

UNIVERSITI PUTRA MALAYSIA

ASSOCIATIONS BETWEEN SOCIODEMOGRAPHY AND ENVIRONMENTAL FACTORS AND BLOOD LEAD (PbB) LEVEL AMONG SECONDARY MALE SCHOOL STUDENTS IN TWO DISTRICTS IN SELANGOR, MALAYSIA

ASILAH BINTI AHMAD

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By

ASILAH BINTI AHMAD

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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By

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May 2014

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The risk factors of PbB levels on adolescents have not been fully described in Malaysia. Due to insufficient local data, this cross-sectional study was conducted to determine the sociodemography and environmental risk factors as well as the predictors of PbB levels among secondary male school students in two districts in Selangor. This study would provide valuable insight on the possible lead exposure routes among understudied subjects and to set basis for future studies on lead-adolescent.

This study involved 194 of Form 2 and Form 4 students attending school in Petaling and Hulu Langat districts. Two-stage sampling was applied as the sampling technique, with stratification by schools and forms. At the first stage, schools were selected at random using a sampling frame containing a list of government secondary schools in the selected districts obtained from Selangor State of Education Department. At the second stage, respondents were selected based on exclusive and inclusive criteria using sampling frames containing lists of students in Form 2 and Form 4, obtained from their respective schools.

C

Finger-prick method was applied to obtain capillary blood specimen. PbB was determined using an atomic absorption spectrometer equipped with graphite furnace. Both sociodemography characteristics (age, family structure, mother's educational attainment, father's educational attainment, mother's working status, father's working status, and family income) and environmental characteristics (household smoking, respondent smoking, type of housing, length of residence, house age, house paint, type

of pipe system, distance house-major road, distance house-factory, and school location) were obtained from self-administered questionnaires.

The results showed that the mean PbB concentration was 4.61μ g/dL (95% CI: $4.01-5.21\mu$ g/dL). Prevalence of PbB concentration more than 10μ g/dL for urban school going adolescents was 5.7%. There were significant differences in the mean of log-transformed PbB with father's working status, family income, type of housing, and school location. Higher PbB levels were observed in respondents who had working father, family income < RM3,000, living in unstructured housing, and attending school in industrial area. This study also observed a non-significant increasing trend of PbB concentration as (1) father's highest education decreases and as (2) respondent cigarettes intake increases. Multivariable analysis indicated that living in unstructured housing and having working father were the significant predictors for PbB levels. Null hypothesis was rejected in favour of alternative hypothesis. Socio-demographic factor namely father's working status and environmental factor namely type of housing were predictive of PbB levels.

In conclusion, the variations in PbB levels on this population were mostly due to other contributing factors outside the study scope. As the environmental factors used in this study are reflective towards assessing indoor exposure, this study suggests that lead exposure in these adolescents was largely contributed from other unknown sources, more likely to be from outdoor sources, yet to be identified.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

HUBUNGAN FAKTOR SOSIODEMOGRAFI DAN PERSEKITARAN DAN ARAS PLUMBUM DARAH DI KALANGAN PELAJAR LELAKI SEKOLAH MENENGAH DI DUA DAERAH DI SELANGOR, MALAYSIA

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Faktor risiko paras Pb darah di kalangan remaja belum dikaji sepenuhnya di Malaysia. Disebabkan kekurangan data tempatan, kajian keratan rentas ini dijalankan untuk mengenalpasti faktor risiko sosiodemografi dan persekitaran paras Pb darah serta prediktor paras Pb darah di kalangan remaja lelaki sekolah menengah di dua daerah di Selangor. Kajian ini dapat memberi fahaman yang berharga berkenaan pendedahan plumbum Pb di kalangan subjek kajian dan juga sebagai asas untuk kajian Pb-remaja di masa akan datang.

Kajian ini melibatkan 194 remaja lelaki Tingkatan 2 dan Tingkatan 4 yang bersekolah di daerah Petaling dan Hulu Langat. Persampelan dua-peringkat digunakan sebagai teknik persampelan, dengan stratifikasi melalui sekolah dan tingkatan. Pada peringkat pertama, sekolah dipilih secara rawak melalui senarai sekolah menengah di dua daerah terpilih yang diperolehi daripada Jabatan Pendidikan Negeri Selangor. Pada peringkat kedua, responden dipilih berdasarkan kriteria inklusif dan eksklusif melalui senarai pelajar Tingkatan 2 dan Tingkatan 4 yang diperolehi daripada sekolah masing-masing.

C

Kaedah cucukan hujung jari digunakan untuk mendapatkan spesimen darah kapilari responden. Paras Pb darah ditentukan melalui spektrometrik penyerapan atom yang dilengkapi dengan relau grafit. Ciri sosiodemografi (umur, struktur keluarga, tahap pendidikan ibu, tahap pendidikan bapa, status pekerjaan ibu, status pekerjaan bapa, dan pendapatan keluarga) dan ciri persekitaran (isirumah merokok, responden merokok, jenis perumahan, tempoh menetap, usia rumah, cat rumah, jenis sistem perpaipan, jarak

antara rumah-jalan raya utama, jarak antara rumah-kilang, dan lokasi sekolah) setiap responden dinilai daripada borang soal selidik yang diisi sendiri.

Hasil kajian mendapati paras purata Pb darah adalah $4.61\mu g/dL$ (95% CI: $4.01-5.21\mu g/dL$). Prevalens paras Pb darah remaja lelaki bandar melebihi $10\mu g/dL$ adalah 5.7%. Terdapat perbezaan min yang signifikan antara log-transformasi Pb darah dengan status pekerjaan bapa, pendapatan keluarga, jenis perumahan, dan lokasi sekolah. Paras Pb darah yang lebih tinggi dapat diperhati pada responden yang mempunyai bapa yang bekerja, pendapatan keluarga < RM3,000, tinggal di rumah tidak berstruktur, dan bersekolah di kawasan perindustrian. Terdapat pola peningkatan yang tidak signifikan pada aras PbB apabila (1) taraf tertinggi pendidikan ibubapa menurun dan (2) pengambilan rokok responden meningkat. Analisis multivariat mendapati tinggal di rumah tidak berstruktur dan mempunyai bapa yang bekerja adalah prediktor paras Pb darah yang signifikan. Hipotesis nul ditolak. Faktor sosiodemografi iaitu status pekerjaan bapa dan faktor persekitaran iaitu jenis perumahan adalah prediktif bagi paras Pb darah.

Kesimpulannya, variasi aras PbB dalam populasi kajian ini lebih berpunca daripada faktor lain di luar skop kajian. Faktor persekitaran yang digunakan di dalam kajian ini lebih menjurus pada pendedahan Pb di dalam rumah. Oleh itu, kajian ini mengandaikan pendedahan Pb remaja kajian ini disebabkan oleh sumber luar rumah dan kajian mengenai pendedahan Pb daripada sumber luar rumah amat diperlukan.

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The author also gratefully acknowledges participants, parents, and teachers who cooperated in the study. This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree Master of Science. The members of Supervisory Committee were as follows:

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Declaration by graduate student

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Declaration by Members of Supervisory Committee

This is to confirm that:

- the research conducted and the writing of this thesis was under our supervision;
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LIST OF ABBREVIATIONS

	AAS	Atomic absorption spectrometer
	ATSDR	Agency for Toxic Substances and Disease Registry
	CDC	Centers for Disease Control
	GFAAS	Graphite furnace atomic absorption spectrometer
	EDTA	Ethylene Diamine Tetra Acetic Acid
	HNO ₃	Nitric Acid
	Mg(NO ₃) ₂	Magnesium Nitrate
	NH ₄ H ₂ PO ₄	Ammonium Dihydrogen Phosphate
	Pb	Lead
	PbB	Blood lead
	SMK	Sekolah Menengah Kebangsaan
	As	Absorption
	g	Gram
	g/L	Gram per liter
	L	Liter
	L/min	Liter per minute
	km	Kilometer
	m	Meter
	ΜΩ	Mega ohm
	mL	Mililiter
	mg/L	Milligram per liter
	mg/kg	Milligram per kilogram
	ng/mL	Nanogram per milliliter
	ppm	part per-million
	ppb	part per-billion
	μL	Microliter
	μm	Micrometer
	µg/dL	Microgram per deciliter

µg/mL	Microgram per milliliter
$\mu g/m^3$	Microgram per cubic meter
m_1	Molarity of the stock solution
m ₂	Molarity of the diluted solution
\mathbf{v}_1	Volume of stock solution
v_2	Volume of diluted solution
α	Alpha
В	Unstandardized beta coefficient
β	Standardized beta coefficient
d	Standard error or precision
F	Ratio in ANOVA
М	Mean
n	Number in a subsample
Ν	Total number in a sample
Р	Prevalence or proportion
р	Probability
r	Pearson correlation
R^2	R-squared
SD	Standard deviation
SE	Standard error
t	Test statistic for <i>t</i> -test
Ζ	Statistic for a level of confidence level
°C	Degree Celsius
%	Percent
>	Greater than
2	Equal or greater than
<	Less than
\leq	Equal or less than

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CHAPTER 1

INTRODUCTION

1.1 Background

Lead has been widely used as additive in petrol for decades resulting being the major source of lead dispersion into human environment. After it was discovered to be harmful to human due to its toxic effects, for the benefit of community health as well as environmental health, the sell and use of lead petrol was banned in many countries, including Malaysia.

After Malaysian government implemented the policy to use unleaded petrol in 1998, lead in ambient air has decreased significantly (Department of Environment Malaysia, 2005). However, in an overview study of the non-occupational exposure to lead (Pb) in East and Southeast Asia found that though the level of Pb-Blood, Pb-Urine and Pb-Food varied substantially among the eleven urban locations, the highest Pb exposure was in Kuala Lumpur (Ikeda *et al.*, 2000). Though leaded petrol is no longer use in many countries including Malaysia, human can still be affected by its toxicity as the remaining lead from the environment can still be absorbed by human body due to its characteristics. Not only is lead a ubiquitous toxicant, but also stable and hard to break down which consequently cause lead to accumulate in the environment (Agency for Toxic Substances and Disease Registry (ATSDR), 2007).

Lead has no beneficial physiological functions to human body thus it is not needed even in a small consumption (Centers for Disease Control and Prevention, 2005). Centers for Disease Control(1991) has set 10 μ g/dL as an advisory and action level for environmental and educational intervention for lead exposure in children. However, no amount of lead is safe. Even at low-doses concentration, as low as 5 μ g/dL, has exhibited effects on cognitive and academic skills in children and adolescents (Lanphear, Dietrich, Auinger, & Cox, 2000).

Other effects of lead poisoning reported on adolescents include stunted growth (Anticona & Sebastian, 2014), inattention symptoms, hyperactivity-impulsivity symptoms (Goodlad *et al.*, 2013), attention deficit hyperactivity disorder (ADHD) (Lucchini *et al.*, 2012), risk of hearing loss (Shargorodsky, Curhan, Henderson, Eavey, & Curhan, 2011), impaired in kidney function (Fadrowski, Navas-Acien, Tellez-Plaza, Guallar, Weaver, & Furth, 2010), external unintentional injuries (Kincl, Dietrich, & Bhattacharya, 2006), and kidney abnormalities (Oktem, Arslan, Dündar, Delibas, Gültepe, & Ergürhan, 2004).

Elevated PbB levels can be caused by various factors. The potential risk factors for increased PbB levels in children and adults have been documented substantially, with few on adolescents. However, these risk factors differ geographically and demographically. Studies on children have shown that having PbB levels greater than $10\mu g/dL$ were associated with age, gender, race, family income, housing age, location of residence, parental occupation, and environmental smoke exposure (Liu, McCauley, Pinto-Martin, Yan, Shen& Needleman, 2013; Levin *et al.*, 2008). While a study on Mexican-American youth aged 1 to 17 years have found that age, family income, housing age, and source of drinking water were significant predictors of PbB levels $\geq 10\mu g/dL$ (Cossío-Torres, Calderón, Tellez-Rojo, & Díaz-Barriga, 2013).

Risk factors also differed based on the levels of exposure. Moralez, Gutierrez, and Escarce (2005) concluded based on multivariate analyses in a study among Mexican-American children and adolescents, the statistically significant predictors of having PbB levels $\geq 5\mu g/dL$ were gender, age, generational status, home language, family income, education of head of household, age of housing, and source of drinking water. However, the same study also concluded that gender, generational status, home language, and education of head of household were not the significant predictors of having PbB levels $\geq 10\mu g/dL$.

Though effects on childhood lead exposure persist until adulthood (Cecil *et al.*, 2008), in Malaysia, most lead studies have been focus more on children and adults with less attention given to adolescents. As a result, available data on adolescents are inadequate. Despite data on risk factors of elevatedPbB levels for adolescents are available from other countries, the existing evidences are an international evidence-based which less reflective to local population. Moreover, these often differed and varied factors of lead levels are also heavily influenced by demographic structure (Ewers &Schlipkoter, 1991) and environmental factors.

Due to this combination of reasons, this present study aimed to determine the potential sociodemographyfactors and environmental factors influencing PbB levels in school going adolescents in two districts in Selangor.

1.2 Problem Statement

As lead poisoning can affect adolescents with adverse health effects, therefore it is important to identify the sources of lead exposure and possible risk factors. However, data on risk factors for increased PbB levels on adolescents in Malaysia is currently lacking and have not been thoroughly described. Meanwhile, findings from other intercontinental studies are more accurate in reflecting to a geographically different population.

Although lead has been extensively studied in children, its risk factors and sources remain uncertain in adolescents. This is because lead studies are often centered on younger children that have higher risk to lead exposure and adults that occupationally exposed to lead, with less focus emphasized on adolescents. This is somewhat unacceptable. Though younger children were claimed to be more at risk to lead poisoning due to pica behavior (Dignamet al., 2004; Gerhardsson, 2004) and their fragile developing bodies (World Health Organization, 2008), older children and adolescents too were vulnerable and sensitive to the harmful effects of lead. In a study of PbB levels and environmental exposure among Saudi schoolchildren aged 6-18 years, a highly significant correlation was observed between PbB levels and anemia in age group 6-12 years old and age group 12-17 years old (Zolalyet al., 2012). Vivoli, Fantuzzi, and Bergomi (1993) found that even low lead exposure may affect stature growth and gonadotropins levels on healthy children aged 11-13 years, the age of the onset of puberty (11-13 years) where the development of adolescent is started (Eagle & Schwartz, 1994). Furthermore, recent findings have shown reversing trend that PbB of adolescents population were the highest among the respective understudied populations (Baeyens et al., 2014; Hegazy, Zaher, Abd El-Hafez, Morsy, &Saleh, 2010).

The risk factors for PbB levels are not only differed by age group, but they are also differed geographically. A study done in the United States found that age, family income, housing age, and source of drinking water were significant predictors of having PbB levels $\geq 10\mu g/dL$ among Mexican-American youth aged 1 to 17 years (Moralez, Gutierrez, &Escarce, 2005). However, the predictors of PbB levels on Mexican adolescents with a mean of age 17 were totally differed which include bone lead levels, male sex, current use of lead-glazed ceramics, and living in Mexico City (Fariaset al, 2008). The difference in these sets of risk factors found in these geographically differed studies implies that the risk factors may not be the same for similar populations in different country. Additionally, the different in the sources of lead and the exposure levels may also contribute to a distinct set of risk factors for elevated PbB levels. Based on multivariate analyses, the significant predictors of having PbB levels $\geq 5\mu g/dL$ among Mexican-American children and adolescents were gender, age, generational status, home language, family income, education of head of household, and age of housing (Moralez, Gutierrez, & Escarce, 2005). However, for those with PbB levels \geq 10µg/dL, the significant predictors were age, family income, housing age, and the source of drinking water.

Due to insufficient local data about the potential sources of lead exposure and possible influencing factors of elevated PbB levels available on adolescents, in addition with the geographically and demographically different risk factors reported for PbB levels, therefore, this cross-sectional study was carried out to determine the sociodemography and environmental risk factors among school going adolescents in Petaling and Hulu Langat district in Selangor. This study also was sought to identify the predictors of PbB levels among the understudied subjects.

1.3 Significance of Study

This part of the study discusses about the importance of documenting the sources of lead exposure and the risk factors of elevated PbB levels on adolescents to future researchers, scientific and social community, health planners and policy makers.

This was the first study in Malaysia, to researcher's knowledge, to report about risk factors and the predictors of lead exposure on adolescents. As for that, this study would not also generate new knowledge but also subsequently provide valuable insight on the possible exposure routes among understudied subjects. Additionally, this research would as well serve as a basis of reference for future researchers in conducting studies on lead-adolescent.

Findings derived from this study would also be beneficial to both scientific and social community in adding new knowledge and expanding the current literatures both local and overseas studies. The new knowledge obtained would fill in the gap currently existing in the research literature.

Available information from this study would be accessible to those who require the use of themas reference in lead exposure prevention planning, health promotion and education programs. Furthermore, these results would aid in improving making and design planning.

1.4 Research Objectives

1.4.1 General Objective

To determine PbB concentration and its association with sociodemographyfactors and environmental factors among secondary male school students in Petaling and Hulu Langat district in Selangor

1.4.2 Specific Objectives

1. To describe sociodemographyfactors (age, family structure, mother's educational attainment, father's educational attainment, mother's working status, father's working status, and family income), environmental factors (household smoking, respondent smoking, type of housing, length of residence, house age, house paint,

type of pipe system, distance house-major road, distance house-factory, and school location), and PbB concentration

- 2. To comparePbB levels betweensociodemographyfactors and environmental factors
- 3. To determine the predictors of PbB levels

1.5 Research Hypothesis

Research hypothesis for this study was developed in attempt to guide the focus on the purpose of the study. The hypothesis is as the following:

H_a: Sociodemography factors (age, family structure, mother's educational attainment, father's educational attainment, mother's working status, father's working status, and family income) and environmental factors (household smoking, respondent smoking, type of housing, length of residence, house age, house paint, type of pipe system, distance house-major road, distance house-factory, and school location) are the significant predictors of PbB levels

1.6 Conceptual Framework

The aspect of interest in this study is clearly outlined in the conceptual framework in Figure 1.1.

1.7 Definition of Terms

1.7.1 Adolescent

Conceptual

According to World Health Organization (2001), adolescent is a person aged between 10 to 19 years old whom within a stage of being in the period of physical, psychological and social maturing from childhood to adulthood.



Figure 1.1 Conceptual Framework 'Associations between Sociodemography and Environmental Factors and Blood Lead (PbB) Level among Secondary Male School Students in Two Districts in Selangor, Malaysia'

Operational

Adolescent in this study refers to respondents aged 14 and 16.

1.7.2 Blood lead

Conceptual

Blood lead refers to the amount of lead in the blood (Coluccio&Malino, 1994). Blood lead level is a test that measures the amount of lead in the blood (MedlinePlus Medical Encyclopedia, nd). It is reported in micrograms of lead per deciliter of whole blood and is abbreviated as $\mu g/dL$.

Operational

About 100 μ L of capillary blood was drawn from each adolescent by a qualified staff nurse. Blood samples were analyzed using atomic absorption spectrometer to obtain the value of lead. The value that was produced in μ g/L unit was converted to μ g/dL. The converted value represents as PbB concentration and was used for data analysis.

1.7.3 Environmental

Conceptual

Environment refers to the conditions that surround someone that influence growth, health, progress, and so forth (Merriam-Webster's online dictionary, n.d.). According to Oxford University Press (n.d.), environment is the surroundings or conditions in which a person, animal, or plant lives or operates.

Operational

Environmental refer to a set of variables which include household smoking, respondent smoking, type of housing, length of residence, house age, house paint, type of pipe system, distance house-major road, distance house-factory, and school location. This information was obtained through questionnaire.

1.7.5 Sociodemography

Conceptual

Sociodemography is a combination of social and demography factors (Merriam-Webster's online dictionary, n.d.).

Operational

Sociodemography factors refer to a set of variables which include age, family structure, mother's educational attainment, father's educational attainment, mother's working status, father's working status, and family income. This information was obtained through questionnaire.

1.8 Scope and Delimitations of Study

The scope of this study was delimited to the association between PbB levels with sociodemographyand environmental factors and the predictors of PbB levels among school going adolescents in two districts in Selangor. The scope included male adolescents aged 14 and 16 attending government schools in Petaling and Hulu Langat districts in Selangor during the school year of 2009. For the purposes of this study, the following delimitations were made:

- 1. As blood specimens need to be stored and kept in good condition immediately, a minimum traveling time was required for transporting the specimens back to the laboratory. For that reason, this study location was delimited to schools within less than two hours travel distance from the laboratory.
- 2. Adolescents aged 15 and 17 years old were excluded as they would sit for national examinations for Lower Secondary Assessment (PMR) and Malaysia Certificate of Education (SPM) respectively at the end of the year. This study was delimited to adolescents Form 2 and Form 4.

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