of respiratory infections and asthma attacks among children exposed to secondhand smoke. However, the sample size of this study was small and the time period over which the incidence of respiratory infections and asthma attacks investigated was limited to three months only.

In this study, ever wheeze or diagnosed asthma was combined because it was felt that 'doctor diagnosed asthma' alone was inappropriate since a large number of Malaysian children with symptoms may not have been diagnosed by a doctor giving rise to possible bias. A systematic review of the evidence relating parental smoking to respiratory symptoms in school-age children reports odds ratio for asthma of 1.21 and 1.40 for wheeze for either parent smoking (Cook & Strachan, 1997, Strachan & Cook, 1998).

There is currently considerable controversy regarding the role of secondhand smoke in the development of asthma. In children one longitudinal study found that late onset (after age 3 years) wheezing was associated with maternal smoking and allergy (Martinez *et al.*, 1995). Another study reported that only children of women with less than high school education developed asthma upon exposure to secondhand smoke (Martinez *et al.*, 1992). Another study



reported that only children with atopy dermatitis developed asthma on exposure to maternal smoking (Murray & Morrison, 1990). Follow-up studies of infants over the first 6-10 years of life found that secondhand smoke was not associated with development of asthma (Horwood *et al.*, 1985, Neuspiel *et al.*, 1989, Sherman *et al.*, 1990).

Childhood asthma is considered to be an allergic disease. Thus if secondhand smoke caused the development of asthma in a person who would not otherwise become asthmatic, secondhand smoke should be associated with a change in that person's atopic status. However from the various studies cited above one is led to the conclusion that secondhand smoke increases asthma but does not change the atopic status of an individual. For example, among a cohort of children followed closely from age 3 through age of 6 years, maternal smoking increased the risk of doctor diagnosed asthma while having no influence or being slightly protective against the development of allergen skin tests (Oddy *et al.*, 1999).

Cook & Strachan (1999) confirmed that exposure to cigarette smoke was a more common cause of early wheezing illness than asthma. The incidence of asthma during the school years was less strongly affected by parental smoking. A similar age-related decline in the strength of the secondhand smoke effect was evident in cross sectional studies (Cook & Strachan, 1997). This may simply reflect the diminishing level of exposure to secondhand smoke from household sources as children grow up.

It must be borne in mind that all the symptoms studied were self reported by the children, and what was considered 'usually' may vary from one child to another. Nevertheless, the term was probably a reasonably good measure because it expresses the child's own feeling. A study by Burr *et al.* (1999) supported that symptoms of wheeze and cough were reported more frequently by children than by parents answering on their behalf; presumably because the children were aware of symptoms that occurred when they were not in their parents' company. Therefore, if he or she has the symptoms enough to be aware of it and considered it to be frequent, it is clearly a health problem.

**5.3 Secondhand smoke exposure and PEFR**

In this study, we used peak expiratory flow rate measurement as an estimation of the lung function. The result showed that exposed children have lower PEFR but the difference was not statistically significant. When PEFR was compared with the number of smokers in the house, the PEFR declined with increasing number of smokers in the house but again was not statistically significant. The lack of association observed in this study may be due to the selection of PEFR as a measure of pulmonary function measurement may not be adequately sensitive to small changes in mild disease states. A normal PEFR did not indicate that other lung function measurements were also normal. Eighteen percent of children with normal PEFR had reductions in forced expiratory flows between 25 and 75% of vital capacity by spirometry (Klein *et al.*, 1995).



Some studies PEFR measurement showed some variation between exposed and unexposed children. For example, a study of 40 children aged 10-11 years in Italy reported lower average levels but greater variability in peak expiratory flow rate in the 20 children exposed to secondhand smoke (Casale *et al.*, 1992). The sample excluded asthmatics and those with acute respiratory problems. Frischer *et al.* (1993) measured PEFR daily over five days in 991 subjects in Germany, they found greater variability among children whose mother smoked but no difference in the level of PEFR between exposed children and those not exposed to maternal smoking. Variability in PEFR was also observed in asthmatic patients. For example, Schwartz *et al.* (2000) did a prospective study for 3 months on asthmatic subjects aged between 7 to 12 years, by measuring their PEFR rate every morning and evening and keeping daily diary of respiratory symptoms. The result showed that exposure to secondhand smoke was associated with a PEFR reduction of 42 L/min in morning and 41 L/min in evening among asthmatic children.

Many studies suggest that pulmonary function decrement in school-aged children is a result of combined early life (including in utero) and current exposures to maternal smoking (Wang *et al.*, 1994). Postnatal exposure secondhand smoke exposure has been associated with small declines in pulmonary function and the mechanism of damage has not been identified (Wang *et al.*, 1994).

### 5.4 Secondhand smoke exposure and cognitive performance

In this study the children cognitive status were assessed by Wechsler Intelligence Scale for Children-III (WISC-III) subtests. The tests measured the general intelligence with the subscales measuring various cognitive abilities. The tests that we used in the study were Arithmetic which measured mathematical knowledge, mental computations and concentrations. Digit Span measured attention span and short-term memory. Coding measured motor coordination, speed of mental operation and short term memory. The combination of the tests was called Freedom From Distractibility (FFD) which refers to attention and concentration. The result showed that the scores of Coding, Digit Span Forward and Digit Span backward decreased when the number of smokers increased but it was not statistically significant. The inverse association was observed for Arithmetic but it was not significant.

In contrast, experimental and human studies have linked secondhand smoke exposure with decreased performance in tests of reasoning ability and language development (Bauman *et al.*1991; Eskenazi and Bergmann 1995), tests of intelligence (Johnson, *et al.* 1999), and an increased risk for grade retention (Byrd & Weitzman 1994). These findings suggested that secondhand smoke exposure may be causally associated with impairments in cognitive skills. Reading ability was especially sensitive to this exposure.



Yolton *et al.* (2004) utilized serum cotinine, a biomarker of secondhand smoke exposure, to examine the relationship between the exposure and cognitive abilities. Cognitive and academic abilities were assessed using the Reading and Math subtests of the Wide Range Achievement Test-Revised and the Block Design and Digit Span subtests of the WISC-III. They found a significant inverse relationship between serum cotinine and scores on reading, math, and block design, but not digit span. The estimated secondhand smoke-associated decrement in cognitive test scores was greater at lower cotinine levels.

Bauman *et al.* (1989) compared the California Achievement Test (CAT) scores of eighth-grade children of smokers and non smokers. They reported a dose-response relationship between the total numbers of cigarettes smoked currently by family members and the children's overall CAT scores, and found differences between the children of smokers and of non smokers, particularly in spelling and language skills. Fried *et al.* (1997) using different assessment tools, found that children exposed to secondhand smoke during childhood but not children whose mothers were exposed to secondhand smoke during pregnancy had lower scores on tests of language/auditory processing.

The mechanisms by which secondhand smoke exert its effects on cognitive function are not known. Research into the effects of nicotine and cotinine (Audesirk & Cabell, 1999) on neurite length suggest that exposure to these substances during prenatal development, as with lead exposure (Schneider *et al.* 2003), may impact both the survival and growth of essential nervous system components even

at very low levels of exposure. While prenatal exposure to tobacco smoke has been found to impact neurite growth and neuronal connections, more research is needed to explore the mechanism by which postnatal secondhand smoke affects cognitive ability and whether this was similar or different mechanism from the effects during prenatal development.

Because many of these adverse health effects are common ailments and secondhand smoke exposure is very widespread, even small increase in average individual risk result in large population risks. Furthermore, there may be susceptible subgroups of children that are at even higher individual risk. Finally, while the effects may be difficult to measure, it is plausible that children's exposure to secondhand smoke and consequent health effects may increase risks of further adverse health effects in adulthood.

### 5.5 Limitations of the study

This study has been designed with much thought and care to obtain valid results as far as possible. However, there were limitations which were beyond the control of the author and scope of the study.

1. The main limitation of the study was the cross-sectional design of the study. Because passive smoking and respiratory symptoms were measured at the same time, the time sequence of the associations observed could not be ascertained definitively. Studies demonstrating the reversibility of adverse effects with reduced exposure to secondhand smoke such as cohort or case control studies would be



useful. However in view of a quite large sample size and the study involved the school children, it would be beyond the resources of this study.

2. A questionnaire was used to determine the respiratory symptoms and exposure status of the children that can lead to measurement bias. It may be underreported of the exposure or over reported of the symptoms. It would be an advantage if the study assessed exposure by measuring cotinine levels. This would take account of changes in exposure to secondhand smoke which occurs as children grow older and spend less time with their parents resulting in a reduction in their exposure. However measuring the cotinine will be very costly because of large number of the sample size. Jennifer A. Seifert *et al.* (2002) has proved that a questionnaire survey reflected the child's exposure to secondhand smoke and the survey was sensitive to varying levels of exposure.

3. The use of the number of smokers in the household as an indicator of secondhand smoke exposure at home does not account for other factors that influence secondhand smoke exposure at home such as room ventilation, duration of exposure, and proximity to smokers. These factors are very subjective and the response may not be reliable. However an afford has been made to categorized the exposure by the number of cigarettes smoked by the household but there were many missing values and it was decided not to analyzed this variable.

4. Smoking status of the children and other potential confounders, such as other sources of indoor air pollution were not included in the study. In Malaysia, other

potential sources of indoor pollution are cooking stoves and domestic insect repellents. A popular type of mosquito repellent is the mosquito coil which was left smoldering for 6-8 hours in the bedroom or under the bed at night. These factors should be considered in the future research.

5. Regarding the lung function test, the used of peak expiratory flow meter to assess the lung function of the children may not be sensitive enough to detect small changes. Spirometry would be better but it was an effort dependent test that required careful instruction and cooperation of the test subjects and studying the primary school children will encounter this problem.



# CHAPTER 6

## SUMMARY AND CONCLUSIONS

In this cross sectional study on the secondhand smoke exposure among primary school children in Kota Bharu Kelantan we found that more than half of the school children were exposed to secondhand smoke at home mainly from the smoking fathers. The exposure was measured by using questionnaire and by assuming that the smoking household members did smoke in the house. This large number of exposed children needs protection because of the adverse health effects of the exposure. In Malaysia, symptoms of upper respiratory tract infections represented about 35% of medical problems among adolescent who seek treatment from health clinics (Ministry Of Health, 2000). We studied on symptoms of cough, phlegm, wheezing or asthma, nose problems and throat problems and found that there was a significant association between secondhand smoke exposure and these respiratory symptoms among school children. The increased in odds ratio when the number of smokers in the house were more than one suggested a dose-response relationship.

We also compared the PEFR reading between the exposed and unexposed children and there was no significant difference between the two groups. Furthermore, the cognitive performance of the schoolchildren in terms of attention and concentration were compared between the exposed and unexposed children. The scores for 4 subtests from WISC-III namely Arithmetic, Coding, Digit Span

Forward and Digit Span Backward were compared and showed no significant difference between these groups. It was concluded that secondhand smoke exposure has an association with respiratory symptoms. On the other hand secondhand smoke exposure has no association with PEFR and cognitive performance in term of attention and concentration of the primary school children in Kota Bharu Kelantan.



# CHAPTER 7

## RECOMMENDATIONS

This study found that more than half of the school children were exposed to secondhand smoke at home and they are vulnerable to the adverse effects of the exposure because they spend much of their time at home. The study also showed that there was an association between secondhand smoke exposure and respiratory symptoms among the children. Therefore, stricter policies and enforcement are needed to protect children from secondhand smoke and its adverse health effects. Legislation is of limited value in reducing exposure in private homes. Professionals, parents, patients, and the public need to be educated about the harmful of secondhand smoke and how to protect children. Health care workers in hospital settings can include secondhand smoke exposure in their initial assessment of all admissions and counsel parents appropriately. The smokers should be encouraged to stop smoking by establishing and promoting quit smoking clinics. Potential smokers need to be identified and praised for not smoking thus far. They also need information about healthy alternatives for reducing stress, such as exercise and may need opportunities to role-play how to resist smoking. Skillful use of mass media, based on principles of communication science, coupled with advocacy that links government public health policy with efforts by health professionals and grassroots groups, is essential to the success of any educational campaign.

This study did not observe an association between secondhand smoke exposure and lung function which was measured by peak expiratory flow meter. It is suggested that other method such as spirometry is used to assess the lung function. If were to use peak flow meter, it is suggested that variation of the PEFR is taking into consideration.

A questionnaire was used to measure the secondhand smoke exposure among the children in this study. The questionnaire should be validated with the cotinine level in Malaysian population to determine the extent of exposure among the children. In exploring the effects of secondhand smoke on cognition of the children, we have studied mainly on the attention and concentration aspect and it showed that they were no difference between exposed and unexposed children. It is suggested that other aspect of cognition being studied such as reading because the literatures suggest it is the most affected or study on the school performances of the exposed compared to unexposed children.



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