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BLOOD-LEAD MONITORING EXPOSURE TO LEADED-GASOLINE AMONG SCHOOL CHILDREN IN JAKARTA, INDONESIA 2005

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ABSTRACT

In Indonesia, except Jakarta, lead (Pb) is still being used in many products especially as octane booster for gasoline. It means that the negative effects of lead, such as: decreasing IQ, decreasing hearing, decreasing growth, and decreasing hemoglobin content are still occurring and will continue in the future. Meanwhile, the longer lead exposure occurs in the environment more dangerous the health effects especially to the children. The Jakarta blood-lead study in 2001 showed that 35% elementary school children have blood lead level (BLL) more than 10 μg/dl, and 2.4% had BLL more than 20 μg/dl (CDC-USAEP 2001).

The objective of this study is to assess the blood lead level patterns of elementary school children in Jakarta urban area in 2005, with the aim to evaluate mean of blood lead levels of 3rd and 4th grade elementary school children in Jakarta urban area. A cross-sectional survey was implemented.

The study was conducted on January to February 2005. The equipment of portable LeadCare and Hemocue were used for analyzing blood-lead and blood hemoglobin (Hb) respectively from children finger blood on site. All of the 20 selected elementary schools agreed to participate the test. A total of 203 students allowed by their parents participate the test. About 5% of the blood samples could not be analyzed. The overall average for Hb-blood is 12.6 mmHg and for Pb-blood is 4.2 μg/dl. Percentage of those children with Pb-blood equal and more than 10 μg/dl is 1.3%.

The declining Pb-blood prevalence from 2001 study is obviously shown the success of Leaded-gasoline phase-out program in Jakarta. It means that the program is success in preventing people exposed to leaded-gasoline in Jakarta, especially to the children from the risk of lead toxic impacts. Thus, the program of phasing-out of leaded-gasoline must be expanded and implemented to all of Indonesia provinces and cities in order to protect lead exposure to people.

Key Words: Air Quality, Blood-lead levels, Health Effects

1. INTRODUCTION

Rapid urbanization and industrialization in Indonesia have created severe air pollution problems, particularly in its major cities. The United Nations Environmental Program ranks Jakarta as the world's third most polluted mega-city, after Mexico and Bangkok. Vehicular traffic emissions are obvious and major sources of air pollution. An ADB-funded regional Technical Asisstance[1] estimated that vehicle emissions in Jakarta amount to approximately 71% of the oxides of nitrogen (NO_x), 15% of sulfur dioxide (SO_2), and 70% of particulate matter (PM_{10})[2] in the total emission loads, and the annual economic cost of the associated health problems will be about $450 million by 2015. The World Bank study[3] estimated health damage due to all sources of air pollution in Jakarta at approximately $300 million per year in 1990, and this was projected to increase tenfold by 2010 unless serious control efforts were implemented. Total population in DKI Jakarta is expected to grow from approximately 9.5 million in 1998 to 11 million in 2005, and to 13 million in 2015.

In Indonesia, except Jakarta-the capitol city, lead (Pb) is still being used in many products especially as octane booster for gasoline. Means that the negative effects of lead, such as: decreasing IQ, decreasing hearing, decreasing growth, and decreasing hemoglobin content are still occur and will continue in the future. The efforts to eliminate effects of environment lead exposure from gasoline had been starting in Jakarta City by replacing leaded gasoline to unleaded gasoline since July 1st, 2001 and will continue to all of provinces in Java Island (the most populated island with about 60% of Indonesia population) in the year of 2002, and finally to all of Indonesia provinces by the year of 2003 for the first scenario, and by the year 2005 for the last scenario. However, the plan seems very difficult to be implemented on time due to political issues and lack of government willingness rather than the economic problems. Meanwhile, the longer lead exposure occurs in the environment more dangerous the health effects especially to the children will be.

The human health impacts of exposure to environmental lead have been extensively researched overseas for many years as well as the respiratory diseases caused by air pollution. Progressive studies have shown these impacts to occur at progressively lower levels of exposure, such that it is now considered by the overwhelming majority of health scientists that there is no threshold level below which these effects do not occur. It is regarded to be one of the most serious health problems facing populations, particularly children. Common symptoms include IQ loss, reading and learning difficulties, hearing loss, difficulties in concentration, adverse on kidney function effects, blood chemistry, and the cardiovascular system as well as adverse reproductive effects for women. The negative impacts of lead pollution on human health are well documented. The most usual indicator of human exposure to environmental lead is the amount that can be measured in blood. The World Health Organization has set a standard for the maximum acceptable blood lead level at 20 micrograms per deciliter and the Center for Diseases Control and Prevention USA suggested children blood lead level is not exceed of 10 micrograms per deciliter.

However, more recent studies have shown measurable and chronic health effects at much lower levels.

Exposure is primarily caused by airborne lead. In congested urban areas, exhaust fumes from vehicles using leaded gasoline typically account for some 90 percent of airborne lead pollution.

- In pregnant women, blood lead concentrations of 10 μg/dl have been associated with potentially adverse development of fetuses and newborn infants.
- In children, blood lead concentrations of 10 μg/dl can cause significant IQ decrement and lower intellectual achievement; can slow down growth rate; and can affect hearing.
- In adults, blood lead concentrations of 10 μg/dl can increase hypertension and heart disease.
- Other health problems include: damage of haemopoietic system, damage of renal system, disturbance of cardiovascular system, neurobehavioral effects, abortion, still-birth, neonatal death, disturbance of immunity mechanism, carcinogen, and so on.

Several studies related to blood-lead level conducted in Jakarta found that: the average of Jakarta public bus drivers' blood-lead was 24.6 μg/dl in 1978 (Achmadi et al, 1978). A 1991 study of blood lead concentrations in Jakarta residents showed such levels to be typical ranging to over than 30 μg/dl in some sections of the population. In particular, 74% of 66 slum dwellers, who live and work in heavily trafficked areas, had blood lead level >30 μg/dl. The 2001 blood –lead study among elementary school children showed 35% had blood lead level (BLL) more than 10 μg/dl, and 2.4% had BLL more than 20 μg/dl (CDC-USEPA 2001). Other studies in Bandung city show similar trends. They are: 30-46% of policemen and public transportation drivers having blood-lead above 40 μg/dl (Djuangsih 1984), and 50% of street vendors having blood-lead above 40 μg/dl (Haryanto, 1993). It must be concluded, therefore, that significant chronic health impacts are caused in many sections of the population in Jakarta, by chronic exposure to environmental lead, and that the major source is lead in gasoline.

The lack of evidences from epidemiological studies, concerning lead and dust air pollution to people's health effects in Jakarta, is believed as a potential reason that may affects to the lack of awareness and willingness of public policy decision makers to develop appropriate strategy for preventing Jakarta population from the hazards of air pollution. Therefore, the study providing information in epidemiological evidences of children health effects caused by air pollution in Jakarta is needed and very important to be conducted in the near future.

2. OBJECTIVES

To assess the blood lead level patterns of elementary school children in Jakarta urban area 2004-2005;

3. METHODS

Study Design

A ***time series cross-sectional survey*** implemented for assessing the blood lead level patterns of school children in Jakarta city and determining changes between 2001 and 2005.

Study Population

The study population will be 3rd and 4th grade children who attend school in Jakarta. Children will be studied because they are the age group that is most vulnerable to health damage from lead and air pollution dust. It is also not feasible to examine all primary school grades because of time and logistic considerations.

Location

For blood-lead study, 4 elementary schools will be selected randomly at surroundings of every single 5 monitoring stations near the roads in Jakarta urban area. The 5 stations are located in: Jasa Marga Office (East Jakarta), EMC-Puspiptek Serpong (Banten), Taman Anggrek Lebak Bulus (South Jakarta), Hotel Indonesia (Central Jakarta), and University of Trisakti (West Jakarta).

Sampling design

Given the size of Jakarta in terms of both population (~12 million) and geography, a simple random sample at the household level was not considered to be logistically feasible. Therefore, a cluster survey design was used for the cross-sectional study. Clusters were defined as elementary schools in five selected air monitoring stations in Jakarta. Four elementary schools nearest every single of the monitoring station are assigned as clusters. Thus, 20 elementary schools will be the source of samples (children). An equal probability random sample of 10, 3rd- and 4th-grade children in each of the 20 schools is selected for inclusion in the study. The number of sample will be 200 elementary school children.

Cross-sectional sampling calculation

Sample sizes were calculated to provide a large enough sample so that the margin of error around the mean (95% CI) was ±10% accounting for clustering. Sample sizes were derived using the following equation:

$$n = \frac{(z)^2 (SD)^2 (1 - IC)}{(\%ME * E\bar{x})^2 \left((1 - (IC)(z)^2 (SD)^2) / (\%ME * E\bar{x})^2 (\#cluster)\right)}$$

$$= \frac{(2.8)^2 (2.8)^2 (1-0.3)}{(0.1 \times 8.3)^2 \times (1-(0.3)(2.8)^2 (2.8)^2 / (0.1 \times 8.3)^2 (20)} = 189$$

z : z-score from previous study

SD : standard deviation from previous study

IC : intracluster correlation (No data were available from the Jakarta study to determine the intracluster correlation. Therefore, a conservative estimate that assumes relatively high clustering was used for intracluster correlation)
ME : margin of error
Ex : expected mean

From calculation above, the number of sample is 189. In order to enhance more validity for the data, we decide to increase the number of sample up to 200.

Data collection

There were 5 study teams of 6 people each (30 people total): Each team includes the following: 1 phlebotomist, 3 interviewers, 1 person to handle all paperwork (consent forms, results sheets, labeling of blood sample), and 1 CHR-UI (Center for Health Research-University of Indonesia) supervisor.

Consent forms and questionnaires distributed to school principals in the selected schools prior to the beginning of the study. The principals asked to send the forms home with the children so that the parents can fill them out and return them to the schools with their children before the CHR-UI team arrives.

The blood draws are performed by the phlebotomist on the study team who was one of the local fieldworkers. The procedure for collecting the blood sample for lead was the following:

- The child's hand is washed with soap and water, dried with a paper towel, wiped with an alcohol prep swab and dried with gauze.
- The finger is punctured with a sterile, non-reusable Tenderlett lancet.
- The first drop of blood is wiped away with gauze.
- 50 ml (about 4 drops) of blood is collected in a capillary tube for lead analysis.
- After the blood is taken, a band-aid is applied for further protection of the puncture site.

Letters are generated to inform parents of their children's blood-lead test results and these will be given to each school principal for distribution 1-3 days after the sample has been collected. The blood samples are tested for lead using the LeadCare portable analyzer (ESA Laboratories, Chelmsford, MA, USA).

The procedure involves placing the sample into a reagent tube and allowing it to rest for at least 1-2 minutes, followed by placing the sample onto the LeadCare electrode. The analyzed result is available in 3 minutes. Because the upper end of the operational range for the LeadCare analyzer is 95^{o}F and ambient temperatures in Jakarta was higher, the CHR-UI team analyzed the bloods in air conditioned rooms in the evenings. Blood specimens do not stored after analyses are completed. Instead, all excess bloods and used materials (lancets, tubes, swabs, wipes, and gloves) are collected in biohazard bags and taken for biohazard disposal.

Duration of the study
The duration of the study is 24 months and started at January 2004 to December 2005, including study preparation, materials development, field preparation, data collection, data analyses, interim report writing, report improvement, and seminar of finding. In general, the study divided into two terms, year-1 of study and year-2 of the study. Comparison between the study years will also be generated.

Organization
The study executed by researcher team from the Center for Health Research – University of Indonesia in collaboration with the Department of Environmental Health - School of Public Health – University of Indonesia and the Environmental Monitoring Center – Sarpedal/Bapedal – the Ministry of Environment. The study is fully supported by JICA-DEMS (Decentralized Environmental Management System) and United States Asia Environmental Partnership (USAEP) – USAID.

4. RESULTS

This study was conducted in January to February 2005. All of the 20 selected elementary schools agreed to participate the test. Totally, a number of 203 students (third and fourth graders) are allowed by their parents participate the test. The participation rate is 100%. Unfortunately, about 5% of the blood samples (11 students) could not be analyzed. The results in detail are as the followings:

Serpong, Tangerang site

The overall average for Hb = 12.8 mmHg
The overall average for Pb = 9.0 μg/dl
Percentage of those children with Pb-blood equal and more than 10 μg/dl is 26.8%.

DKI Jakarta site

The average Pb-blood in Jakarta Selatan = 5.1 μg/dl
The average Pb-blood in Jakarta Timur = 4.4 μg/dl
The average Pb-blood in Jakarta Pusat = 4.6 μg/dl
The average Pb-blood in Jakarta Barat = 2.4 μg/dl

Variable	Obs	Mean	Std. Dev.	Min	Max
hb	161	12.56	1.10	8.8	15.6
pb	151	4.15	1.67	0.0	11.2

The overall average for Hb in DKI Jakarta = 12.6 mmHg
The overall average for Pb in DKI Jakarta = 4.2 μg/dl

Percentage of those children with Pb-blood equal and more than 10 μg/dl is 1.3%.

Comparison with 2001 Pb-blood study:
Albalak et.al. of CDC-USAEP Pb-blood study among 396 elementary school children, in DKI Jakarta in 2001, found that geometric means of Pb-blood children is 8.6 μg/dl and about 35% of the children having Pb-blood levels above 10 μg/dl. With almost same methodology and design study, our findings obtain Pb-blood means of 4.2 μg/dl and 1.3% children have Pb-blood levels above 10 μg/dl. This declining Pb-blood prevalence is obviously shown the success of Leaded-gasoline phase-out program in DKI Jakarta. It means that the program success in preventing people in Jakarta, especially children from the risk of the dangerous of leaded-gasoline. Thus, the program of phasing-out of leaded-gasoline must be expanded and implemented to all of Indonesia provinces and cities in order to protect lead exposure to people.

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