Public health implications of environmental pollution in urban Indonesia

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The current levels of environmental pollutant in Indonesian cities, especially in Jakarta and Surabaya, as well as other cities in Java island, already have the potential for public health impact. Of particular concern and surveillance value are atmospheric particulate matter, sulphur dioxide, nitrous oxide, carbon monoxide, heavy metals (lead, cadmium and mercury) and pesticide residuals. These are also entering the food and water supply with particular risk to the socio-economically disadvantaged. Control strategies for environmental pollution are needed and public health programs for high risk groups are a must.

Key words: pollution, urban areas, health

Introduction

Indonesia has made remarkable economic and social progress since 1967. It is transforming itself into a modern state with a chance of joining the ranks of economically successful Asian nations within the next ten years.

The increase in industrial activity in Indonesia, as a consequence of population growth and economic development, has been accompanied by the problems of environmental pollution eg. food, water and air pollution. The most important source of air pollution in urban areas is transportation, while industries and households contribute most to water pollution[1-3]. It is estimated that transportation contributes almost 80% of total air pollution in Jakarta, with other sources, such as industries and house holds, 20%.

In the last five years there has been a remarkable increase in the number and density of motor vehicles, as well as oil energy consumption[4]. This has been followed by an increase in air pollutants.

In the last twenty years, all of Indonesia's cities have expanded with marked differences in the pace of their growth. In Java, the population increase of the metropolitan areas of Jakarta, Bandung, Semarang and Surabaya were most pronounced. They now account for 42% of the national urban population. Most of Indonesia's cities are located on the island of Java. Java accounts for 62% of the 384 cities with a population of 10 000 or more; 62% of the 43 cities with a population of 100 000 or more; and 34 cities above 500 000[5,6].

Among the outer islands almost half of the cities with 10 000 or more are located on Sumatra island. The rest are located on other major islands such as Kalimantan, Sulawesi, Bali, Irian Jaya, Maluku, East and West Nusatenggara. With the current population growth ranging from 1.69-12.29% per year[6] and socio-economic growth, these cities will have environmental pollution problems unless action is taken.

Overall epidemiological perspectives of environmental pollution and health

To relate environmental pollution to public health requires an epidemiological approach. This can help establish causality. Systematic surveillance contributes to their analysis.

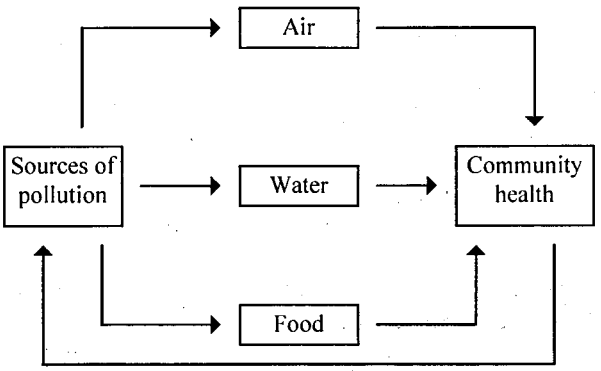
Epidemiology is defined as the study of the distribution and determinants of health related states or events in specified populations and the application of this study to the control of health problems.

The overall epidemiological model for the environmental pollution related to health could be drawn as follows:

As shown in Figure 1, potential adverse effects can directly or indirectly affect a community through air or other mode of transmission eg watershed or plantations (food). Using this model, this paper reviews trends in pollutant sources, studies at the transmission level and public health implications.

The studies presented here are case studies.

Figure 1. Epidemiological model for environmental pollution and health.



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Studies at source and about transmission of environmental pollutants in Indonesian cities

These may refer to the increase in number of cars and their energy consumption per capita, linked to population growth through fecundity, age structure and urban migration and to environmental behaviour.

Air pollution

Scattered and incidental monitoring has been conducted at places believed to be industrial, trade and traffic areas, as well as settlements, in cities of the island of Java and in the outer islands eg. Sumatra, Kalimantan and Sulawesi[7,8]. Yet, such measurements were not systematic, except in Jakarta and it is therefore difficult to analyse trends.

Studies were done in 1982 on the ambient level of air pollutants in several cities, such as Jakarta, Bogor, Semarang, Jogyakarta, Bandung and Surabaya (Population from 2 to 8 million), located on the island of Java[7]

They were followed by another study in the outer islands of Medan and Palembang (Sumatra), Menado (North Sulawesi), Banjarmasin, Pontianak and Balikpapan (Kalimantan) in 1984[7].

The study team concluded that, in general, suspended particulate matter was an air pollutant problem in all cities in 1982 as well as 1984, since the air pollutants were recorded above the National Air Quality Standard (AQS) level. NO_2 was also recorded above the level of Air Quality Standard in some places (points) in most cities which were studied[7].

Relatively more systematic measurements, from which the trend in air pollution could be deduced were made by the Research Centre for Urban and Environment Studies in 1984, 1985, 1986, 1987, 1988 and 1989. The available data indicate that, although there were fluctuations, a slight increase in the level of air pollutants occurred. An increase for the period of 1982-1984 was followed by the period 1986-1989. It was forecast that, without action all eight parameters of air pollution will reach or cross the line for Air Quality Standard level, in 5 to 10 years[1,2].

We could conclude that, while some pollutants were still below Air Quality Standard (AQS) in cities of outer islands, Jakarta showed an increase. The air pollutants of concern here suspended particulate matter, SO_2 and NO_2[3].

Water and food contaminated by environmental pollutants

There have been few studies of food which relate to environmental pollutants. Some examples follow. Studies of food contaminated by environmental pollutants include those of Wargasasmita[9], Asijati[10] and Rukaesih[10]. In her study, Rukaesih found that many vegetables planted near busy roads contain *lead*; the vegetables had a Pb content above the Tolerable Weekly Intake according to the WHO standard.

Heavy metals like *cadmium* were found in the rice of West Java[14]. *Mercury* was also studied[15,16].

Pesticide pollutants are found in stream water and vegetables[13,14] with residues in some vegetables below standard and others particularly in North Sumatra and West Java, in cabbages, above Acceptable Daily Intakes. The level of concentration of carbamate was 4.893ppm in the drought season and 3.307ppm in the rainy seasons, whereas the Maximum Allowable Concentration (MAC) according to WHO is 0.4ppm. In other words, populations were exposed to pesticide stream pollution as well as pesticide residues in food. No studies with regard to the reproductive system among farmers have been done.

Heavy metals in the *drinking water* in Gresik, Surabaya, have been measured and shown to be above the standards, notably for lead and cadmium[15].

Many studies of food and water indicate that drinking water and food are contaminated by heavy materials, especially in low level socio-economic communities.

Public health implications: estimates and surveys

Studies of environmental pollutants and human health are usually based on several episodes in which sudden peaks of, for example, air pollutants have been associated with immediate morbidity and mortality patterns. Correlation studies, such as measuring the air pollutant associated with the fluctuation in. upper respiratory tract disease have been few in Indonesia. With no continuous monitoring figures and an inadequate reporting and recording system, such correlational studies (using secondary information) could not be established.

Some correlation studies of health and environmental pollution have been done in cities such as Jakarta and Surabaya by Universities and/or the Ministry of Health. using medical records of health centres and/or hospitals.

Some time ago, a study, in 1978 indicated that the average of Pb level in the city bus drivers blood was 0.246 mg%, with a range of 001 mg% to 0.541 mg%. All except two of 54 drivers, were below the acceptable level[16].

Among the air pollutants emitted by mobile sources in Indonesia are tetra ethyl lead (Pb) and carbon monoxide, both of which have potential adverse systemic health effects. Their effects can be monitored practically and specifically. Therefore they can be utilised as indicators of the public health effects of air pollution in urban areas[17,18].

One of the most recent studies done by Achmadi[23], analysed the risk differences among sub-groups of the population exposed to air pollutants in an Indonesian urban setting.

People, because of occupation and living area, may be considered as high risk[19,20].

Organic lead compounds, such as tetra ethyl lead, are used extensively as fuel additives in Indonesia. An effect of organic lead is on heme biosynthesis.

Smoking adds to other sources of pollution. Among the population under study only 19% of the bajaj (mini-taxi) drivers, 16% of the street vendors and 10% of the population in slum areas were not smokers. In other words, the majority may well be worsened by combined ambient air and tobacco pollutants. Tobacco smoking is an important source of CO as a pollutant, and usually makes the largest contribution to the CO body burden in those who smoke[18,19].

The guideline for lead in air should be based on the concentration of lead in blood. A blood lead value of 0.02μg/100mL may be regarded as the borderline for dividing the non adverse-effect from the lowest-adverse-effect level[18]. In the population studied, average lead concentration was above acceptable.

For COHb concentration, the population mean average was 10.95%. For street vendors and bajaj drivers it was 9.1% and 8.51% respectively. The average concentrations

of COHb among policeman have been reported to be 25-31.69%.

While the mean Pb for a control minimally exposed group was 0.0065μg/100cc, city slum dwellers, bajaj drivers and street vendors had averages of 0.0928, 0.0697 and 0.0290 respectively. There were no differences in COHb between urban and rural populations, but there were significant differences in Pb level. Urban populations tend to have higher average levels of Pb.

The level of Pb among slum area dwellers were so high (mean 0.0928 μg/100mL) maybe due to food contaminated by Pb from the air and other sources. The most important pathway by which atmospheric lead enters the food chain is thought to be direct food and foliage contamination. The contamination depends on the rate of fall out.

Most people in the area studied lived near a heavily polluted river and most consumed shallow well water. There was a limited possibility of pollution by Pb from the water supplies as well.

The risk analysis

By analysing the odds-ratios[1] the relative risk for air pollutant effects for each segment (group) of the urban population could be ascertained[20].

1. The *blood Pb level* could be used as the indicator of the effect of (air) pollutant in the exposed group. For example, bajaj drivers, slum area dwellers and street vendors combined had a relative risk 12.8 times the reference group i.e. minimally exposed people in the rural area. City dwellers in the study had risk based on the blood Pb, 27.4 x the reference, and the bajaj driver group 15.4 x the reference. For the street vendors, relative risk was 4.4 x reference. Perhaps these people lived in areas that are not heavily polluted.
2. Studies of chronic pesticide poisoning have been done by many researchers in Indonesia[14].The prevalence of *poisoning among farmers* is between 8.5% and 50% of populations surveyed. There are at least 100 million farmers using and or directly exposed to pesticide in Indonesia. The prevalence of organophosphate poisoning among farmers eg in horticulture in Brebes is even worse. Farmers were exposed heavily to a vast number of pesticides in the field. A number of severe poisonings have been reported[14].
3. The *pollutants found in certain working conditions* and environments in Indonesia can also be reviewed.

   Among 70 workers of a lead acid battery recycling shop for example, 77.6% of the workers surveyed had blood lead above 0.025 mg/100mL. Another study in East Java revealed that among a community who live in an area surrounding an industrial area, the average level of blood lead was 0.297 mg/100mL[15].

   Heavy metals such as cobalt, iron, cadmium, mercury, (Hg), molybdenum, and silver can adversely affect spermatogenesis and accessory sex organ function.

   Lead is known to be capable of producing teratospermias, and probably plays a role in the increased incidence of stillbirths.

   The total Hg blood levels of a community surveyed nearby oil drilling activities ranged from 0.33-7.83 μg/gram (ppm) compared to a community living where there are no oil drilling activities 0.24-3.49 μg/gram[12]. Although these figures are considered acceptable, the accumulation of Hg in the population is threatening, since the vegetables being consumed by the populations in the area of activities, ranges from 12.5-50 ppm. The WHO limit is 30 ppm. Studies also document risk in workers exposed to mercury pollution in the gold workers and dentistry.

   The above figures indicate that some heavy metals have potential for effects on the reproductive system. Yet studies of clinical outcomes on the reproductive system have not been done. But studies of contaminant pathways and bioindicators reveal above acceptable values.
4. Mukono, in an extensive study, found significance differences in Chronic Obstructive Pulmonary Disease prevalence between exposed (urban air) and unexposed areas in Gresik, Surabaya ($p = 0.00001$). The prevalence of COPD among women examined in the urban area with heavy pollution was 26.06%, while unexposed area only 7.56%. The risk for having COPD was 3-3.3 times higher compared to the unexposed area.

Conclusion

The current levels of environmental pollution in Indonesian cities, especially in Jakarta, Surabaya and other cities in Java island, already have the potential for public health impact. Of particular concern and surveillance value are atmospheric particulate matter, sulphur dioxide, nitrous oxide, carbon monoxide, heavy metals (lead, cadmium and mercury) and pesticide residuals. These are also entering the food and water supply with particular consequence for the socio-economically disadvantaged. Control strategies for environmental pollution and public health programs for high risk groups are needed.

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印尼都市環境污染對公共衛生的影響

摘要

目前印尼城市，特別是耶加達（Jakarta）、泗水（Surabaya）和爪哇島的其它城市，其環境染程度已足以影響公共衛生，特別關注和監視的是大氣層的一氧化二氮（笑氣）、一氧化碳、重金屬（鉛、鎘和汞）和農藥殘餘污染。這些亦使食物和食水污染，並造成了社會經濟的損失，對環境污染的控制策略是需要的，同時對一些處在高度危險的人群，必需要有一個公共衛生的計劃。

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