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Case study of a solid waste scavenger community with respect to health and environment

Kungskulniti, Nipapun, Dr.P.H.

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U·M·I
300 N. Zeeb Rd.
Ann Arbor, MI 48106

CASE STUDY OF A SOLID WASTE SCAVENGER COMMUNITY WITH RESPECT TO HEALTH AND ENVIRONMENT

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Nipapun Kungskulniti

DISSERTATION COMMITTEE:

F. DeWolfe Miller, Chairman
Kirk R. Smith
Arthur M. Kodama
Lawrence K. Koseki
Peter G. Flachsbart

To my parents,

sisters,

and brothers

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ABSTRACT

This study was an investigation of a solid waste scavenger community at the On-Nooch Dump Site in Bangkok, Thailand. The purpose was to identify the dimensions of the public health conditions of solid waste scavengers and their community. Cross-sectional field surveys and measurements were undertaken to characterize the distribution and magnitude of health-related problems and environmental conditions. Scavengers were found to be exposed to hazardous conditions due to the waste materials at the dump site. Cuts and punctures from sharp materials were the most common complaints among scavengers. Health symptoms like headache, diarrhea, respiratory illness, skin diseases and back pain were also reported. There was a high prevalence of childhood respiratory illness especially among those children of households where cigarette smoking was present. Children had poor nutritional status and were commonly infected by intestinal protozoa and helminths. An appreciable proportion of adult respondents was below the normal range for lung function performance. Seroprevalence of HBV infection was found to be high among male respondents in addition to six respondents that had possible HIV

infections. The quality of the community water supply was low. Air pollution measurements showed acceptable ambient air levels except for particulate levels (TSP and RSP). Levels of indoor, outdoor, and personal exposure NO_2 were found to be similar. Data for an inner-city project apartment community named Din-Dang were also collected for comparison. A priority rating index and recommendations for public health condition improvements were presented.

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CHAPTER I

INTRODUCTION, LITERATURE REVIEW, AND RATIONALE

1.1 Introduction

To certain groups of people in third world countries, municipal solid wastes constitute primary earning resources. These people retrieve all reusable, reclaimable, and recyclable items from discarded waste materials in order to sell or use them for their very survival. Scavenging for material recovery is commonly undertaken throughout the storage, collection, and disposal stages of waste systems (Cointreau, 1982; Cointreau et al., 1984).

In Cairo, Egypt, solid waste collection and disposal are traditionally operated by the private sector, the so called Zabbaleen, a group of Christian migrants originally from the Coptic villages around Assiut in Upper Egypt. (Haynes, 1979; Rust, 1987). They collect wastes from primarily high- and middle-income areas of the city using donkey carts and take them back to their dwellings for the recovery and reuse. Organic wastes are used to raise pigs while scraps and recyclables are sorted to be traded.

Street scavenging is a common occupation for a living among pavement dwellers of Calcutta, India (Mukhrjee, 1975). Numbers of slum dwellers and street sleepers in Cebu City, Philippines, are also street scavengers (Fernandez and Torre, 1986). "Gypsies" of Istanbul, Turkey, are another example of street scavengers (Curi and Kocasoy, 1982).

Likewise, scavenging at dump sites as one's livelihood has long existed and been practiced in the shadow of great cities like Manila (Keyes, 1982), Bandung and Cimahi (Poerbo et al., 1984), Bangkok (Baldisimo and Lohani, 1988), Calcutta (Furedy, 1984), Lima (Cointreau et al., 1984), and Cali (Birbeck, 1978). There are an estimated 5,000 scavengers at dump sites in Manila, 1,000 in Mexico City, 1,000 in Lima (Cointreau et al., 1984), 2,500 in Bandung and Cimahi (Poerbo, 1984), and 400 in Cali (Birbeck, 1978). Dump-site scavengers usually have their settlements nearby, at the edge of, or even on the dump. These scavengers and their families, as well as the communities in which they live, are surrounded by the unsanitary working and living conditions of the open dump environment. They are also likely to be exposed to hazardous constituents from waste materials, waste treatment, and disposal processes.

1.2 Literature Review

The business of scavenging is historically documented. Perry's (1978) description to San Francisco scavengers in the early decades of twentieth century is worth citing: "In a city with no municipal sanitation services, scavenging became a way to make a living, particularly if one carefully sorted out the refuse to save everything that might be saleable." "Bone-Grubbers" and "Rag-Gatherers" were descriptive terms of scavengers in nineteenth century London used by Maythew's (1968) London Labour and the London Poor. Maythew (1968) narrated, "The bone-grubber generally seeks out the narrow back streets, where dust and refuse are cast, or where any dust-bins are accessible. The articles for which he chiefly searches are rags and bones--rags he prefers--but waste metal, such as bits of lead, pewter, copper, brass, or old iron, he prizes above all."

In these days, solid waste scavengers are mainly associated with third world countries where urban poverty is prevalent. To date, studies of scavengers are primarily devoted to the social, economic, and cultural contexts of their particular countries with implications for planning and policy decisions. A few studies have investigated the health of these solid waste scavengers using questionnaire surveys.

Conceptually, solid waste scavengers' working conditions are more or less comparable to those of municipal garbage collectors and/or resource recovery plant workers' working environments. Therefore, reviews of related studies regarding health aspects of municipal garbage collectors and workers of resource recovery processing plants will be presented following the reviews of scavenger studies.

1.2.1 Scavenger Studies

A number of studies have descriptively delineated the life and social characteristics of solid waste scavengers without examining their health status. These studies were generally preliminary with small sample sizes. For instance, Birkbeck (1978,1979) described the nature of work and the typical characteristics of garbage dump scavengers in Cali, Columbia. These people were nicknamed "Vultures" by the rest of Cali's populace and their exploitation was common. Though the sample size was small, the case study documented low educational attainment among scavengers and the relatively high number of child scavengers. Descriptive information regarding scavengers in the Philippines (Keyes,

1982) and Indonesia (Fatimah and Utami, 1982; Versnel, 1982; Poerbo et al., 1984) have also been documented. These scavengers also had low socio-economic status.

Information concerning the health of scavengers was reported by a few studies from the Philippines (Fernandez and Torre, 1986; Baldisimo, 1985), Nepal (Khyaju, 1986), Indonesia (Harahap, 1984), and Thailand (Butsapak, 1984; Leelakuldhanit, 1987). These studies reported similar findings of health complaints like respiratory, intestinal, and skin diseases as well as headache, backache and injuries among scavengers. However, this health complaint information was derived using questionnaire interviews subject to respondents' recall and level of concern or sensitivity to health symptoms. Hence, over or under reporting of information would be anticipated. Interestingly, scavengers were found to be fairly satisfied with their work conditions from a study in Bangkok (Leelakuldhanit, 1987).

There was an epidemiological investigation of the health risks of scavengers in Egypt (Zabbaleen) by Miller et al. (1982). The study used representative samples of the Zabbaleen community located on the outskirts of Port Said. Intestinal parasitic infections were found common among these people. *Ascaris lumbricoides* was the most frequently detected parasites. The rate of estimated crude infant mortality measured by recall was high. An appreciable number of hand injuries among adults were detected from this examination.

In contrast to other scavenger communities, the Tokyo scavenger community named "Ants' Villa" was a successfully organized scavenger cooperative engaged in the business of recovering value from all recyclable wastes (Taira, 1969). The community was clean and prosperous. It had workshops, residential structures, a child recreation house, a community restaurant and a store.

See Table 1.1 for summary of scavenger studies.

1.2.2 Related Studies: Sanitation Workers and Related Environmental Conditions

The health of sanitation workers was examined in a few studies. New York City sanitation workers were found to have an incidence of coronary heart disease almost two times that of other groups of males in similar age categories (Cimino, 1975). However, this result could have been biased by confounding factors like smoking or eating habits which were not taken into account by the study. The investigator

Table 1.1 Summary of Scavenger Studies

Study Focus	Place	Reference
Descriptive Profile	Columbia	Birkbeck, 1978; 1979
	Philippines	Keyes, 1982
	Indonesia	Fatimah and Utami, 1982 Versnel, 1982 Poerbo et al., 1984
	Japan	Taira, 1969
Health Complaints: respiratory, intestinal and skin diseases, ache and injuries	Philippines	Fernandez and Torre, 1986 Baldisimo, 1985
	Nepal	Khyaju, 1986
	Indonesia	Harahap, 1984
	Thailand	Butsapak, 1984 Leelakuldhanit, 1987
Infant Mortality Rate, Parasitic Infections, Hand Lesions	Egypt	Miller et al., 1982

also reported that these workers had a much higher frequency of injury than that of other industrial workers and each year they sustained 50 to 100 puncture wounds as a result of handling hospital and similar wastes. In a later study, Cimino and Mamtani (1987) observed that the incidence of injuries among New York City sanitation workers had declined but the severity of injury, measured by the number of days lost per incident had increased. The severity ratio for these workers was the highest in the nation and equivalent to underground mining workers. Since this study used injury statistics from the employee records, it was subject to the quality of the records. Typically, minor injuries were likely to be under-reported.

A survey in Manila employing questionnaires revealed frequent complaints of accidental injuries and sore muscles among municipal garbage collectors (Baldisimo, 1985). A study also using questionnaires of 11 workers of an experimental compost plant in Sweden, where solid wastes are processed, found symptoms of nausea, headache, fever, and/or diarrhea among 6 workers (Lundholm and Rylander, 1980).

In addition to these studies of the health of sanitation workers, the environmental health conditions of solid waste facilities were also measured by a number of studies in Europe and the U.S. High concentrations of dust and microbial aerosols were found at sanitary landfills (Rahkonen et al., 1987) and resource recovery plants (Diaz et al., 1976; Constable and Ray, 1979; Mansdorf, 1983). The aerosols found were also in the respirable-size range (Rahkonen et al., 1987; Mansdorf, 1983). Various studies resulted in the recovery of a large number of total bacteria, fecal coliform and *S. aureus* (Diaz, 1976; Mansdorf, 1983) as well as fungus species like *Penicillium, Cladosporium, A. fumigatus,* and *A. nidulans* (Constable and Ray, 1979). However, human pathogens were not detected from these studies. Trace metals and organic vapors were found to be low or non-detectable in a study by Mansdorf (1983).

See Table 1.2 for summary of sanitation worker and environmental condition studies.

1.2.3 Pollutants and Their Sources

This section reviews information on specific air pollutants with respect to their sources or origins in the concerned environments. Cognizance of the pollutant sources is useful for monitoring and assessing environmental conditions of the study community. Pollutants included in this review are nitrogen dioxide, suspended particulates,

Table 1.2 Summary of Sanitation Worker and Environmental Condition Studies

Condition	Study Group/ Location	Reference
Coronary Heart Disease, Injury Statistics	Sanitation Workers	Cimino, 1975 Cimino and Mamtani, 1987
Health Complaints:		
injuries, sore muscles	Sanitation Workers	Baldisimo, 1985
nausea, headache, fever, diarrhea	Compost Workers	Lundholm and Rylander, 1980
Dust, Microbial Aerosols	Landfills	Rahkonen et al., 1987
	Resource Recovery Plants	Diaz et al., 1976 Constable and Ray, 1979 Mansdorf, 1983

sulfur dioxide, formaldehyde, and volatile organic compounds.

In the ambient atmosphere, the major sources of nitrogen dioxide (NO_2) emissions are attributable to the combustion of fossil fuels in stationery sources such as power plants and in mobile vehicular sources (World Health Organization, 1987; 1988). Vehicular exhausts from traffic are the leading source of NO_2 in the urban ambient air (World Health Organization, 1988). Incineration is also a contributing source of NO_2 to the atmosphere (Brunner, 1985). In the indoor environment, NO_2 is primarily emitted from combustion sources such as fuel burning for cooking or heating and tobacco smoking (Fisk et al., 1987). Indoor NO_2 concentrations can exceed those of outdoor air for households that have unvented combustion sources and poor ventilation. Several studies reported that NO_2 levels in households with gas appliances were greater than outdoor NO_2 levels (Dockery et al., 1981; Quackenboss et al., 1982; Spengler et al., 1983; Clausing et al., 1986) and than in households with electrical appliances (Speizer et al., 1980; Melia et al., 1978; Palmes et al., 1977; Marbury et al., 1988; Nitta et al., 1990). Elevated levels of NO_2 in homes that use kerosene or wood-burning appliances have also been documented (Leaderer et al., 1986; Berwick et al., 1989; Sofoluwe, 1968). Residences or offices of cigarette smokers were found to have higher levels of indoor NO_2 than those of non-smokers (Good et al., 1982; Kim et al., 1986).

Suspended particulates are also emitted from combustion processes including sources like transportation and waste incineration. In the urban ambient environments, exhaust emissions from vehicles especially those with diesel engines are significant sources of suspended particulate matter (World Health Organization, 1988). Indoor combustion appliances and tobacco smoke are major contributors of indoor suspended particulates (Fisk et al., 1987; Girman et al., 1982). Several studies have revealed that levels of indoor suspended particulates in the houses have exceeded those outdoors (Ju and Spengler, 1981; Sexton et al., 1984; Stock et al., 1985). Elevated indoor suspended particulates were found in association with coal-burning (Zhang et al., 1988), wood-burning (Moschadreas et al., 1980) and biomass-burning stove use (Smith and Ramakrishna, 1986). Smokers'homes were found to have higher levels of respirable suspended particulates as compared to non-smokers' homes (Spenger et al., 1981; Binder et al., 1976).

Sulfur dioxide (SO_2) and formaldehyde (HCHO) are also combustion generated products which can be emitted from indoor combustion appliances as well as cigarette smoking (Fisk et al., 1987; World Health Organization, 1987). Generation of SO_2 is associated with the amount of sulfur contained in the burning fuels. Elevated levels of SO_2 were found in homes with the use of kerosene heaters (Leaderer et al., 1986) as well as wood- and coal-burning stoves (Sofoluwe, 1968; Zhang et al., 1988). The studies of Leaderer et al. (1986) and Zhang et al. (1988) also reported much lower concentrations of SO_2 in homes with gas stove use. In a recent study, Kim (1990) reported significantly higher levels of HCHO in residences using kerosene heaters as well as residences with cigarette smoking as compared to residences without these sources.

Sources of volatile organic compounds (VOCs) include combustion by-products, vehicular emissions, paints, lubricants, adhesives, solvents, bioeffluents, and consumer products (Godish, 1989; Sterling, 1985). Benzene, toluene, m&p-xylene, o-xylene, and ethylbenzene are common automotive related VOC species (Harkov et al., 1987). Methylene chloride is used in paint removers, metal degreasing, and plastics production. Hexane is present in cleaning compounds, glues, and thinner solvents. Toluene and benzene are in paints, enamels, and lacquers (Sterling, 1985).

1.3 Rationale

Solid waste scavengers are present in appreciable numbers especially in third world cities. They bear direct exposure to mixed and contaminated wastes, which constitute potential health hazards. It is conceivable that health risks for dump-site scavengers are even more prevalent than among municipal garbage collectors and resource recovery workers due to their practice of unscrambling piles of mixed and contaminated garbage.

Although the risks of garbage scavenging are as old as human habitation, the co-mingling of hazardous chemical and medical wastes creates an entirely new category of exposures and risks, ones that would not exist in either strictly modern or traditional settings. These conditions illustrate one of the interactions that can develop because of the "risk overlap" between traditional and modern risks in rapidly growing developing countries (Smith, 1988). The model by Smith (1988) in Figure 1.1 is presented to explain the risk overlap theoretical framework for the dump-site scavengers in developing countries. The figure shows the

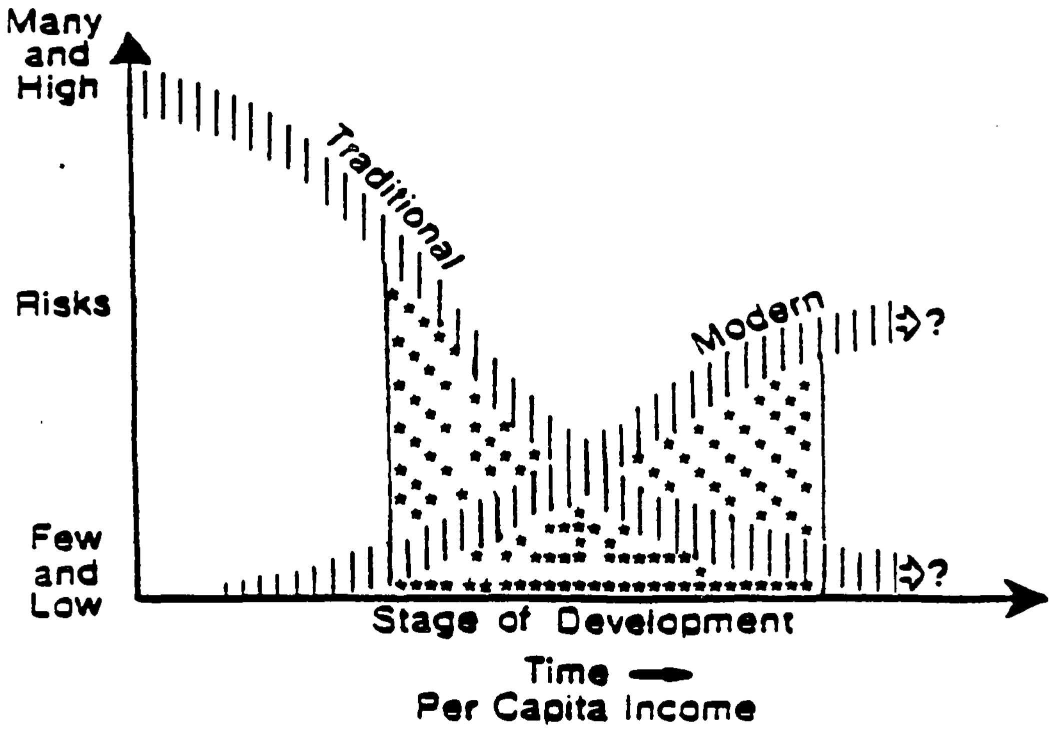

Figure 1.1 The risk overlap model (Smith, 1988)

The patterned area represents the risk overlap.

risk transition due to gradual substitution of traditional risks (the downward curve on the left) by modern risks (the upward curve on the right) over time as a result of economic development. Hence, there is a stage where both traditional and modern risks overlap (the patterned area) and that is where most developing countries are at present. This scenario applies to the dual risks of the dump-site scavengers in developing countries where they are subject to excessive amounts of both type of risks. This risk overlap leads to interactions that exacerbate the risks of scavenging in the dump where traditional waste and modern waste like hazardous chemical and medical wastes are being improperly disposed of. Thus, the public health risk of scavengers in developing countries at the present is even greater than in the past.

The public health conditions of scavengers who encounter adverse working and living conditions have been studied inadequately. The few studies that did investigate the health of scavengers were preliminary and mostly used interview questionnaires to obtain the information. The studies to date have not measured and documented the actual environmental health conditions present at dump sites and in their adjacent communities.

The health related conditions expected in a scavenger community include childhood respiratory illness, malnutrition, intestinal parasitic infections, poor lung function health, and human immunodeficiency virus (HIV)/ hepatitis B virus (HBV) seroprevalence. Air pollutants and water contamination are environmental conditions expected in this kind of community. Combustion generated pollutants such as NO_2, suspended particulates, SO_2, hydrocarbons including HCHO, and VOCs may adversely affect the community air quality given the presence of waste burning and incineration nearby. Furthermore, the use of cooking fuels as well as cigarette smoking in the households can also contribute to indoor combustion products. At the open dump, VOCs can be emitted from the discarded wastes containing VOCs. The decomposition of organic wastes can also produce air contaminants, such as hydrogen sulfide and methane.

The existence of solid waste scavengers and their communities that bear exposure to hazardous conditions associated with dump sites are prevalent; and yet information concerning scavenger heath and environmental conditions has been lacking. This lack of information justifies this descriptive study. The purpose of the study was to investigate the dimensions of the public health conditions of solid waste scavengers and their community at the dump site by means of field surveys and measurements of health and environmental conditions. Another purpose was to compare the public health conditions of solid waste scavengers with those conditions of people living in a different environmental setting. Therefore, a case study to explore the selected health and environmental conditions of a solid waste scavenger community and an apartment community in Bangkok, Thailand was undertaken.

CHAPTER II

MATERIALS AND METHODS

2.1 Study Design

This research was a descriptive cross-sectional case study of a solid waste scavenger community with specific attention to health and environmental conditions. Information was collected by means of field surveys and measurements to explore the distribution of and relationships among characteristics of the study population and their environment. The solid waste scavenger community at the "On-Nooch " disposal site in suburban Bangkok, Thailand was the selected study site.

This study also investigated whether selected health and environmental conditions of this scavenger community were different from that of a different environmental setting, a low-income urban community. The "Din-Dang" project apartment community in inner city Bangkok was selected for this purpose since it was a low-income apartment community situated in the central area of Bangkok with a comparable population size to that of the On-Nooch Community. The selected health and environmental conditions used in the comparison included childhood respiratory illness, nutritional status, intestinal parasitic infections, lung function performance, water quality, and air pollutants. The health conditions, such as childhood respiratory illness, malnutrition, and intestinal parasitic infections, were expected to be a greater problem in the On-Nooch Community. Water supply at the On-Nooch Community was expected to be contaminated as opposed to the Din-Dang Community which was expected to have a better supply of quality water. Differences in air pollutant levels between the communities were also expected. The Din-Dang Community was expected to have high levels of automotive-related pollutants due to the presence of heavy traffic at the site whereas the On-Nooch Community was expected to have high levels of combustion related byproducts generated from waste burning.

The field study took place in two periods: February-June 1988 and November 1988-April 1989. The first period of the study was used to prepare measurement and survey methods. The interval between the study periods was the rainy season in Thailand, a period in which collection of data would have been difficult, if not impossible. Like most research, this study was also subject to budget and time constraints.

2.2 Site and Population Description

A description of the solid waste scavenger community at On-Nooch Disposal Site is presented. Background information on Bangkok solid waste collection is also included. A description of the Din-Dang project apartment community is also presented.

2.2.1 On-Nooch Community

Bangkok, the capital city of Thailand, covers 1.6 thousand km^2 and has over 5.5 million inhabitants. The Bangkok Metropolitan Administration (BMA) is the city's political and administrative authority and the metropolitan area is divided into 24 administrative districts. The management of solid waste is the responsibility of the BMA's Department of Public Cleansing. Over 4000 tons/day of municipal solid waste are collected by municipal collection trucks and taken to three disposal sites: On-Nooch (in the East), Nong-Khaem (in the West), and Ram-Intra (in the North) (Bangkok Metropolitan Administration, 1988). Figure 2.1 illustrates locations of the sites. Over 90 percent of

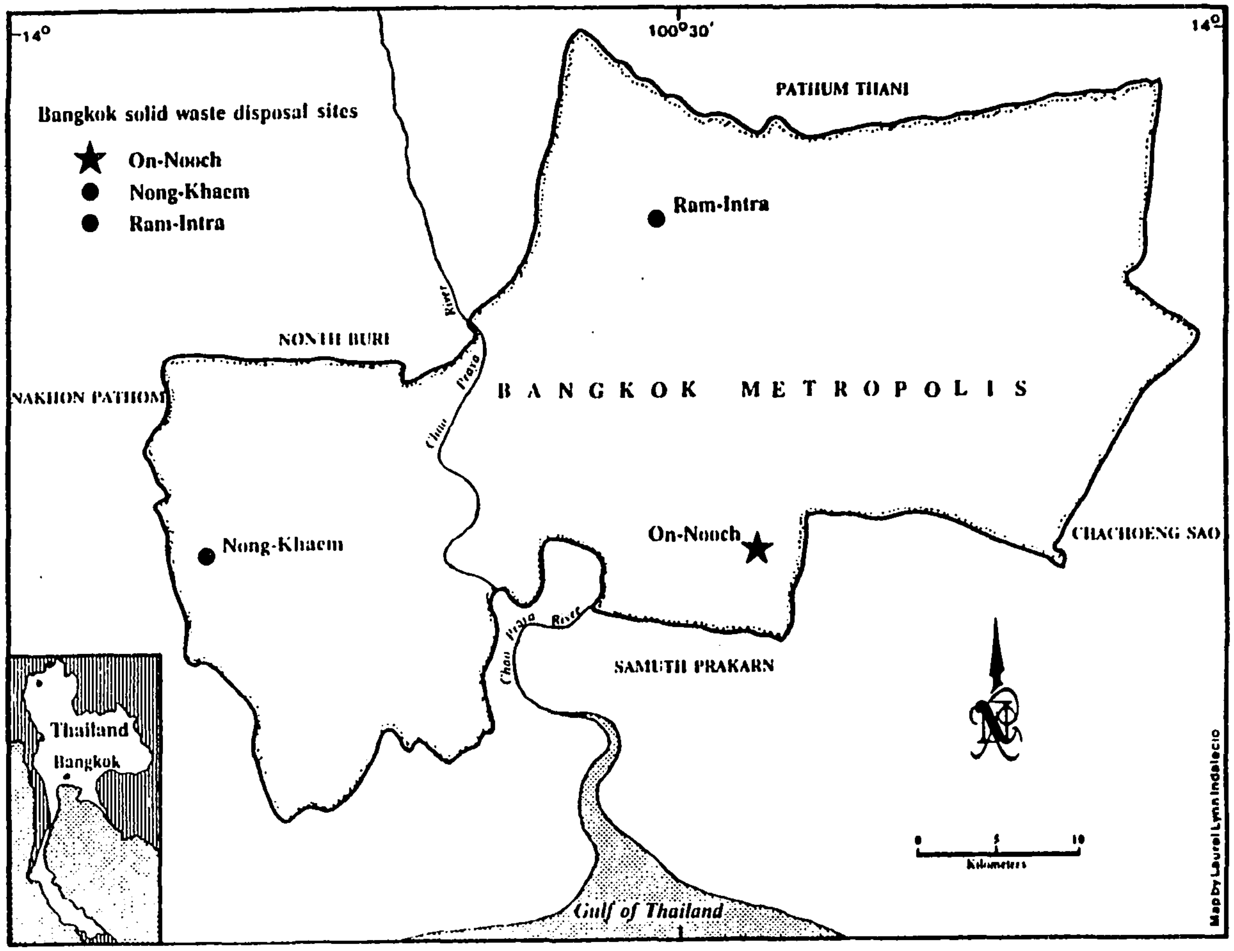

Figure 2.1 Locations of solid waste disposal sites in Bangkok

the collected waste brought to these sites is disposed of by open dumping. Waste scavengers are present at all three of the open-dump sites.

The On-Nooch Disposal Site has been in operation since 1964 and, at 0.9 km^2, is the largest and oldest operating disposal site in Bangkok. The amount of waste delivered to On-Nooch site is about 1,500 tons/day including small-industry, hospital, and medical clinic wastes. Only about 400 tons/day of incoming waste can be processed by the two primary composting and incinerator facilities at On-Nooch due to their low capacity, age, and the characteristics of the waste. The remaining waste, incinerator ash, and primary compost are dumped at the open disposal site. Smoldering fires from spontaneous combustion and other burning are frequently present.

The On-Nooch dump contains two tipping areas where wastes have accumulated to form hills 10-12 meters high. There is a runway up each hill to each tipping point at which there is a turn around area. The runways and turning areas are paved with movable planks to keep the heavy municipal collection trucks from sinking into the solid waste. On top, there are 13 and 15 unloading spots which radiate outward from the two tipping floors respectively. Around 10-15 scavengers are territorily located at each unloading spot while another 20-30 scavengers roam after the two compacting tractors. At any one time there are approximately 400 scavengers working at the two sites. Shelters, built from recovered materials, are also present on the dump and serve as scavenger collection depots and shaded resting areas. Food stalls and vendors are present in spite of the unsanitary conditions on the dump. Flies are plentiful especially in summer. Resalable, reusable, and edible items at the open dump are all retrieved. Reclaimed materials are sold daily in the late afternoon to middlemen or owners of small businesses who go to the dump site. Thus, this mountain of garbage is full of human activity regardless of the odorous, contaminated, polluted, and unsightly environment.

Some scavengers carry out further sorting, washing, and cleaning of collected items at their home compounds in the community bordering the dump site, contributing to the slum-like appearance of the community. This community had a population count of 1,929 in October 1988 (Van den Bossche, 1988). The age and sex distributions of the community population are shown in Table 2.1. Most people in the

Table 2.1 Population Counts* at On-Nooch Community

Age (yr)	Male	Female	Total (%)
0- 5	147	124	271 (14)
6-15	215	224	439 (23)
16-45	496	487	983 (51)
>45	114	122	236 (12)
Total	972	957	1,929 (100)

*October 1988 (Adopted from Van den Bossche, 1988) community are engaged in scavenging and reclaiming activities although some do have other jobs. A segment of this community are squatters while the majority rent or own their homes. Piles of recovered materials are commonly seen, as well as the ongoing processes of sorting, cleaning, and drying. The burning-off of coatings and waste residues to reclaim valuable metal is also seen.

Most parts of the community are surrounded by or sited directly over polluted water, a mixture of rainwater, domestic waste, and dump leachate. This congested human settlement lacks any water drainage system for this low-lying location. The better-off members in the community have piped water systems and electricity from the city. Others gain access to these services indirectly by purchasing them from their neighbors. The practice of storing water in containers, such as big jars and barrels, is common. Commercially available treated bottled water for drinking is present as well.

There is a health relief organization, the Primary Health Care-Mother and Child Health Center, which has been situated next to the community since 1987. In addition, a day-care school for preschool children, operated since 1985 by the BMA, is located adjacent to the center.

2.2.2 Din-Dang Community

The Din-Dang project apartment complexes were built in 1963. This was the first low-income apartment project in Bangkok. They are situated along the main street, named Din-Dang, in the inner city. They are eight four-story buildings with 20 units per story, stretching along Din-Dang street. Altogether, there are 640 apartment units. Each unit consists of one all-purpose studio room with a small porch in the back. The unit is naturally ventilated. The volume of the unit is around 3.5x10x3 cubic meters (100 m^3).

The occupants of these apartment units are low-income families, mostly resettled squatters. However, some occupants of these units have sold their residential rights to middle-income families. The Population of the Din-Dang community numbered 2,534 in March 1989 (see Table 2.2). The Din-Dang Day-Care School under the support of the Department of Public Welfare and the Young Women's Christian Association (YWCA) is situated across the street from the project apartments.

See Figure 2.2 for the location of On-Nooch and Din-Dang Communities in Bangkok.

Table 2.2 Population Counts* at Din-Dang Community

Age (yr)	Male	Female	Total (%)
0-5	66	76	142 (5)
5-15	169	178	347 (14)
15-45	758	859	1617 (64)
>45	190	238	428 (17)
Total	1,183	1,351	2,534 (100)

* March 1989

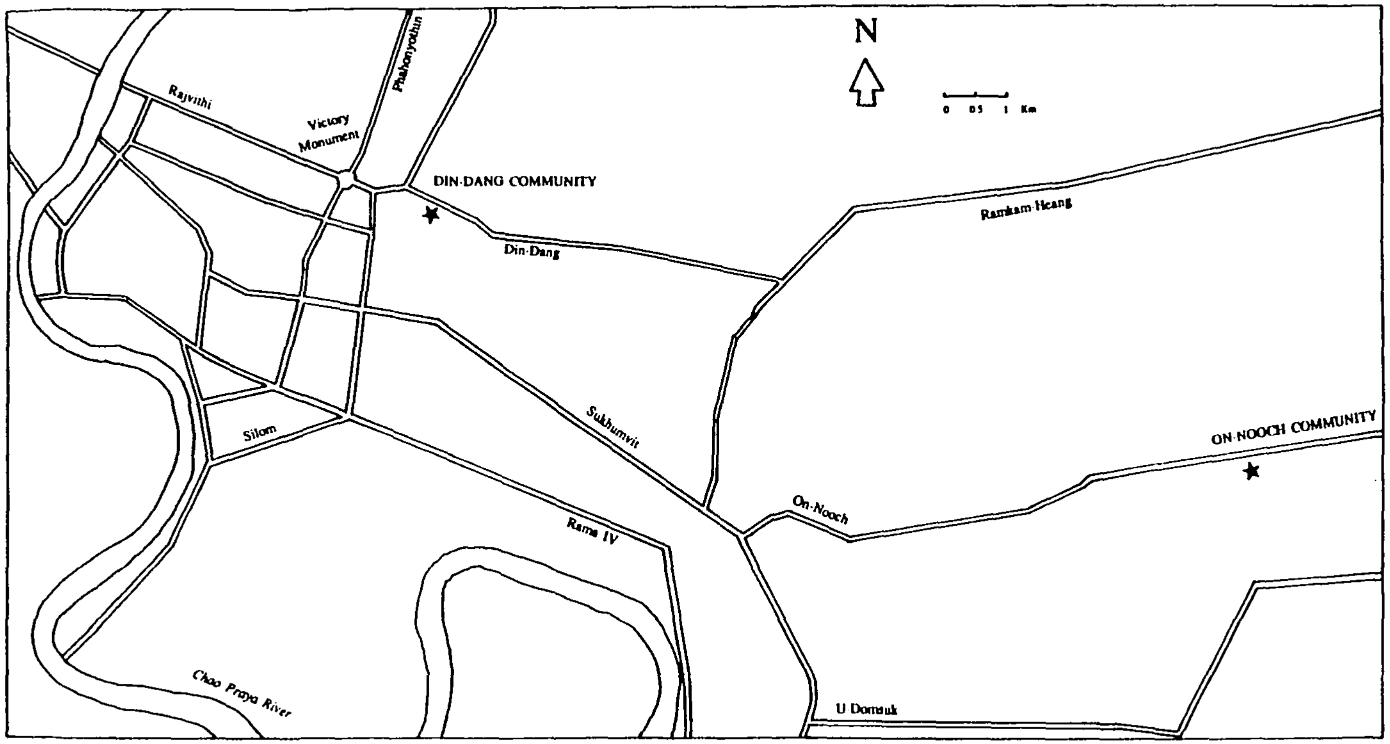

Figure 2.2 Location of On-Nooch and Din-Dang Communities in Bangkok

2.3 Data Collection and Measurement

Collection of data was accomplished by means of field surveys and measurements using various instruments. In addition to demographic and socio-economic information, measurements of health-related characteristics and environmental conditions were made. Laboratory analyses were supported by several collaborative laboratories in Bangkok and the USA. The study measurements included:

1) Scavenger Data

Structured questionnaires were used to gather data on demographic, socio-economic, occupational and health-related characteristics from solid waste scavengers (see Appendix I). Scavengers working at the On-Nooch Dump were recruited to be interviewed. The interviewers went to the dump and approached the scavengers to ask for their cooperation in granting an interview. The interviewers were not stationed at one location but instead went to various areas frequented by the scavengers. Interviewers identified themselves, requested participation from scavengers they approached, received permission to proceed with the questionnaire and then questioned the scavengers and recorded their answers.

2) Childhood Respiratory Illness

Structured questionnaires were used to gather data on respiratory illness among young children (0-5 years) in both On-Nooch and Din-Dang Communities. These provided demographic and socio-economic data as well as household characteristics such as type of cooking fuel use, smoking behaviors, and others. The questionnaire was modified from a standardized respiratory questionnaire for children (Ferris, 1978; World Health Organization, 1980). (See Appendix I.) Door-to-door surveys in both communities were undertaken for those households with children ages 0-5. Data were collected by administering the questionnaires to the available adult persons most intimate to the children in the households.

3) Nutritional Status

The data for children (0-5) surveyed for respiratory illness data were also measured for weight and length/height using a portable scale and an infantometer or a measuring tape for older children respectively. The weight of the child was plotted against his/her age on the Thai Growth Chart, a weight-for-age chart, to obtain the nutritional status of that child (Department of Health, 1987).

The chart provides area curves indicating normal weight as well as first, second, and third degree malnutrition for Thai children ages 0-5. First, second, and third degree malnutrition connote that the weight of the child is 84-75%, 74-60%, and less than 60% of the reference weight respectively.

4) Intestinal Parasitic Infection

Children attending the On-Nooch or Din-Dang Day-Care Schools and who are residents of those respective communities were recruited to give stool specimens. With the cooperation of the school teachers, specimen containers were distributed after the school day with an explanation to the children as well as a letter to their parents or guardians. Those who came to pick up their children at the end of the day were also asked to have their children provide specimens for this study. Stool specimens from these children were brought to school in the morning and then immediately transported to the Bangkok School of Tropical Medicine laboratory for examination. Specimens were examined for both protozoan and helminthic infection. This was done under the microscope by means of the simple smear, formalin-ether technique (Hunter et al., 1966), and the modified Kato-Katz's method (Katz et al., 1972).

The formalin-ether technique concentrates helminth larvae, eggs and protozoan cysts from each specimen as sediment by centrifugation. Formalin (10%) and ether solution are used to partition out fecal debris from sedimentation. The simple smear method is useful to recover the trophozoites of protozoa which cannot be detected due to deformity or destruction by the formalin-ether technique.

The modified Kato-Katz's method is used to quantify the number of helminth eggs per gram of feces. This involves measuring the stool specimen by filling a hole (6 mm) in a small piece of cardboard (3x4x0.137 cm^3) which each batch having been standardized to obtain the average weight for this volume of feces. This volume of measured feces, with known weight, is then covered with cellophane strip soaked in glycerine-malachite green solution and pressed to facilitate examination under microscope. This quantitative method is useful to assess the degree of helminthic infection.

5) Lung Function Test

Adult residents of both On-Nooch and Din-Dang Communities were recruited to perform the lung function test. Household visits and announcements were made to urge adult residents to participate. The equipment was set up in various accessible locations in the communities. Each participant was questioned as to age, gender, occupation, cigarette smoking status, and height was measured (see Appendix I). Lung function tests were carried out by a trained technician using a computerized Vitalograph spirometer. The technician instructed the subjects in the forced expiratory maneuver and demonstrated the appropriate technique. The expiratory maneuver was carried out while standing and without a noseclip, and was repeated until three satisfactory tests were obtained. The rating of lung function performance as to normality was determined by using Miller's prediction quadrant method (Miller et al., 1956). A normality rating using this diagnostic aid was based on the percentage ratio between measured forced expiratory volume in one second (FEV_1) and measured forced vital capacity (FVC) which was projected on the x axis of the quadrant grid and the percentage ratio between measured vital capacity (VC) and predicted forced vital capacity

(FVC) which was projected on the y axis of the quadrant grid. The point of intersection of these coordinates resulted in a placement which corresponded to a normal or defective (below normal) rating for lung function performance.

6) Human Immunodeficiency Virus (HIV) and Hepatitis B Virus (HBV) Serologic Test.

Serological test for seroprevalence of HIV antibody and hepatitis B surface antigen/antibody in On-Nooch Community was carried out. Dump and community visits, as well as announcements were made to enlist participants for the serologic testing. All participants were paid a nominal fee as an incentive. In addition, participants were administered questionnaires covering demographic information and history of blood transfusion, jaundice, sexual behaviors, sexually-transmitted disease, intravenous (IV) drug use, and occurrence of needle pricks while scavenging (see Appendix I). Blood specimens were transported to the Laboratory and analyzed by the enzyme linked immunosorbent assay (Ragni et al., 1986).

7) Water Quality Measurements

The household water supply of the On-Nooch Community was surveyed. Potable water samples from On-Nooch and Din-Dang Communities were collected. These samples from different households' storage containers were collected as well as from commercially bottled water used by households. In addition, water samples from other sources in On-Nooch Community, such as wells and ponds, were collected. All water samples were analyzed within six hours for microbiological quality using the standard membrane filtration method to assay for total and fecal coliforms (American Public Health Association, 1985). The assays were done in duplication. Turbidity and pH were also measured. Laboratory analyses were done at Mahidol University Faculty of Public Health.

8) Air Pollution Measurements

Three types of direct reading detector tubes were used to measure selected air pollutants at the study sites. Direct readings of specific indicating color layer changes in the tubes were made through the scale on the tubes giving the measured concentration of particular air contaminants. Types of direct reading tubes tested in the field included:

a) Long-duration detector tubes used in conjunction with low-flow personal pumps for hydrocarbons (HC), nitrogen dioxide (NO_2), and carbon monoxide (CO).

b) Detection tubes used in conjunction with a piston pump for HC, hydrogen sulfide (H_2S), and formaldehyde (HCHO).

c) Diffusion tubes for NO_2, CO, and hydrogen cyanide (HCN). These types of tubes require no pumps for carrying out the measurement.

Pre-testing of these tubes in the field indicated that they were not sensitive enough for use in community settings. Low levels of air contaminants cannot be successfully detected using these tubes. Therefore, direct reading detector tubes were not used for air pollution measurements in this study.

Other more sensitive sampling techniques and analysis methods were used to measure levels of selected air pollutants in this study. Air pollutants which were measured are described as follows:

a) NO_2

Two kinds of personal passive samplers for NO_2, the so called Palmes tube (Palmes et al., 1976) and the NO_2 filter badge (Yanagisawa and Nishimura, 1982), were tested at the study sites to assess their performance. Both kinds of samplers collected NO_2 through the diffusion process and were to be quantified spectrophotometrically. Similar to the Palmes tube that collected NO_2 on screens coated with triethanolamine (TEA), filter badges collected NO_2 on filters saturated with the same solution. However, the sensitivity in detecting NO_2 gas was better with filter badges which out-performed the Palmes tubes. Under the same circumstances, NO_2 filter badges were able to detect typical NO_2 concentrations over a 24-hour exposure time whereas Palmes tubes were not. Palmes tubes were capable of week-long measurements however. Because of the better sensitivity, the NO_2 filter badge was selected to be used for NO_2 measurements in this study.

Personal exposure, indoor, and outdoor samples for NO_2 levels were taken for a 24-hour exposure period at both On-Nooch and Din-Dang Communities. NO_2 filter badges were pinned to young children's clothes near their breathing zone for personal exposure samplings. Guardians of these children were instructed to keep sampling badges attached to their children at all time. Children included in the sampling were the very young and those likely to be home all the time. Indoor sampling was done by placing the badge in the household within the vicinity of the center of the house, at a position around 100-130 cm from the floor. Badges were also placed outside the households away from kitchen windows at similar levels for outdoor samplings. Duplicates of 10% of samples were collected. Field blanks were taken to correct measured concentrations of the samples.

All NO_2 filter badge samples were shipped to the Air Pollution Laboratory at Harvard University, Massachusetts for analysis. Extraction of NO_2 was done by the use of azodye-forming reagent which was a color developing reagent. The colored sample solutions were then measured by using spectrophotometer (Yanagisawa and Nishimura, 1982).

b) Total suspended particulate (TSP) and respirable suspended particulate (RSP)

TSP and RSP were sampled both indoors and outdoors for a 24-hour exposure period by means of filtration (Eller, 1984). Samplings were taken at the same locations for NO_2 measurements. To collect particulate samples, filter cassettes loaded with preweighed glass fiber filters were connected to personal sampling pumps with flow rates around 1.7 liter/min. Additionally, nylon cyclones used to fraction out particles larger than 5 micron in aerodynamic diameter were assembled so as to collect RSP samples. All samples were analyzed at Mahidol University Faculty of Public Health laboratory by means of the gravimetric method (filter weighing). Filters were placed in a desiccator before each weighing.

c) Sulfur dioxide (SO_2), H_2S, and HCHO

Outdoor SO_2, H_2S, and HCHO were sampled for a 24-hour exposure time by using impingers filled with absorbing solutions connected to the personal sampling pumps. A flow rate of 0.5-0.8 liter/min was used. SO_2 and HCHO samples were analyzed at Mahidol University Faculty of Public Health laboratory whereas H_2S samples were done at the Chulalongkorn University Faculty of Sanitary Engineering laboratory.

Method for SO_2 Determination (U.S. Environmental Protection Agency, 1988): SO_2 present in the air is absorbed by an absorbing reagent, potassium tetrachloromercurate, and form a stable complex. This complex is treated with formaldehyde and an acid-bleached pararosaniline solution to form a distinct colored solution which then can be measured by spectrophotometry.

Method for H_2S Determination (Katz, 1977) : H_2S in the air is captured by an alkaline suspension of cadmium hydroxide and the sulfide is precipitated as cadmium sulfide. The collected sulfide is determined by measurement of the methylene blue generated by the reaction of the sulfide with an acid solution of N,N-dimethyl-p-phenylenediamine and ferric chloride and with the use of a spectrophotometer.

Method for HCHO Determination (Meadows and Rusch, 1983): HCHO present in the air is aspired to be absorbed by a 1% sodium bisulfite solution. The aspired solution is treated with 1% of chromotropic acid reagent and then concentrated sulfuric acid to form purple monocationic chromogen which is then spectrophotometrically measured for levels of HCHO.

d) HC and Methane (CH_4)

Outdoor grab samples were collected using five layer, 20 liter sampling bags connected to personal sampling pumps. Each sampling was taken for around 30 minutes to fill up the bag. Air samples were transported back to and were analyzed at Chulalongkorn University Faculty of Sanitary Engineering laboratory by using a Hydrocarbon analyzer with a flame ionization detector (Katz, 1977). The analyzer reads out concentrations of total hydrocarbons and methane.

e) Volatile Organic Compound (VOC)

Outdoor VOCs were grab sampled by aspiring air through cartridges containing organic polymer adsorbent Tenax using personal sampling pumps with a flow rate of 0.1 liter/min for five hours. These Tenax cartridges were provided and analyzed by the Battelle Columbus Laboratories, Ohio.

The sample cartridges, including a blank, were immediately shipped back to the same laboratory for analysis after sampling. Recovery of VOCs from Tenax cartridges was accomplished by automated cryogenic preconcentration and thermal desorption (McClenny et al., 1984). The vapors were then introduced to the gas chromatograph where the constituents were separated from each other. A flame ionization detector was used to quantify the concentrations of recovered compounds. Mass spectrometry was utilized as an additional verification for compound identification.

All personal sampling pumps used for air pollution measurements were calibrated before and after samplings by means of the bubble meter method.

2.4 Data Analysis

Descriptive statistics and cross tabulations were performed. The relationship between respondent characteristics and health status was determined using the Chi-square test or Fisher's exact test when the expected count in one or more cells was less than five. Odds ratios were calculated to test for associations. Student's t test and analysis of variance were also done. Statistical packages used for data analysis were Systat (1985) and Epistat (Gustafson, 1985).

CHAPTER III

RESEARCH RESULTS

Illustrations of On-Nooch Community and Din-Dang Community as well as study measurements are shown in Appendix II. These pictures mainly illustrate conditions of scavenger life at the On-Nooch site.

The number of participating respondents for each type of subject-related measurements at the On-Nooch and the Din-Dang Communities is presented in Table 3.1. Results of the research study for health-related and environmental conditions in both communities are described as follow:

3.1 Scavenger Profile

A total of 297 scavengers, or approximately 74% of the scavenger population, at the On-Nooch Dump Site were interviewed. There were 185 males and 112 females, which was equivalent to a ratio of 1:0.61 between the male and female respondents. Data on the scavengers are summarized in Tables 3.2, 3.3, and 3.4. Most of the respondents were in the 16-35 age group (67%) with 18% were less than 16 years old. The mean income was 85 baht/day ($1 = 25 Baht).

Table 3.1 Summary Table of Those Examined by The Study

Examination	Age groups included	Male	Female	N
I. <u>On-Nooch Community</u>				
Scavengers	7-67	185	112	297
Respiratory/Nutrition	0-5	106	108	214
Parasites	3-8	34	23	57
Lung Function	17-68	29	116	145
HIV/Hepatitis B	15-62	109	0	109
II. <u>Din-Dang Community</u>				
Respiratory/Nutrition	0-5	64	74	138
Parasites	3-5	8	11	19
Lung Function	15-66	34	93	127

Table 3.2 Demographic Data of Interviewed Scavengers at On-Nooch Dump

Age Distribution	Number (Percent)		
	Male	Female	Total
<16	31 (11)	22 (7)	53 (18)
16-25	99 (33)	37 (13)	136 (46)
26-35	33 (11)	29 (10)	62 (21)
36-45	12 (4)	11 (4)	23 (8)
>45	10 (3)	13 (4)	23 (7)
Total	185 (62)	112 (38)	297 (100)

Table 3.3 Socio-Economic Data of Interviewed Scavengers at On-Nooch Dump (N=297)

Characteristics	Percent
<u>Education</u>	
None/less	9
Primary school	81
Secondary school	8
Vocational school	1
<u>Income</u>	
Average = 85 Baht/day (S.D. = 41 Range = 20-300)	
<u>Work Pattern</u>	
Hours Worked/Day	
<7 hours	6
7-10 hours	83
>10 hours	11
Working Schedule	
Within the hours of 0700-1700	75
Work in the Rain	78
Time at this Job	
<1 years	7
1-5 years	51
6-10 years	27
>10 years	15
Average = 6 years (S.D.= 5)	
Work Days	
Everyday	57
Sunday off	18
Saturday & Sunday off	10
Friday off	4
Friday & Sunday off	3
Work on weekends & holidays	2
Other	7
Year Round Work	96
Non-Scavenging Job	
None	95
Worker	2
Student	2
Other	2

Table 3.4 Health-Related Data of Interviewed Scavengers at On-Nooch Dump (N=297)

Characteristics	Percent
Symptom Complaints	
Headache	36
Diarrhea	13
Respiratory related	8
Skin disease	5
Other	2
Cut/Injured from	
Glass	88
Needle	73
Metal	25
Bamboo	30
Clothing Worn	
Hat	98
Nose/mouth covering	32
Gloves	72
Shirt sleeves	
Long	87
Short	13
Slacks	
Untucked long pants	36
Tucked long pants	65
Shorts	<1
Shoes	
With socks	90
Without socks	2
Boots	6
Slippers	2
Appine-Tab (Stimulant) Taking/Day	
None	79
1 tablet	17
2 tablets	3
3-6 tablets	1
Place of Taking	
Dump Site	86
Home	14
Frequency of Baths/Day	
Once	24
Twice	69
Three times	7
Place to Bath	
Home	97
Other	3

On the average, male scavengers earned slightly more than their female counterparts; i.e., 89 baht/day versus 79 baht/day. Most had only a primary school education and worked at the dump site seven days a week, seven to ten hours a day, and all year round, regardless of season.

A high percentage of respondents had been injured by glass (88%), which was followed by injuries from needlesticks (73%), bamboo (30%), and metal (25%). Needlestick, herein, means being pricked or stuck by a discarded hypodermic needle(s) while working on the dump. Headache symptoms were the most common complaint (36%), followed by diarrhea, respiratory-related symptoms, skin disease, and back pain. In comparison to males, females reported more headache and respiratory-related symptoms ($p<0.001$ and $p=0.03$ respectively). Most had worked one to ten years (78%) and 15% had worked more than ten years. Only 7% of those questioned had been working for less than one year. The average scavenger work experience was six years. Length on the job was not found to be related to health symptom complaints ($p>0.05$).

3.2 Childhood Respiratory Illness/Nutritional Status

Measurements for childhood respiratory illness and nutritional status data were taken from children 0-5 years of age in both communities.

At On-Nooch Community, data were obtained from 214 children, equivalent to 79% of the population in this age group. There were 106 males and 108 females which were 72% and 87% of their age cohort respectively. The male to female population ratio in this age group was 1:0.84 while the male to female ratio among respondents in this age group was around 1:1.

At Din-Dang Community, data were obtained from 138 children, equivalent to 97% of the population in this age group. There were 64 males and 74 females which were 97% of their age cohort for both genders as well. The male to female ratio among respondents was 1:1.2 which was the same as for the population in this age group.

Summary statistics for respondent, health-related, household, and parental characteristics for subject children are presented in Table 3.5, 3.6, 3.7, 3.8 respectively. The respondent characteristics, herein, mean the characteristics of respondents who provided information on the children.

Table 3.5 Respondent Characteristics among Children (0-5 yr) Assessed for Respiratory Illness

Respondents' Characteristics	On-Nooch (N=176)	Din-Dang (N=126)
	Percent	
Gender		
Male	10	6
Female	90	94
Age		
$\bar{X} \pm$ S.D.	31 ± 13 yr	36 ± 15 yr
Education		
None/Less	20	10
Primary School	73	54
Secondary School	5	20
Vocational/Higher	2	16
Relationship with the child		
Father	7	0
Mother	65	56
Grandmother	14	23
Other	14	21

Table 3.6 Health-Related Characteristics among Children (0-5 yr) Assessed for Respiratory Illness

Children's Characteristics	On-Nooch (N=214)	Din-Dang (N=138)
	Percent	
Gender		
Male	50	46
Female	50	54
Low-Birthweight	10	6
Breastfeeding	73	73
Degree of Malnutrition*		
Normal	69	88
1st Degree	28	12
2nd Degree	3	<1
Freq Resp Illness/Mo*		
<Once	71	86
Once-Twice	16	13
Three or more	13	<1
Mean Score[1] of Resp Illness**	4.2 ± 2.4	2.3 ± 1.8
Family History of Resp Illness		
Chronic Cough	15	22
Chronic Phlegm	19	21
Bronchitis	16	22
Asthma/Allergies	27	24
Tuberculosis	3	7

*Significant at $p<0.001$ for Chi-square test

**Significant at $p<0.001$ for Student's t test

[1]Score=Summation of positive responses to respiratory illness questions (See Table 3.6.1)

Table 3.6.1 List of Symptoms and Illness for Score of Childhood Respiratory Illness

Symptoms/Illness	Question # in the Questionnaire
Cough	Q.18, Q.19, Q.20
Phlegm	Q.21, Q.22, Q.23
Wheezing	Q.24
Shortness of Breath	Q.25
Chest Illness before Age 2	Q.28
Asthma/Allergies	Q.29
Bronchitis/Pneumonia	Q.30
Whooping Cough	Q.31
Sinusitis	Q.32
Score	Summation of the above responses
(Possible Score = 0-13)	(Yes=1, No=0)

Table 3.7 Household Characteristics among Children (0-5 yr) Assessed for Respiratory Illness

Household Characteristics	On-Nooch (N=174)	Din-Dang (N=115)
Household Member		
$\bar{X} \pm$ S.D.	6 ± 3	6 ± 3
	Percent	
# School Aged Children* (>5≤12 yr)		
None	44	58
one	31	31
>one	25	11
Cooking Fuel Use*		
Gas	37	73
Charcoal	49	12
Firewood	7	0
Electric/None	7	15
Cigarettes Smoked within Household*		
None	12	33
1-19 /day	56	55
20 more/day	32	12

*Significant at $p<0.01$ for Chi-square test

Table 3.8 Parental Characteristics among Children (0-5 yr) Assessed for Respiratory Illness

	On-Nooch (N=176)		Din-Dang (N=126)	
	Father	Mother	Father	Mother
	Percent			
Occupation				
Unemployed	6	43	6	35
Hired Worker	59	20	52	39
Self-employed	5	9	13	12
Civil Servant	4	1	29	14
Refuse Scavenger	26	27	0	0
Education				
None/less	14	20	0	3
Primary School	68	71	28	44
Secondary School	12	7	27	24
Vocational School	6	2	28	21
Bachelor/more	0	0	17	8
Income (Baht/Mo)				
Average	1,905	942	2,980	1,280
S.D.	1,050	1,038	2,799	1,808
Range	0-6,000	0-6,000	0-14,000	0-8,400

Respondents included mostly mothers of the children and an appreciable number of grandmothers.

Distribution of subject children for low-birthweight, breastfeeding, and family history of respiratory symptoms and illness was similar for both communities. Seventy three percent were breastfed. Ten percent were low-birthweight, born less than 2500 grams for On-Nooch children and 6% for Din-Dang children.

The mean score for respiratory illness based on a maximum of 13 points or 1 point for each respiratory-related question (see Table 3.6.1) was significantly different between the two communities ($p<0.001$). The mean respiratory illness score for On-Nooch children was 4.2 (S.D.=2.4) as compared to 2.3 (S.D.=1.8) for Din-Dang's children. Similarly, the frequency of respiratory illness per month was significantly different for both communities ($p<0.001$). The On-Nooch children had higher monthly respiratory illness frequencies than the Din-Dang children. Thirteen percent of On-Nooch children had three or more respiratory illness consequences as compared to less than 1% for the Din-Dang children.

There was significant difference in the nutritional status between the two communities ($p<0.001$). Din-Dang children had better nutritional status than On-Nooch's. Thirty percent were undernourished (28% and 3% for the first and second degree of malnutrition respectively) for On-Nooch whereas only 12% were undernourished (<1% for the second degree of malnutrition) for Din-Dang.

Average household size was six persons for both communities. The other household characteristics related to children, such as prevalence of school-aged children, cooking fuel use, and smoking within household were significantly different between the two communities ($p<0.01$). Cooking fuel use in their households consisted mostly of charcoal or liquid-propane gas, 49% and 37% for On-Nooch as compared to 12% and 73% for Din-Dang respectively. Smoking in these children's households was more common in the On-Nooch Community. The prevalence of smoking within the households was 88% for On-Nooch as compared to 67% for Din-Dang.

The differences for parental characteristics from these two communities were that parents of children from Din-Dang had more education, higher status occupation, and earned more money than those of the On-Nooch's.

At the On-Nooch Community, a quarter of the observed children's fathers as well as mothers were refuse scavengers at the dump. Most of the parents had only a primary school education.

Parents were divided into two groups: scavengers (either or both parents are scavengers) and non-scavengers at On-Nooch Community to determine the effect on child respiratory illness. Results of this grouping for prevalence of respiratory illness among these children are shown in Table 3.9. The mean respiratory illness score for children of scavenger parents was not different from those of non-scavenger parents. There was no significant relationship between the frequency of children's respiratory illness per month and the parent's occupation. The odds ratio was 1.5 for scavenger parent status and frequency of respiratory illness per month.

The common household air pollution factors such as the presence of cigarette smoking and cooking fuel use in the household were divided to determine their effect on the prevalence of respiratory illness among the observed children at the On-Nooch and Din-Dang Communities (Table 3.10, and 3.11 respectively).

At On-Nooch, children from households where smoking was present had significantly higher mean respiratory illness score than those from households where smoking was absent

Table 3.9 Childhood Respiratory Illness by Parental Occupation at On-Nooch Community

(N=214)	Mean Score of Respiratory Illness	
Parental Occupation		
Scavenger	4.3 ± 2.2	T=0.72
Non-Scavenger	4.1 ± 2.5	p=0.47

	Freq. Respiratory Illness/Mo.			
	<Once	Once-twice	Three or More	Combined
Parental Occupation				
Scavenger	54	16	13	29
Non-Scavenger	97	19	15	34
OR[1]	1.00	1.51	1.56	1.53
p[2]		0.37	0.39	0.21

[1]OR=Odds Ratio

[2]p Value for Chi-square test

Table 3.10 Childhood Respiratory Illness by Household Air Pollution Factors at On-Nooch Community

(N = 214)	Mean Score of Respiratory Illness	
Smoking within Household		
Presence	4.3 ± 2.4	T=2.95
Absence	2.8 ± 1.7	p=0.004
Cooking Fuel Use		
Yes	4.2 ± 2.4	T=0.72
No	3.7 ± 2.6	p=0.47

		Freq. Respiratory Illness/Mo.			
		<Once	Once-twice	Three or More	Combined
Smoking within Household					
Presence		131	32	27	59
Absence		20	3	1	4
	OR[1]	1.00	1.63	4.12	2.25
	p[2]		0.33	0.12	0.22
Cooking Fuel Use					
Yes		138	34	28	62
No		13	1	0	1
	OR	1.00	3.20	NC[3]	5.84
	p		0.22	0.10	0.05

[1]OR=Odds Ratio

[2]p Value for Chi-square or Fisher's exact test where it is more appropriate.

[3]NC=Not calculable

Table 3.11 Childhood Respiratory Illness by Household Air Pollution Factors at Din-Dang Community

(N = 138)	Mean Score of Respiratory Illness	
Smoking within Household		
Presence	2.3 ± 2.0	T=0.56
Absence	2.1 ± 1.5	p=0.58
Cooking Fuel Use		
Yes	2.3 ± 1.9	T=0.54
No	2.1 ± 1.4	p=0.59

		Freq. Respiratory Illness/Mo.			
		<Once	Once-twice	Three or More	Combined
Smoking within Household					
Presence		79	12	1	13
Absence		40	6	0	6
	OR[1]	1.00	1.01	NC[3]	1.10
	p[2]		0.81	0.67	0.93
Cooking Fuel Use					
Yes		102	15	1	16
No		17	3	0	3
	OR	1.00	0.83	NC	0.89
	p		0.51	0.86	0.55

[1]OR=Odds Ratio

[2]p Value for Chi-square or Fisher's exact test where it is more appropriate.

[3]NC=Not calculable

(p=0.004). Mean respiratory illness score was slightly higher for households using cooking fuel as compared to those using electric cooking or neither. There was a significant relationship between the prevalence of children's respiratory illness per month and the use of cooking fuel in the household (p=0.05, odds ratio=5.8) but not the presence of smoking in the household. Nevertheless, odds ratios of 4.1 and 1.6 were found for presence of household smoking and three or more respiratory illnesses per month, and one or two respiratory illnesses per month respectively.

At the Din-Dang Community, neither the presence of smoking nor the use of cooking fuel in these children's households were found to have an effect on the prevalence of childhood respiratory illness.

3.3 Parasitic Infection

Stool specimens were collected from 57 On-Nooch children ages 3-8 years, 34 males and 23 females, attending the On-Nooch Day-Care School. The respondent rate was about 84% of the community children attending the school. Table 3.12 shows the prevalence of parasitic infection among these children. Hookworm infection was the most prevalent of the

Table 3.12 Prevalence of Parasitic Infection in Examined Children

Parasite	Number	(Percent)	
I. On-Nooch Community (N=57)			
Protozoa			
Blastocystis hominis	1	(2)	
Endolimax nana	3	(5)	
Entamoeba coli	11	(19)	
Entamoeba histolytica	1	(2)	
Giardia lamblia	25	(44)	
Helminth			
Ascaris lumbricoides	2	(4)	
Enterobius vermicularis	3	(5)	
Hookworm	8	(14)	NEPG=400[1]
Opisthorchis viverrini	2	(4)	
Trichuris trichiura	1	(2)	
Strongyloides stercoralis	2	(4)	
II. Din-Dang Community (N=19)			
Protozoa			
Entamoeba histolytica	1	(5)	
Giardia lamblia	6	(32)	
Helminth	Not found		

[1]NEPG = Number of eggs/gram of faeces by Kato-Katz's technique (Geometric Mean)

helminthic infections while *Giardia lamblia* was the most prevalent of the protozoan infections. Sixty-five percent of these children were infected by one or more parasites.

Stool samples were also collected from 19 Din-Dang children attending the community day-care school which was over 90% of the respondent rate. There were eight males and 11 females ages 3-5 years old. None of these children were infected by helminths. Protozoan infection by *Giardia lamblia* was found in an appreciable number (Table 3.12).

3.4 Lung Function Performance

At the On-Nooch Community, a total of 145 respondents, 117 females and 28 males ages 17-68 years old were administered the lung function test. Sixty percent of the participants were in the normal range, with the remainder outside the normal range. Table 3.13 shows the relationship between the lung function results and the characteristics of the participants. There was no association between below-normal lung function performance and scavenger occupation, or current/past smoking behavior, or long-term ($\geq$10 yr) residency. Presence of smoking in the household and below-normal lung function performance was associated but not significant (OR=2.1, p=0.13).

Table 3.13 Results of Lung Function Performance by Respondent Characteristics at On-Nooch Community

(N=145)	Lung Function Below-Normal	Lung Function Normal	
Scavenger			
Yes	7	21	OR=0.43[1]
No	51	66	p=0.11[2]
Current/Past Smoker			
Yes	18	41	OR=0.51
No	40	46	p=0.08
Presence of Household Smoking			
Yes	49	63	OR=2.07
No	9	24	p=0.13
Length of Residency			
≥ 10 yr	37	56	OR=0.98
< 10 yr	21	31	p=0.91

[1]OR=Odds Ratio

[2]p Value for Chi-square test

At the Din-Dang Community, a total of 127 respondents from among community residents were administered the lung function test. There were 34 males and 93 females ages 15-66 years old. Sixty percent of these participants fell in the normal range for their lung function performance. The characteristics of current/past smoking behavior, presence of smoking in the household, and long-term residency were not found to be associated with subnormal lung function performance (see Table 3.14).

3.5 HIV and HBV Seroprevalence

The measurement for HIV and HBV seroprevalence was carried out at On-Nooch only. One hundred and nine (109) males contributed blood specimens for HIV antibody and HBs antigen/antibody testing. There were six positive tests (6/109) or 5% of this sample for HIV Ab and these were all scavengers. For HBs Ag and HBs Ab there were 20 (20/109 or 18%) and 26 (26/109 or 24%) positive results respectively. Occupational and HIV risk factor characteristics of the respondents were also examined in the analysis of this data. Summarized results are shown in Table 3.15 for HIV data and Table 3.16 for HBV data. No significant relationship was found between respondent characteristics and HIV infection,

Table 3.14 Results of Lung Function Performance by Respondent Characteristics at Din-Dang Community

(N=127)	Lung Function Below-Normal	Normal	
Current/Past Smoker			
Yes	9	27	OR=0.39[1]
No	42	49	p=0.04[2]
Presence of Household Smoking			
Yes	24	47	OR=0.55
No	27	29	p=0.14
Length of Residency			
≥ 10 yr	35	60	OR=0.58
< 10 yr	16	16	p=0.27

[1]OR=Odds Ratio

[2]p Value for Chi-square test

Table 3.15 Seroprevalance of HIV Antibody among Males at On-Nooch Community by Different Characteristics

(N=109)	HIV Antibody Positive	HIV Antibody Negative		
Scavenger				
Yes	6	76	p=0.17[1]	OR=[2]
No	0	27		
Needlesticks				
Yes	2	44	p=0.50	OR=0.67
No	4	59		
IV Drug User				
Yes	1	3	p=0.21	OR=6.67
No	5	100		
Needle Sharing				
Yes	1	2	p=0.16	OR=10.1
No	5	101		
Blood Transfusion				
Yes	3	32	p=0.29	OR=2.22
No	3	71		
Jaundice				
Yes	0	7	p=0.66	OR=[2]
No	6	96		
Homosexual				
Yes	0	2	p=0.89	OR=[2]
No	6	101		
STD History				
Yes	0	18	p=0.33	OR=[2]
No	6	85		
Sex with Prostitutes/ Condoms Use				
Yes/Never	0	22	p=0.32	OR=[2]
Yes/Sometimes	2	14	p=0.32	OR=2.29
Yes/Always	0	3	p=0.84	OR=[2]
No	4	64		

[1]p Value for Fisher's exact test

[2]OR=Not calculable

Table 3.16 Seroprevalance of Hepatitis B Antigen/Antibody among Males in On-Nooch Community by Occupation

(N=109)	HBs Antigen Positive	HBs Antigen Negative	
Scavenger			
Yes	12	70	p=0.08[1] OR=0.41[2]
No	8	19	
	HBs Antibody Positive	**HBs Antibody Negative**	
Scavenger			
Yes	18	64	p=0.58[3] OR=0.67
No	8	19	

[1]p Value for Fisher's exact test

[2]OR=Odds Ratio

[3]p Value for Chi-square test

or HBV infection. However, high odds ratios for HIV infection were found in IV drug (OR=6.7) user and needle sharing (OR=10.1) groups.

3.6 Water Quality

A water supply survey of 442 households in On-Nooch Community was carried out. Almost all households had direct or indirect access to a piped running water system. Only 28% of household actually paid directly for their piped water service while the rest had to purchase water from those with service. Water from shallow wells and ponds were used by only a few households (3%) and mostly for the purpose of household washing and cleaning. Some natural ponds and stagnant water holes were used to clean plastics salvaged from the dump. Rain water and commercially available bottled water were used as sources of drinking water for many households (15% and 12% for rain and bottled water respectively). Like water services, services for electrical use were very similarly acquired by community members. It was found that 25% of households had registered use of the electrical supply. Some of them had connected their lines to supply electricity to their neighbors as a way of earning money. About 3% of the households did not utilize electricity.

A total of 33 water samples from different sources in the community were collected. Twenty-six were from households' storage containers including commercially available bottled water, three were from the running water system, and four were from shallow wells and ponds. Results of water analyses are shown in Table 3.17. Both total coliform and fecal coliform bacteria were detected in almost all potable water samples. An average of 35 and 53 CFU/100 ml for fecal coliforms were recovered from water samples taken from households' storage containers where stored water was acquired from the running water system and rain catchments respectively. An average of 17 CFU/100 ml for fecal coliforms was found in commercially bottled water samples. Water samples from the running water system showed an average of 2 CFU/100 ml for fecal coliforms. High counts (>10,000 CFU/100 ml) of fecal coliforms were detected from shallow well and pond samples.

Of six water samples collected from Din-Dang, coliform bacteria were not detected from samples of the running water system. An average of 67 CFU/100 ml for fecal coliforms were recovered in samples taken from household's storage

Table 3.17 Results of Water Samples Analyzed at the Communities

Source	pH	Turbidity NTU	Coliforms (CFU/100ml) Total	Fecal
I. <u>On-Nooch Community</u>				
Storage Containers				
Tap [17][1]	8.1 (0.27)[2]	3 (1.1)	130 (160)	35 (35)
Rain [6]	8.2 (0.38)	3 (0.97)	110 (93)	53 (83)
Bottled Water [3]	8.4 (0.40)	3 (1.1)	59 (38)	17 (20)
Running Water [3]	7.8 (0.21)	2 (0.31)	3 (15)	2 (3)
Wells&Ponds [4]	7.3 (0.25)	29 (7.3)	650,000 (1300K*)	450,000 (880K)
II. <u>Din-Dang Community</u>				
Storage Containers				
Tap [2]	8.2	2	98	67
Bottled Water [2]	8.3	2	44	3
Running Water [2]	8.1	2	0	0

[1][] = Number of samples

[2]() = Standard Deviation

*K = 1,000 times

container where stored water was acquired from the running water system. Bottled water samples detected an average of 3 CFU/100 ml for fecal coliforms.

3.7 Air Quality

The results of air pollution measurements for NO_2, particulates, SO_2, H_2S, HCHO, HCs, VOCs are presented below. Results are also shown in Tables 3.18, 3.19, 3.20.

3.7.1 NO_2

Results obtained from On-Nooch samples for personal, indoor, and outdoor mean NO_2 levels were similar at 28, 30, and 36 ug/m^3 respectively (Table 3.18). Higher mean concentrations of NO_2 were found at Din-Dang with a similar pattern for personal, indoor and outdoor levels. The values for personal, indoor, and outdoor mean concentrations were 150, 130, and 130 ug/m^3 respectively.

There was no significant difference in NO_2 levels among households based on smoking or non-smoking and/or use of cooking fuel for both communities. Results of the factorial analysis of variance for the presence of smoking and use of cooking fuel in the households in regard to their indoor NO_2 levels are presented in Table 3.18.1.

Table 3.18 Mean Concentrations (ug/m³) of Measured Air Pollutants

	24-hr Exposure Period		
Pollutants	Personal	Indoor	Outdoor
I. On-Nooch Community			
NO_2	28 (6.0,22%)[1] n=28	30 (8.1,27%) n=73	36 (5.1,14%) n=4
TSP	-	490 (130,27%) n=12	490 (250,51%) n=3
RSP	-	210 (130,62%) n=12	180 (82,46%) n=3
SO_2	-	-	5.5 (0.5,9%) n=6
H_2S	-	-	5.5(1.3,24%) n=4
HCHO	-	-	6.7 (2.3,34%) n=3
II. Din-Dang Community			
NO_2	150 (66,44%) n=19	130 (52,40%) n=54	130 (26,20%) n=4
TSP	-	410 (88,21%) n=8	510 (130,25%) n=3
RSP	-	210 (120,57%) n=8	230 (29,13%) n=3
SO_2	-	-	50 (17,34%) n=6

[1]() = Standard Deviation, %Coefficient Variation

Table 3.18.1 Results of Factorial ANOVA for Indoor NO_2 Levels

I. On-Nooch Community

Analysis of Variance

Source	SS	DF	MS	F	P
Fuel[1]	66.8	1	66.8	3.68	0.059
Smoke[2]	35.4	1	35.4	1.95	0.168
Fuel*Smoke	59.2	1	59.2	3.26	0.076
Error	1218.0	67	18.2		

II. Din-Dang Community

Analysis of Variance

Source	SS	DF	MS	F	P
Fuel	140.7	1	140.7	0.18	0.670
Smoke	2589.2	1	2589.2	3.38	0.072
Fuel*Smoke	79.8	1	79.8	0.10	0.748
Error	37558.6	49	766.5		

[1]Fuel=Use of cooking fuel in the household.

[2]Smoke=Presence of smoking in the household.

(Each factor was dichotomized as yes and no)

Table 3.19 Outdoor Concentrations (mg/m^3) of Hydrocarbons Measured at On-Nooch Dump and Community

	On-Nooch Dump (N=1)	On-Nooch Community (N=4)
Total NMHC[1]	5.5	5.6 (1.4,25%)[2]
Methane	20	0.3 (0.25,83%)

[1]NMHC = Non-methane hydrocarbons

[2]() = Standard Deviation, %Coefficient Variation

Table 3.20 Outdoor Concentrations (ug/m^3) of Volatile Organic Compounds by Tenax Grab Sampling

Compound	On-Nooch Dump (N=1)	On-Nooch Community (N=2)	Din-Dang Community (N=1)
Benzene	13	14	25
Ethylbenzene	120	6	13
Ethyltoluene	46	10	10
n-Heptane	25	3	24
n-Hexane	25	4	40
C7 Hydrocarbon	20	3	18
Isopentane	6	1	11
Methyl Chloroform	61	-	-
Methylcyclopentane	9	1	14
2-Methylhexane	12	2	14
3-Methylhexane	14	2	16
2-Methylpentane	11	2	23
3-Methylpentane	8	2	15
Methylene Chloride	26	-	-
n-Octane	23	2	12
n-Pentane	5	1	14
Toluene	700	31	72
1,2,4-Trimethylbenzene	54	3	14
m&p-Xylene	330	12	56
o-Xylene	110	4	17

3.7.2 TSP and RSP

At On-Nooch, mean indoor and outdoor TSP concentrations were both 490 ug/m^3. Mean concentrations for indoor and outdoor RSP were 210 and 180 ug/m^3 respectively. There were slightly higher levels of RSP indoors than outdoors.

At Din-Dang, levels of TSP and RSP were higher outdoors than indoors, especially for TSP. The levels for indoor and outdoor TSP were 410 and 510 ug/m^3 respectively. Mean levels of indoor RSP were the same for both communities.

3.7.3 SO_2, H_2S, HCHO

Relatively low concentrations of outdoor SO_2 were detected at On-Nooch, whereas much higher concentrations were found at Din-Dang (5.5 ug/m^3 versus 50 ug/m^3).

H_2S and HCHO samples were taken at On-Nooch only. Mean concentrations for outdoor H_2S and HCHO detected in this community were 5.5 and 6.7 ug/m^3 respectively.

3.7.4 HC and CH_4

Samples for hydrocarbons were only taken at On-Nooch. A relatively high concentration of CH_4 (20 mg/m^3) was detected at the open-dumping area, whereas mean concentrations of only 0.3 mg/m^3 were found in the community

(Table 3.19). Concentrations of 5.5 mg/m^3 of non-CH_4 hydrocarbons were detected at the open-dumping area while comparable mean concentrations of 5.6 mg/m^3 were detected in the community.

3.7.5 VOCs

Table 3.20 shows outdoor VOC concentrations. High concentrations of toluene (700 ug/m^3) were detected at the open-dumping site as well as ethylbenzene (120 ug/m^3), m&p-xylene (330 ug/m^3), and o-xylene (110 ug/m^3). Appreciable amounts of benzene, methylene chloride, and methyl chloroform were also recovered at the open-dumping area. VOC species concentrations detected in the On-Nooch Community were relatively low although appreciable amounts of benzene were found. On the other hand, VOC species concentrations found in the Din-Dang Community were generally higher than those of the On-Nooch Community. Moreover, the distribution of VOC concentrations at Din-Dang reflected VOC levels at traffic locations while a VOC pattern consistent with domestic and industrial solvents was present at the dump.

3.8 Indoor NO_2 and Childhood Respiratory Illness

The relationship between indoor NO_2 levels and childhood respiratory illness was investigated for both communities. At On-Nooch, there were 84 subject children assessed for respiratory illness in households measured for NO_2 levels. The levels of indoor NO_2 were not significantly different for these households regardless of children's respiratory illness scores, or frequencies of respiratory illness per month.

At Din-Dang, there were 64 subject children assessed for respiratory illness in households measured for NO_2 concentrations. Children with respiratory illness scores equal to or greater than three had significantly higher indoor NO_2 levels in their households ($p=0.004$). There was no significant difference in indoor NO2 levels for these households regardless of children's frequencies of respiratory illness per month.

CHAPTER IV

DISCUSSION

In this chapter, the research results of the study are discussed; comparisons of the findings from the On-Nooch and Din-Dang Communities as well as with previous and related studies are made where applicable.

4.1 Scavenger

The finding that the most common educational level among scavengers was primary school was consistent with other studies done at this site (Butsapak, 1984; Leelakuldhanit, 1987). There was an appreciable percentage of young scavengers (<16 years old) working at the garbage pile. Scavengers as young as seven years old were present. Generally, health complaints reported by scavengers (headache, diarrhea, respiratory symptoms, skin disease, back pain, cuts, and injuries) were consistent with previous studies (Butsapak, 1984; Leelakuldhanit, 1987). The finding that female scavengers had more complaints of headache and respiratory illness than male scavengers may have been due to the fact that females were more sensitive to or concerned with their health conditions than males. It should be noted that the prevalence of using Appine-Tab (a central stimulant or amphetamine-like tablet) among scavengers was frequently under-reported since they were afraid that it could be viewed negatively. From intimate conversations with scavengers, it was apparent that Appine-Tab was commonly abused among scavengers so as to be able to withstand the bad conditions on the garbage pile. The average income of scavengers, 85 baht/day, was slightly higher than the Bangkok minimum wage of 78 baht/day at the time of the research period. It is interesting to note that many of them stated that they preferred scavenging on the garbage pile to being paid as laborers which they felt restricted both their freedom and their potential earnings.

The common profile of low educational attainment, child scavengers, and health complaints found among scavengers was in accordance with other studies in developing countries (Birkbeck, 1978; Birkbeck, 1979; Fernandez and Torre, 1986; Harahap, 1984; Khyaju, 1986).

Potential biases of the obtained results could be attributed to the nature of the samples and poor memory recall in responding to the questionnaires. Although an appreciable number of scavengers were interviewed, they were self-selected. Those who were not present at the time of the interview as well as those who refused to be interviewed could have been significantly different from the sample obtained.

4.2 Child Health

Respiratory illness, nutritional status, and parasitic infection of the observed children are discussed in the following section.

4.2.1 Respiratory Illness

The high prevalence of childhood respiratory illness found in the On-Nooch Community was consistent with findings of the community's Primary Health Care-Mother and Child Health Center's statistics (Van den Bossche, 1988). One hundred and seventeen (117) upper respiratory infections (URI) among 217 visits (54%) and 230 URI cases among 378 visits (60%) were diagnosed among patients ages 0-5 years in 1987 (July-December) and 1988 respectively at this center (Van den Bossche, 1988). Children of scavenger parents were not found to have higher childhood respiratory illness as compared to children of non-scavenger parents.

In comparison to the Din-Dang Community, the prevalence of childhood respiratory illness in On-Nooch was significantly higher ($p<0.001$). At On-Nooch, children from households where smokers were present had a significantly higher mean respiratory illness score than children from households without smokers. Moreover, there was a borderline significant relationship between the prevalence of On-Nooch children's respiratory illness per month and the use of cooking fuel in the household. In contrast, no relationship between smoking and cooking fuel use in the household was found on the prevalence of children's respiratory illness at the Din-Dang Community. This discrepancy could be due to the fact that there were more heavy smokers present in On-nooch households than those of Din-Dang's and that more time was spent for cooking by On-Nooch householders who used cooking fuel. The average time spent per day for cooking with cooking fuel use was 77 minutes for On-Nooch households as compared to 67 minutes for Din-Dang households. Moreover, cooking fuel use in On-Nooch households utilized more charcoal and firewood which generated more smoke as compared to liquid-propane gas (LPG). Unlike LPG, combustion of charcoal and firewood cannot be limited to the time of cooking only. The extra combustion before and after the cooking process using charcoal and firewood could possibly elevate the levels of pollutants.

4.2.2 Nutritional Status

The level of 30% with sub-normal nutritional status found among children in the On-Nooch Community was consistent with that found by the Primary Health Care-Mother and Child Health Center (Van den Bossche, 1988). Consistency of diagnosis of first degree malnutrition in this study and at the Center was also found.

On-Nooch children had significantly lower nutritional status as compared to Din-Dang children (28% and 3% versus 12% and <1% for first and second degree malnutrition).

In comparison to the national surveillance of nutritional status among children 0-60 months, children in the On-Nooch Community have a higher percentage of malnutrition than either in the central Thai region or in the country as a whole (30% versus 11% and 24%) (Department of Health, 1987).

At On-Nooch, 79% of the target children could be observed for respiratory illness/nutritional status. Though it was quite a good proportion, potential biases could possibly arise if children not observed by the study were all of a condition, either in poor or good health. This would lead to a significant variation in the results. Potential biases regarding subject samples were not expected at Din-Dang since almost all target children (97%) were covered for this assessment. Similar to other questionnaire studies, the results of this study were also subject to the potential problems of recall among respondents.

4.2.3 Parasitic Infection

Despite a small sample size, most tested children in the On-Nooch Community were found to be infected with intestinal protozoa and helminths, while no helminthic infections were found in children from Din-Dang. Parasitic infection was common in the On-Nooch Community since factors contributing to intestinal parasitic infections were more pronounced than in other urban settings like Din-Dang. For instance, the On-Nooch Community area was not paved, children did not wear shoes, and unsanitary household and community conditions were present. Moreover, On-Nooch households were more crowded with children than Din-Dang's.

The *Opisthorchis viverrini* infected cases found at On-Nooch suggested that the cases were migrants from other areas where intermediate hosts like certain snails and fish were present in addition to the habit of eating raw fish (Harinasuta and Harinasuta, 1984; Upatham et al., 1984).

4.3 Lung Function Performance

Health assessment among 145 On-Nooch community respondents measured by lung function test suggested that respondents' pulmonary health was not good since an appreciable percentage (40%) were found to be below the normal range for lung function performance. Scavenger occupation was not associated with abnormal lung function among respondents. Surprisingly, past or current smokers were not found to have an association with abnormal lung function. It is possible that the result is confounded by occupational exposure which contributed more to poor lung function health for the non-smokers. Also, these smokers might be only light smokers. Although not significant, the odds ratio for the presence of cigarette smoking in a household and an abnormal lung function was 2.1. Therefore, being in a household where smoking was present may contribute to a reduction in lung function.

The findings of 127 Din-Dang respondents were comparable to those of On-Nooch's. However, smoking in the household was not found to be associated with sub-normal lung function. This was possibly because there were relatively light smokers present in these households.

Since these samples were self-selected, a potential bias in the results was not unexpected. It was possible that subjects who participated in the test were non-representative, having either particularly poor or good health.

4.4 HIV/HBV Seroprevalence

Serological tests among 109 male respondents from On-Nooch revealed a prevalence of 18% of hepatitis B antigenemia in the community in addition to six individuals with possible HIV infection (no confirmatory tests were done). There was no significant relationship between the HIV infection and risk characteristics among respondents. The odds ratios for scavengers, IV drug users, and among those practicing needle sharing were high. The odds ratio for being a scavenger and having HIV infection was not calculable due to a zero frequency in one of the cross tabulation cells. Being a scavenger was not associated with HBV infection.

The prevalence of 18% HBs antigenemia among examined respondents was relatively high. Previous studies done in Bangkok have shown the prevalence of HBs Ag positive ranging from 5 to 10% (Seidl and Chandanayingyong, 1984; Pramoolsinsap et al., 1986; Brown, 1987). The high prevalence of HBs antigenemia in On-Nooch was expected since unsanitary environments, poor personal hygiene and crowding were present.

It should be noted that false positive results for the HIV test are possible since no necessary confirmation tests were done due to a limited budget. Recall and under-reporting were potential problems for this type of questionnaire. Additionally, respondents of these sera tests were self-selected which might potentially bias the results.

4.5 Environmental Conditions

The environmental conditions with respect to water and air pollution are addressed in the following section.

4.5.1 Water Quality

Poor quality potable and non-potable water was present in the On-Nooch Community. The detection of fecal coliform bacteria in these water samples indicated fecal contamination of water sources. The presence of any fecal coliforms is unacceptable according to drinking water quality standards. Frequent contamination of water storage containers was expected given the poor personal hygiene, environmental conditions, and lack of sanitation. Ponds and water holes, used to clean retrieved plastic sheets, were heavily contaminated. The fecal coliform bacteria levels detected in well and pond samples were exceedingly high.

Contamination of water storage containers was also detected at Din-Dang but no contamination was found in the running water. This suggested that contaminations were induced through storing.

Unfortunately, commercially available bottled water which was confidently used among both communities' households to serve their drinking water needs was also of low quality.

4.5.2 Air Quality

Household air quality in both On-Nooch and Din-Dang Communities seemed likely to be influenced by the quality of outdoor air as indicated by the results of measuring selected pollutants, such as NO_2, TSP, and RSP. The mean concentrations for these pollutants were either similar both outdoors and indoors or higher outdoors. This was not unexpected since these households were naturally ventilated and very much dependent on open windows and doors for ventilation for the hot weather of the tropics. Mean concentrations of personal exposure for NO_2 taken from very young children who were likely to be home at all times were in accordance with those taken from fixed stations for indoor NO_2 in these households. This supported the applicable use of fixed station samplings for household air pollution measurements.

Much higher mean concentrations of NO_2 as well as SO_2 were found in Din-Dang than in On-Nooch. The explanation for high concentrations of NO_2 detected at Din-Dang was the presence of heavy traffic and bus stops at the site. Moreover, numbers of commercial establishments in this area could have possibly contributed NO_2 and SO_2 through on site fuel consumption. Small industrial-business institutions might be present within the region as well.

It should be noted that air pollution measurements in this study were taken over a limited time period and were also subject to the daily fluctuations of air contaminants. Moreover, the sampling sites of this study were not selected for the purpose of representing the entire city of Bangkok. Therefore, obtained results were not meant to be generalizable beyond the sites nor the sampling period. In addition, the results of measured pollutants from such a small sample size lent themselves to limited analysis and interpretation.

The annual mean for 24-hour integrated ambient NO_2 levels of a residential location in Bangkok monitored by the Department of Health (Mahapol and Katetud, 1987) was around 20 ug/m^3 from 1983-1986 with a maximum value of 160 ug/m^3. A NO_2 concentration as high as 320 ug/m^3 in samples taken from a major street in Bangkok was found as measured in the months of August and September 1986 (Mahapol and Katetud, 1987). The NO_2 levels in the On-Nooch and Din-Dang Communities seemed to be compatible with those of the above study.

The mean NO_2 concentrations of 19 ug/m^3 (10 ppb) and 24 ug/m^3 (13 ppb) for indoor and outdoor air, respectively, taken from twenty Bangkok homes in February 1983, were reported from a study by Mori and associates (1987). Their study sampled NO_2 using NO_2 filter badges for an exposure period of one week. Their finding of a similarity in levels of indoor and outdoor NO_2 among samples were consistent with this study at On-Nooch and Din-Dang. Concentrations of NO_2 found in their study seemed to be compatible with those of On-Nooch community, but not with those of Din-Dang's. It is notable that the Din-Dang site was a traffic site whereas the sampling sites in their study were most likely to be in residential areas since their samples were taken from researchers and colleagues' home environments. Moreover, it was expected that ambient NO_2 levels in urban Bangkok have elevated over the past five years due to the large increase of vehicles on the streets as well as a lack of control for NO_2 from vehicular emission. In addition, the sampling time of one-week exposure period for the Mori et al. (1987) study as compared to the 24-hour exposure period in this study could have partly accounted for the discrepancy of NO_2 levels due to the fluctuation over the sampling period.

The pattern of indoor NO_2 levels as a function of outdoor NO_2 concentrations was also found in other Asian cities like Manila and Taipei as well as Seoul and Tokyo during the summer (Yanagisawa, 1990). The use of unvented space heaters for these northern Asian cities during winter was a major source contributing to elevated indoor NO_2 levels.

Data for ambient NO_2 levels compiled from 42 cities throughout the world revealed that the annual mean concentrations of NO_2 during the period of 1980-1984 ranged from 20 to 90 ug/m^3 with an extreme of about 103 ug/m^3 (World Heath Organization, 1988). The maximum daily average NO_2 levels were also reported for numbers of cities (such as Vancouver, Hong-Kong, Jerusalem, Toronto, and others.) and were commonly around 100-200 ug/m^3. Ambient NO_2 levels found at Din-Dang seemed to follow the common high levels of NO_2 in those urban cities.

The impact of NO_2 on health was assessed by comparing NO_2 results obtained with exposure limit standards and guidelines. (See Table 4.1 for air quality standards and guidelines.) The levels of NO_2 in the On-Nooch and Din-Dang Communities were far below the Thai national ambient air quality standard of 320 ug/m^3 for one-hour average NO_2 levels (Office of the National Environment Board, 1986). In comparison to WHO guidelines (World Health Organization, 1988) of 150 ug/m^3 for 24-hour average NO_2 levels, both communities' mean NO_2 levels did not exceed the guidelines. However, NO_2 concentrations found in the Din-Dang Community did not meet the USEPA ambient air quality standards which specify an annual mean concentration of 100 ug/m^3 for

Table 4.1 Ambient Air Quality Standards and Guidelines (as ug/m^3, 24-hr average except where specified)

	Thailand[1]	U.S. EPA[2]	WHO[3]
NO_2	320 (1-hr mean)	100 (annual mean)	150
TSP	330	-	150-230
PM_{10}	-	150	-
SO_2	300	365	100-150

[1]Office of the National Environment Board (1986)

[2]U.S. Environmental Protection Agency (1988)

[3]World Health Organization (1988)

ambient NO_2 (U.S. Environmental Protection Agency, 1988). (See Figure 4.1.)

High Levels of particulates found in both communities were comparable. TSP concentrations of 490 ug/m^3 collected from the On-Nooch Community were higher than the 24-hour average of 260 TSP ug/m^3 (maximum value = 640 ug/m^3) from Bangkok residential areas in 1986 monitored by the Department of Health (Mahapol and Katetud, 1987). High concentrations of particulates found in On-Nooch were possibly attributable to fugitive dust from unpaved earth and the nearby open dumping site. Particulates were also generated from nearby composting and incinerating facilities as well as the smoldering combustion of garbage at the open dump. Moreover, sorting and reclaiming processes used to salvage materials by community members could have contributed to elevated levels of particulates.

TSP levels in Din-Dang were similar in range to those found at Bangkok traffic locations. The 24-hour average levels of TSP taken from curbside monitoring stations in Bangkok were reported around 200-700 ug/m^3 in 1985-1987 (Office of the National Environment Board, 1988). Levels of particutes found in urban Bangkok were known to be high and showed an increasing trend over the years (Traisawasdichai

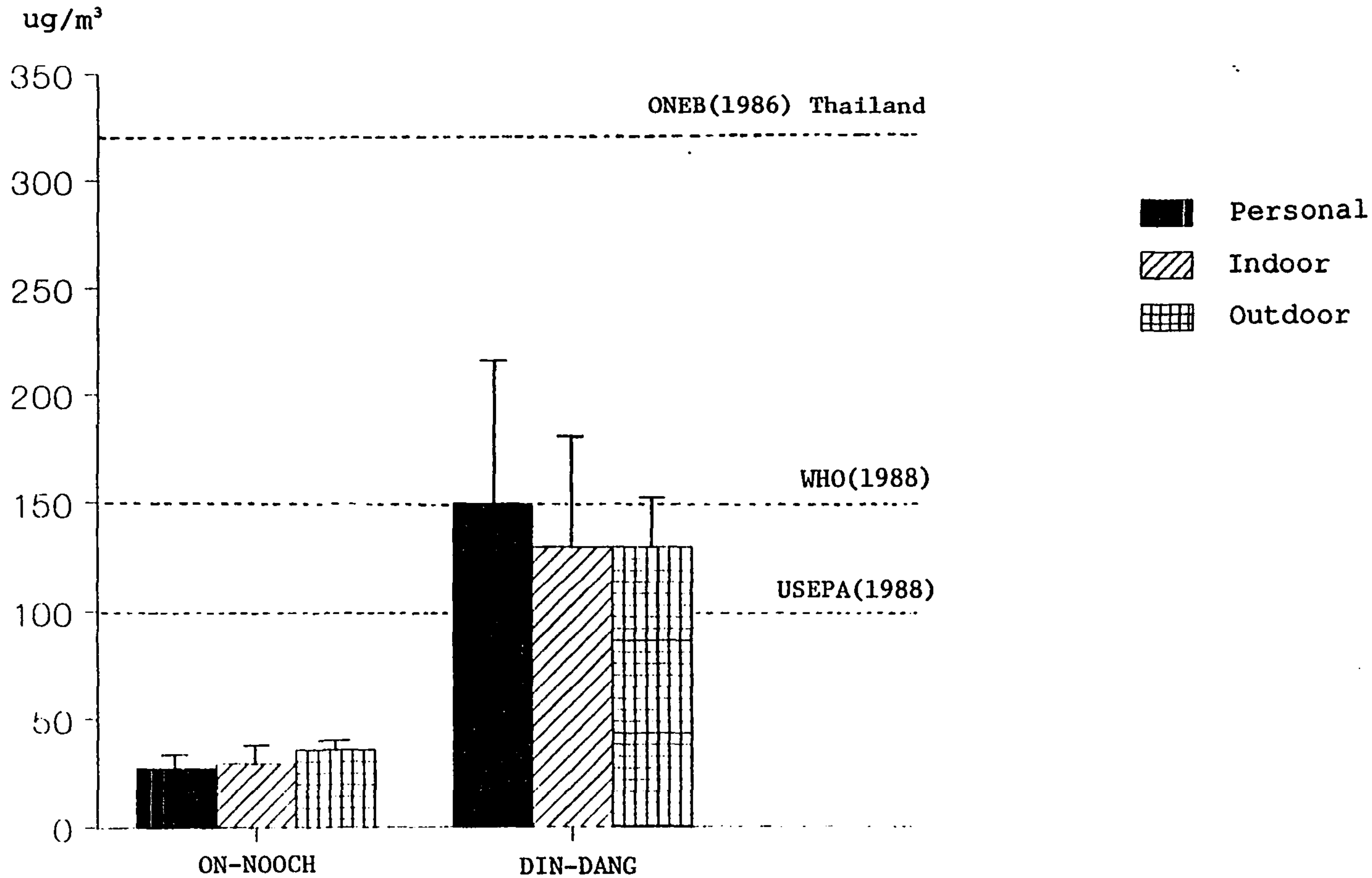

Figure 4.1 Levels of detected NO_2 (24-hr integrated averages) compared to standards and guideline

and Noipitak, 1989). Assessment of trends in urban particulate concentrations during the 1973-1985 period among cities in the Global Environment Monitoring System (GEMS)/Air network showed that Bangkok had the second highest yearly average increase (over 12%) in annual average TSP levels and had the highest yearly average increase (20%) in the 98 percentile TSP concentrations (World Health Organization, 1988).

Data from the GEMS/Air network for the 1980-1984 period (World Health Organization 1988) revealed that annual TSP averages in Bangkok were comparable to those of Bombay and Guangzhou (around 200 ug/m^3) but were much higher than cities like Tokyo and New York (around 60 ug/m^3). Lower levels of TSP in these cities were the result of achievements in reduction of particulate emissions.

Levels of TSP found in On-Nooch and Din-Dang exceeded the Thai national ambient air quality standard of 330 ug/m^3 for 24-hour average TSP levels (Office of the National Environment Board, 1986). Fine particulate matter, such as RSP with an aerodynamic diameter smaller or equal to five micrometers, in ambient air are not regulated in Thailand presently. However, using the 24-hour PM_{10} (particulate matter with an aerodynamic diameter less than or equal to 10 micrometers) ambient air quality standard of the U.S. Environmental Protection Agency (1988) which is 150 ug/m^3 for comparison, the RSP concentrations in these communities were excessive. In comparison to WHO guidelines, TSP levels in these communities were also over the range of 150-230 ug/m^3, the daily average TSP guideline (World Health Organization, 1988). (See Figure 4.2 and Figure 4.3.)

The low concentration of SO_2 (5.5 ug/m^3) in the On-Nooch Community was in accordance with that of natural background concentrations (World Health Organization, 1988). Mean level of 55 ug/m^3 SO_2 found in Din-Dang was comparable to the 24-hour average levels of 30 ug/m^3 for Bangkok ambient air reported by the Office of the National Environment Board (1988).

The commonly occurring values for annual average urban SO_2 levels during 1980-1984 in cities of the GEMS/Air network was between 20 and 60 ug/m^3 (World Health Organization, 1988). Levels of SO_2 found in Din-Dang were compatible with those in other cities.

In comparison to the Thai national ambient air quality standard of 300 ug/m^3 for 24-hour average SO_2 level (Office of the Environment Board, 1986), and also the U.S. Environmental Protection Agency (1988) ambient air quality

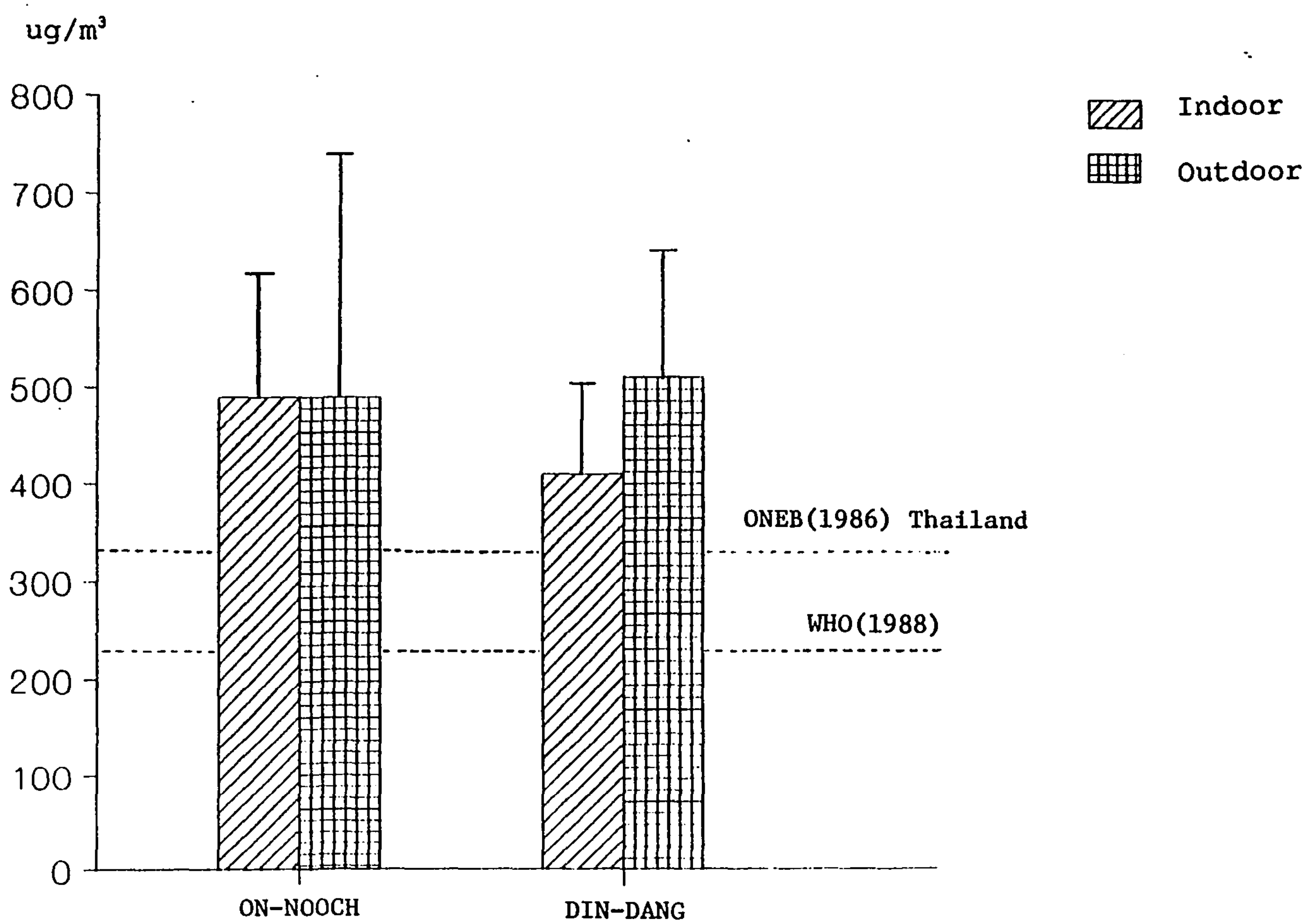

Figure 4.2 Levels of detected TSP (24-hr integrated averages) compared to standard and guideline

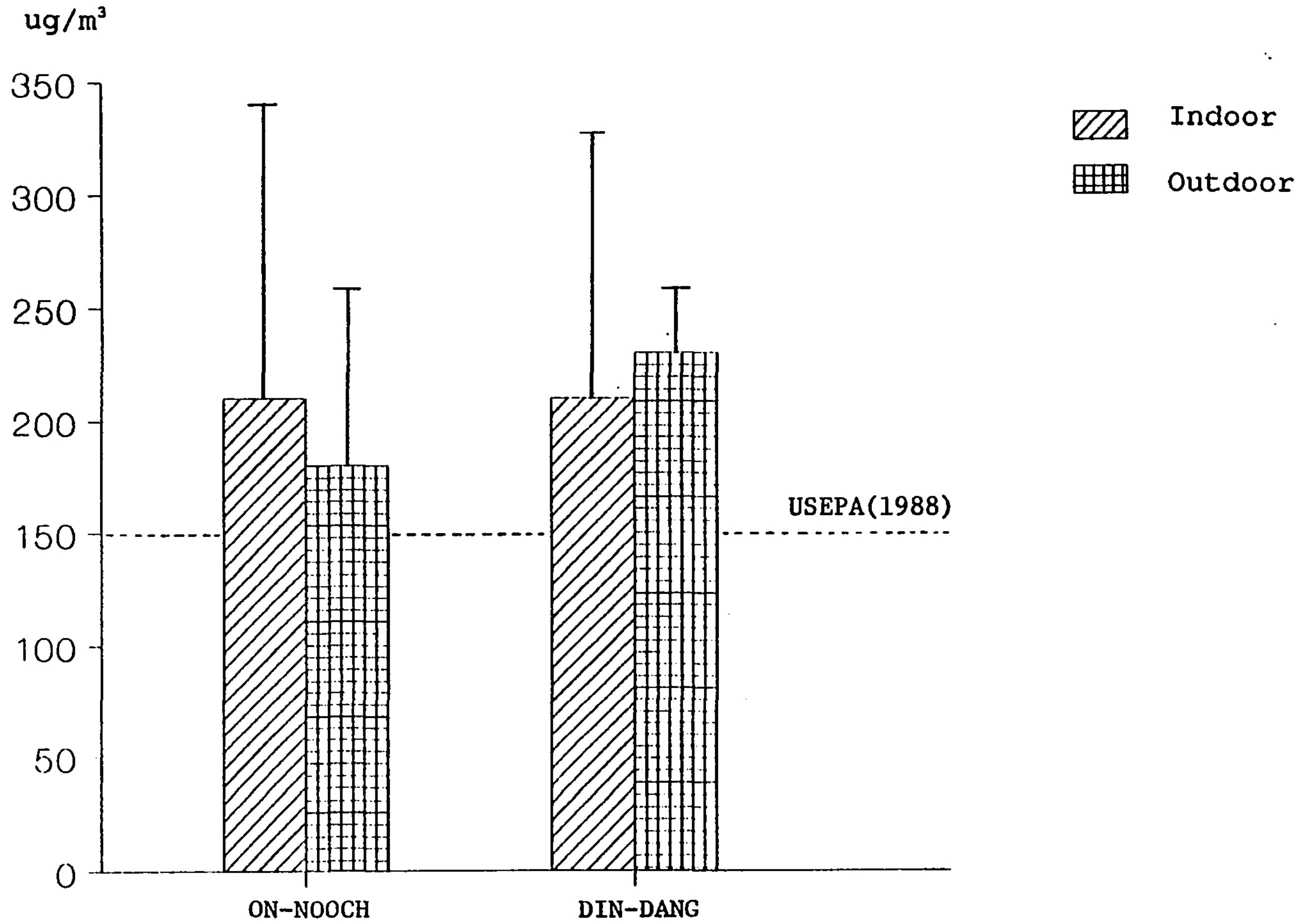

Figure 4.3 Levels of detected RSP (24-hr integrated averages) compared to standard for PM_{10}

standard of 365 ug/m^3 for 24-hour average SO_2 level, concentrations of SO_2 in On-Nooch and Din-Dang were far below these standards. Additionally, levels of SO_2 found in these two communities did not exceed the range of 100-150 ug/m^3 recommended by WHO guidelines for daily ambient average SO_2 (World Health Organization, 1988). (See Figure 4.4.)

Very low concentrations of H_2S (5.5 ug/m^3) were observed outdoors at the On-Nooch Community, though it was slightly higher than the estimated value of 0.3 ug/m^3 for average background ambient air H_2S level (World Health Organization, 1981). This was probably due to the contribution of waste fermentation and decomposition present nearby the site. There is no existing ambient air quality standard for H_2S. However, a guideline value for an ambient H_2S level of 150 ug/m^3 (24-hour average) has been recommended by the World Health Organization (1987).

A level of 6.7 ug/m^3 HCHO found in the On-Nooch Community was in accordance with levels in typical urban air, approximately 5-10 ug/m^3 HCHO as an annual average (World Health Organization, 1987). The threshold of irritation for this gas was reported at 100 ug/m^3 and this

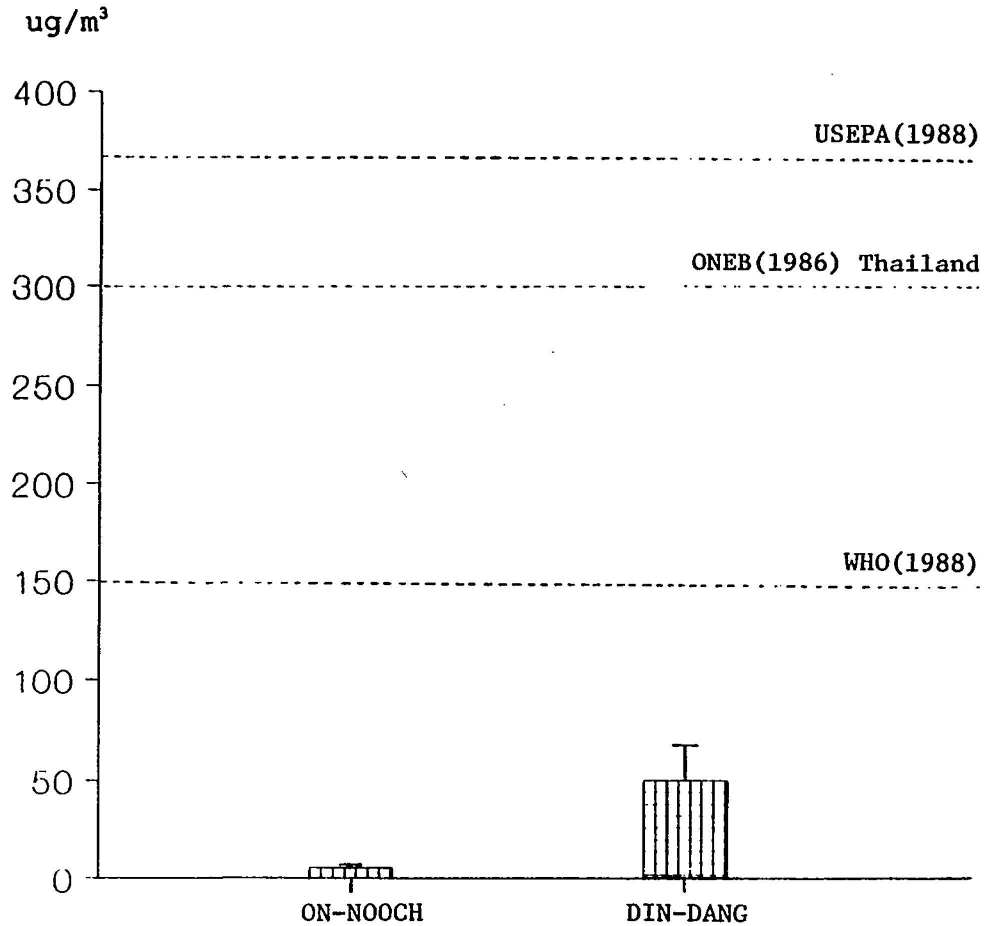

Figure 4.4 Levels of detected ambient SO_2 (24-hr integrated averages) compared to standards and guideline

was recommended as an air quality guideline value (World Health Organization, 1987).

Hydrocarbon (non-CH_4) standards have been revoked from the U.S. Environmental Protection Agency (1983) ambient air quality standards. The standard for total non-CH_4 HCs was 0.16 mg/m^3 for three hours (6-9 a.m.) in the past. Obviously, total non-CH_4 HCs found at the open-dumping area and On-Nooch Community (5-6 mg/m^3) were relatively high. This might be partly due to solid waste disposal and combustion processes present in the area. High levels of CH_4 found at the open-dumping site were possibly due to the decomposition of solid waste.

Several VOC species found at the dumping (tip) area were at much higher concentrations than in the nearby On-Nooch Community. Apparently, these VOCs found at the dump were the contribution of emissions from disposed waste like solvents, paints, cleaning substances, consumer products, and other wastes. For example, piles of retrieved paint cans were present at the sites. The detected high levels of toluene could be due to the volatilization of left-over paints. There were domestic waste disposed at the dumping site as well as industrial and research waste. The presence of methylene chloride as well as methyl chloroform was a potential indication of industrial waste contamination at the dump. Moreover, flue gas from incinerators as well as exhaust emissions from busy garbage trucks also in part contributed to VOCs in the area. Though high levels of VOCs were present at the dumping site, it did not seem to have an influence on the nearby On-Nooch Community.

VOC species found at On-Nooch were much lower than those of Din-Dang which were of auto-related sources. Emissions from automobiles were the major contributors to VOCs at the Din-Dang site. The VOCs in Din-Dang were not consistent with those at the dumping site, and most of the VOCs were much lower.

Air quality standards for ambient VOCs are not available presently. However, levels of VOCs species found at the dump area and Din-Dang Community were quite low as compared to the limited guidelines recommended by the World Health Organization (1987) and OSHA's workplace standards (Occupational Safety and Health Administration, 1989). WHO air quality guidelines are 3 mg/m^3 for methylene chloride, 7.5 mg/m^3 for toluene (24-hour average). OSHA's permissible exposure limits (eight-hour time weighted average) as mg/m^3 are, 3 for benzene, 375 for toluene, 435 for ethylbenzene and o-,m-,p- isomers of xylene, 1,740 for methylene chloride, and 1,900 for methyl chloroform.

4.6 Air Contaminants and Respiratory Health

The high prevalence of respiratory illness among observed young children in the On-Nooch Community were not found to be related to their household NO_2 levels since the detected levels were low and variations of NO_2 were limited. At the Din-Dang Community, the detected levels and variation of NO_2 were much greater, and it was found that children with respiratory illness scores equal to or greater than three had significantly higher indoor NO_2 levels in their households than those with lower respiratory scores.

Particulate matter was found at high (exceeded standards) and comparable levels both at On-Nooch and Din-Dang Communities. Studies have reported an association between particulates and increased respiratory illness as well as deficits in lung function (World Health Organization, 1979; U.S. Environmental Protection Agency, 1982; Ericsson and Camner, 1983). However, in this study the relationship between particles and respiratory health was not analyzed due to the small sample size of particulate samples collected. In considering high levels of particulates present, especially RSP which could penetrate the lower respiratory tract, it seems a reasonable conjecture that prevalence of childhood respiratory illness as well as decrements in adult lung function found in these communities were in part due to these particles. The chemical and biological composition of these particles are of significance as well. This matter warrants further investigation.

Though viable particles were not measured, it is expected that high levels of microbial air contaminants would be present at the dump site and its nearby On-Nooch Community due to the presence of unsanitary environments and conditions. For example, a study conducted in China found that air bacteria counts at the municipal dump were high and that hemolytic bacteria in dump scavengers' nasal mucous coats were significantly higher than those of the control group (Bo, 1990). It might be possible that the high prevalence of childhood respiratory illness at On-Nooch was in part due to the contribution of microbial air contaminants.

Though several air contaminants detected at these communities did not exceed the standard or guideline levels for individual pollutants, exposure to a mixture of these acceptable levels of individual pollutants might be able to pose hazardous conditions to respiratory health.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

Case study of a solid waste scavenger community with respect to health and environment was accomplished by collecting data and information at the On-Nooch Disposal Site, Bangkok. Surveys and measurements were undertaken to characterize the distribution and magnitude of the health-related and environmental conditions. In addition, data for a project apartment community (Din-Dang) in Bangkok City were also collected for comparison.

Findings for the On-Nooch and the Din-Dang Communities are summarized in Table 5.1.

Scavengers were exposed to hazardous conditions due to the waste materials at the dump site. Not only domestic, but hospital, research- laboratory as well as industrial wastes are also deposited at the site. Cuts and punctures from sharp materials were the most common complaints among scavengers. Health symptoms like headache, diarrhea, respiratory illness, skin disease and back pain were also reported.

Table 5.1 Summary of Findings for The On-Nooch and Din-Dang Communities

Indicators	On-Nooch	Din-Dang
Childhood Respiratory Illness	High prevalence Mean score = 4.2 29% $\geq$ one illness/mo.	Low prevalence Mean score =2.3 14% $\geq$ one illness/mo.
Nutritional Status	30% undernourished	12% undernourished
Intestinal Parasitic Infection	65% infected by one or more parasites	No helminthic infection
Cuts & Injuries among Scavengers	88% glass 73% hypodermic needles	Not done
Lung Function Performance	40% below-normal	40% below-normal
HIV/HBV Seroprevalence	6 respondents HIV Ab+ 20 respondents HBs Ag+	Not done
Water Quality Total & Fecal Coliforms	Found in potable & non-potable water samples	Not found in samples of the running water system
Air Pollution (As compared to standard and guideline levels)		
NO_2	Below	Above
TSP, RSP	Above	Above
SO_2	Below	Below
H_2S, HCHO, HCs, CH_4	Below	Not done
VOCs	Below	Below

The health of children in the On-Nooch Community was not good. There was a high prevalence of childhood respiratory illness especially among those children of households where cigarette smoking was present. Poor nutritional status among young children in the community was also found. These conditions were significantly greater in On-Nooch than in the Din-Dang Community ($p<0.001$). Infections of intestinal protozoa and helminths were much more common in On-Nooch children.

Assessment of lung function performance among adult respondents in the On-Nooch and Ding-Dang Communities indicated that an appreciable proportion of them were below the normal range.

Seroprevalence of HBV infection was found to be high among male respondents in On-Nooch. In addition, six respondents had possible HIV infections, albeit unconfirmed by tests.

The quality of the water supply in On-Nooch was low. Total and fecal coliforms were detected in almost all potable water samples. The Din-Dang Community had a better water supply quality since contaminants were found in fewer samples and at reduced levels.

Results of air pollution measurements at the On-Nooch Community indicated acceptable levels for air quality standards except for particulate matter (TSP and RSP). Levels of particulates were similar for both communities. Ambient air at Din-Dang was found to be more contaminated with NO_2, SO_2, and VOCs which was primarily due to heavy vehicular traffic present at the site. On the dump, relatively high levels of VOC species were detected.

Household air quality in these communities was a function of the ambient air quality. Levels of indoor, outdoor, and personal exposure NO_2 were found to be similar. In addition, indoor particulate levels were comparable to those of outdoors.

The detected indoor NO_2 levels at On-Nooch failed to correlate with childhood respiratory illness. In contrast, Din-Dang children with respiratory illness scores equal to or greater than three had significantly higher indoor NO_2 in their households ($p=0.004$).

5.2 Conclusions

A number of indicators were selected to investigate the health-related and environmental conditions at the solid waste scavenger community at the On-Nooch Dump Site. The measured conditions (indicators) that showed existence of public health hazards are compiled and aggregated into categories of child health, adults' health, and environmental health as presented in Figure 5.1. The framework in Figure 5.1 is developed to appraise the overall community health of On-Nooch by combining assessed environmental levels of child health, adults' health, and environmental health to derive an index for the community. The index as shown in the framework signifies that the overall community health for On-Nooch is poor.

Several public health conditions at the On-Nooch Community were hazardous as seen by the environmental levels found. These hazards need to be recognized, addressed, and alleviated. Public health activities are to be undertaken to resolve the poor health conditions. It would be difficult, if not impossible, to simultaneously remedy all the poor health conditions in the On-Nooch Community. Priority rating for these poor health conditions is needed to facilitate the decision-making in selecting outreach actions to remedy priority problems. Therefore, a prioritization system is developed for the purpose of determining which poor health conditions in the On-Nooch

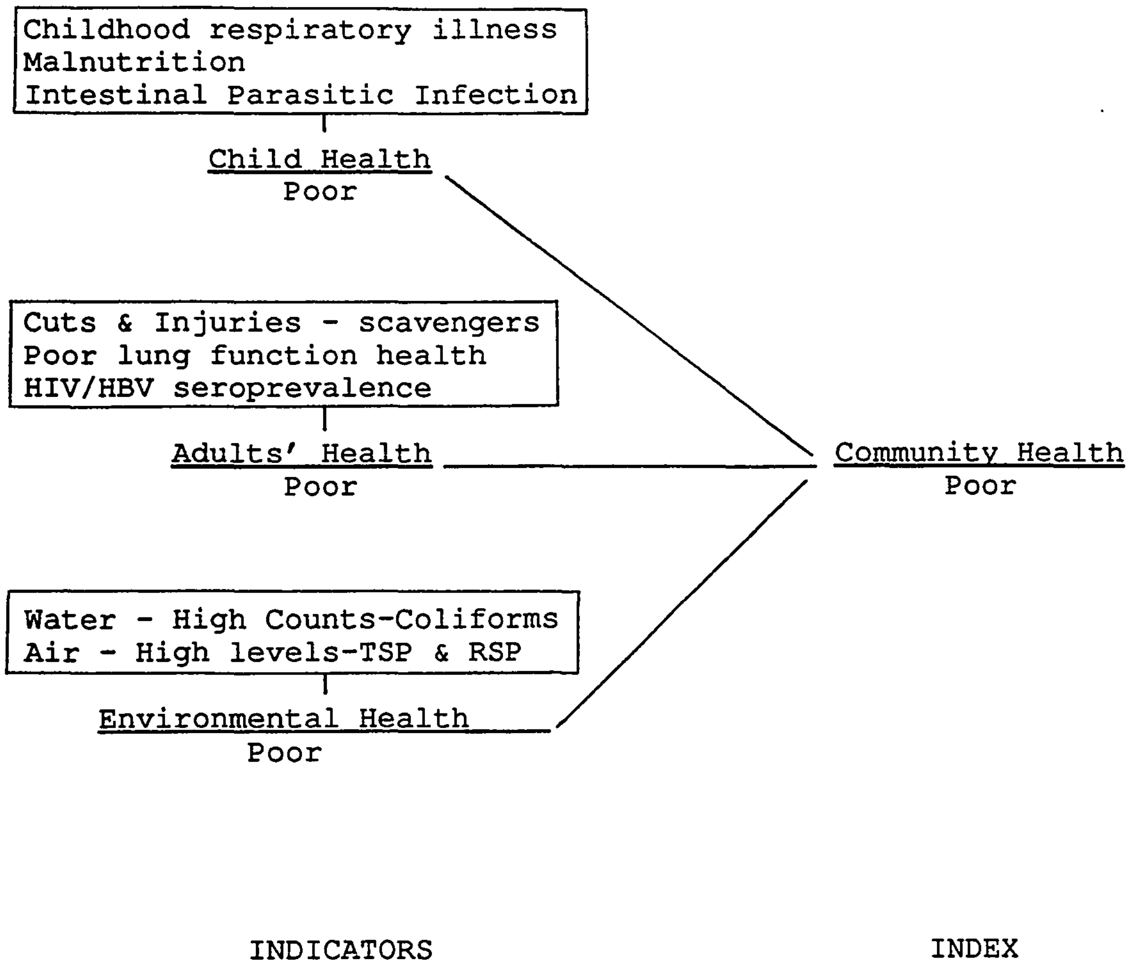

Figure 5.1 Framework for the community health index of the On-Nooch Community

Community merits high priority to receive public health action.

A simple index is employed in making priority ratings. The index, as a score, is the weighted sum of the subindex scores (Ott, 1978). The index model can be mathematically represented as :

$$\text{Index} = \sum w_i I_i$$

Where w = weight

I = subindex

i = 1 to n , number of subindices

The highest index score for the particular condition represents the highest priority rating for receiving action. A proposed set of six modified subindicies as A) seriousness of condition, B) size of condition, C) age distribution, D) time delays, E) cost-effectiveness, and F) uncertainty is used to derive an index in determining priority rating for poor health conditions at the On-Nooch Community (Pickett and Hanlon, 1990; Vilnius and Dandoy, 1990; Walsh, 1986; 1988; Jamison and Mosley, 1991; Chen and Soe, 1986; Chicken and Hayns, 1989; Cothern and Marcus, 1987). Each subindex has a score ranging from 0 to 100.

The poor health conditions found at the On-Nooch Community are all included in the analysis. They are childhood respiratory illness, malnutrition, intestinal parasitic infection, cuts and injuries among scavengers, poor lung function health, HIV and HBV seroprevalence, water contamination by fecal coliforms, air pollutant by particulates. The air pollution conditions of NO_2, SO_2, H_2S, HCHO, HCs, VOCs are not included in the analysis since their measured levels were below the standards; therefore, they are not considered potentially poor health conditions.

Following are the analyses using the six subindices and their weights to derive the index scores for priority ratings of the poor health conditions at the On-Nooch Community.

A) Seriousness of condition

Seriousness is one of the major element used in public health priority rating (Pickett and Hanlon, 1990; Vilnius and Dandoy, 1990; Chen and Soe, 1986). Seriousness is usually expressed as the degree of death and disability associated with the condition. In this analysis, the criteria applied for determining seriousness of a condition is the extent to which a condition lies along a scale from risk factor to health outcome, its degree of life-threat and degree of communicability. The rating scale for these factors and the overall scores for seriousness of the conditions are shown in Table 5.2. Childhood respiratory illness warrants the highest rating since it is a health outcome with a high degree of communicability and a medium-high degree of life-threat. Risk factor conditions such as water contamination by coliforms and air pollutant by particulates score the lowest.

B) Size of condition

Size or magnitude of the condition is the other major element used in public health priority assessment (Pickett and Hanlon, 1990; Vilnius and Dandoy, 1990; Chen and Soe, 1986). The size of a condition is generally assessed by the prevalence or incidence rates in the study population. The rating scale for the size of a condition at the On-Nooch Community is based on the prevalence of the condition as presented in Table 5.3. The prevalence for each condition is based on the environmental and health measurements of this study. The prevalence of water contamination by coliforms and air particulates is qualitatively 100% and receives the score of 100 since all members of the community drink the same quality of water and breathe the same quality of air. The results show that cuts and injuries among

Table 5.2 Ratings for Seriousness of Conditions at On-Nooch Community

Criteria for seriousness of condition ratings

Rating:	Low	medium-low	medium-high	high
Score:	25	50	75	100

Factor: a) risk factor ----------------> health outcome
b) non -------------------> very life-threatening
c) non -------------------> very communicable

Condition	(Factor & Score) a	b	c	a+b+c	Mean Score
Childhood respiratory illness	100	75	100	275	92
Malnutrition	100	75	25	200	67
Intestinal parasitic infection	100	50	75	225	75
Cuts & Injuries among scavengers	100	75	25	200	67
Poor lung function health	75	50	25	150	50
HIV seroprevalence	100	100	50	250	83
HBV seroprevalence	100	75	75	250	83
Water-Coliforms	25	25	25	75	25
Air-TSP,RSP	25	25	25	75	25

Table 5.3 Ratings for Size of Conditions at On-Nooch Community

Criteria for size of condition ratings

Prevalence of the condition	Score
0-25 %	25
26-50 %	50
51-75 %	75
76-100%	100

Condition	Score
Childhood respiratory illness	50
Malnutrition	50
Intestinal parasitic infection	75
Cuts & Injuries among scavengers	100
Poor lung function health	50
HIV seroprevalence	25
HBV seroprevalence	25
Water-Coliforms	100
Air-TSP,RSP	100

scavengers, water contamination by coliforms, and air pollution particulates receive the highest scores. HIV and HBV seroprevalence is rated the lowest on size of the condition.

C) Age distribution

The age distribution of the population affected by the environmental and health conditions is a significant element for public health priority assessment since it determines years of potential life lost from premature death. Young children affected by these conditions generate the most years of potential life lost from early death or disability.

Four age groups, young children, children, adults, and elders are used as rating criteria for the conditions studied at On-Nooch. The highest score is given to a condition that affects young children whereas the lowest score is given to a condition that affects elders. Results of the ratings of the conditions are shown in Table 5.4. The conditions of water contamination by coliforms and air particulates affect young children through elders since all age groups in the community are affected by these conditions. Therefore, water contamination by coliforms and air particulates warrant the highest score.

Table 5.4 Ratings for Conditions at On-Nooch Community by Age Distribution Factor

Criteria for age distribution ratings

Age distribution	Score
elders	25
adults	50
children	75
young children	100

Condition	Score
Childhood respiratory illness	100
Malnutrition	100
Intestinal parasitic infection	75
Cuts & Injuries among scavengers	50
Poor lung function health	50
HIV seroprevalence	50
HBV seroprevalence	50
Water-Coliforms	100
Air-TSP,RSP	100

D) Time delays

Diseases in man are categorized as developing quickly (acute) or over a long period of time (chronic). Those diseases that develop in a short period require prompt action. Therefore, acute health outcomes score highest on a priority rating scale. Table 5.5 presents the rating score for study conditions at On-Nooch. Childhood respiratory illness and cuts and injuries among scavengers are given the highest scores based on their acute nature. Health conditions or diseases from air pollution particulates usually take a long time to develop. Therefore the air particulates at On-Nooch score the lowest on this scale.

E) Cost-effectiveness

The cost-effectiveness of control strategies for the various conditions studies is vital in assessing public health priorities. Some conditions are easily controlled at very little cost while other conditions are difficult and/or very costly to control. Unless control of the condition is cost-effective, action to affect the condition is of low-priority. The more cost-effective the condition, the higher priority is the condition.

Table 5.5 Ratings for Conditions at On-Nooch Community by Time Delay Factor

Criteria for time delays ratings

	Time-delays			
Rating :	very short	short	long	very long
Score :	100	75	50	25

Condition	Score
Childhood respiratory illness	100
Malnutrition	75
Intestinal parasitic infection	75
Cuts & Injuries among scavengers	100
Poor lung function health	50
HIV seroprevalence	75
HBV seroprevalence	75
Water-Coliforms	75
Air-TSP,RSP	25

Ratings of the cost-effectiveness of the study setting conditions is summarized in Table 5.6. Malnutrition, intestinal parasitic infection, cuts and injuries among scavengers, and HBV seroprevalence score the highest for cost-effectiveness. This is because of the availability of relatively simple and effective control strategies, that is a nutritional supplement program for malnutrition, medication for parasitic infection, protective gear like gloves and boots for preventing cuts and injuries among scavengers, and hepatitis immunization shots for HBV control. Childhood respiratory illness and water contamination by coliforms are relatively more complicated to control and therefore score lower. Childhood respiratory illness may involve many risk factors including air pollution. This makes it complicated to control. Treatment for childhood respiratory illness by antibiotics is not always appropriate since the illness may not be due to bacterial infection. Moreover, antibiotic sensitivity to the children and antibiotic resistance to the bacteria might be problems for treatments with antibiotics. The difficulty in improving water quality is that even with an improved water supply source there still may be poor water quality due to the presence of poor hygienic practices and

Table 5.6 Ratings for Conditions at On-Nooch Community by Cost-Effectiveness Factor

Criteria for cost-effectiveness ratings

	Cost-effectiveness			
Rating :	Low	medium-low	medium-high	high
Score :	25	50	75	100

Condition	Score
Childhood respiratory illness	75
Malnutrition	100
Intestinal parasitic infection	100
Cuts & Injuries among scavengers	100
Poor lung function health	25
HIV seroprevalence	25
HBV seroprevalence	100
Water-Coliforms	75
Air-TSP,RSP	25

unsanitary environmental condition in the community of use. HIV and air particulates score the lowest due to the difficulty in controlling them. There is neither adequate treatments nor immunization for HIV. Reduction of air particulate levels is complex and costly since it involves regulatory enforcement of the many contributing sources. Moreover, this difficulty is compounded by the presence of fugitive dust in the community.

F) Uncertainty

Uncertainty is the magnitude of doubt in either qualitative or quantitative terms (Chicken and Hayns, 1989). The degree of uncertainty about the conditions being assessed is essential for setting priorities for action. The more uncertainty the condition, the lower its priority since it is not prudent to take action on doubted conditions or with substantiation through questionable and/or one-dimensional measures. Ratings of uncertainty for the conditions at On-Nooch is presented in Table 5.7. Childhood respiratory illness and malnutrition conditions are rated as having low uncertainty since the conditions are substantiated as consistent with findings of the community's Primary Health Care-Mother and Child Health Center's

Table 5.7 Ratings for Conditions at On-Nooch Community by Uncertainty Factor

Criteria for uncertainty ratings

	Uncertainty			
Rating :	low	medium-low	medium-high	high
Score :	100	75	50	25

Condition	Score
Childhood respiratory illness	100
Malnutrition	100
Intestinal parasitic infection	100
Cuts & Injuries among scavengers	75
Poor lung function health	75
HIV seroprevalence	50
HBV seroprevalence	100
Water-Coliforms	50
Air-TSP,RSP	75

statistics. Intestinal parasitic infection and HBV seroprevalence also receive the highest scores. This is simply because methods used for intestinal parasitic infection and HBV seroprevalence measurements are reliable. Cuts and injuries among scavengers, poor lung function health, and air particulates score lower since some degree of uncertainty can be expected from the measure of these conditions. Cuts and injuries among scavengers were self-reported which results in the possibility of recall bias. A number of factors might affect the accuracy of lung function and air particulate results as well. Participants might have not performed their best for the lung function test due to shyness or awkwardness. Only a limited number of air particulate samples were collected for only a limited period. Lastly, HIV seroprevalence and water contamination by coliforms score the lowest. High uncertainty can be expected in the HIV seroprevalence condition due to the lack of necessary confirmatory tests for HIV. Water sample analyses for coliforms were done on a limited number and during a limited period. In addition, the coliform test is only a bacterial indicator used for water quality determination. There is a known uncertainty in the association between the presence of bacterial indicators like coliforms and pathogenic microorganisms in the water.

Weights for subindices

Each subindex is given a weight based on the comparative importance with other subindices used in the assessment of priorities. The weighting scale for the subindices ranges from 0 to 10. As shown in Table 5.8, uncertainty receives the most weight. The second most weight is cost-effectiveness followed by time delays, size of condition, seriousness of condition, and age distribution. Unless you have a high certainty about the existence of the condition, no action should be considered for that condition since wasted resources may result. Therefore, the factor of uncertainty out weighted the other subindicies. Cost-effectiveness should be considered next since there is no point in using limited resources for conditions too costly to control effectively. Time delays is the next important factor in the prioritization system since it determines the urgency of the condition. Once the of time factor is considered, size and seriousness, respectively, should receive next consideration. The least

Table 5.8 Priority Rating for Public Health Condition Improvement at On-Nooch Community by Index Score

Index Score = Weighted sum of six subindex scores

Weighting for each subindex :

(based on its relative importance for receiving action on a rating scale 0-10.)

Subindex	Weights
Seriousness of condition	2
Size of condition	4
Age distribution	1
Time delays	6
Cost-effectiveness	8
Uncertainty	10

Condition	Index Score	Priority Rating
Childhood respiratory illness	2684	High
Malnutrition	2684	High
Intestinal parasitic infection	2775	High
Cuts & Injuries among scavengers	2734	High
Poor lung function health	1600	Low
HIV seroprevalence	1466	Low
HBV seroprevalence	2566	Medium
Water-Coliforms	2100	Medium
Air-TSP,RSP	1650	Low

significant factor in the system is age-distribution as it seems to be less pressing than other factors.

Priority rating

After applying the weights to the corresponding subindicies, summation of weighted subindex scores are calculated to determine the index score for each condition. Priority of these conditions are then rated as high, medium or low according to their relative index scores. The index scores and their priority ratings for the conditions are presented in Table 5.8. The conditions with relatively high index scores, those rated as high priorities for action in this assessment process, are the intestinal parasitic infection, cuts and injuries among scavengers, childhood respiratory illness, and malnutrition. HBV seroprevalence and water contamination by coliforms are rated as medium priorities whereas air particulates, poor lung function health, and HIV seroprevalence are given a low priority rating.

5.3 Recommendations

Recommendations for improvements at the On-Nooch Community and at the open dump are presented below with recommendations for future research.

1) On-Nooch Community

The poor community health of the On-Nooch Community should be improved. Intervention programs to improve public health conditions at the On-Nooch Community are recommended.

Intestinal parasitic infection is a high priority for action according to the criteria utilized in this study. Diagnosis and treatment of infections along with a health promotion program should be arranged for the community. Personal hygiene such as not consuming raw or contaminated food, washing hands before eating, wearing shoes, using latrines, and so on should be emphasized. Residents need to improve their household and community sanitation. A community clean up program with participation by the residents should be implemented.

Diagnosis, treatment and control programs are needed for childhood respiratory illness, malnutrition, and HBV infections. Improvements in personal hygiene and community sanitation would also be beneficial to control these poor health conditions. Nutritional supplements in conjunction with nutritional health education should be implemented. Immunization for HBV infection is recommended.

An anti-smoking campaign among residents offers a basic means to improve lung function health.

HIV seroprevalence needs further tests for confirmation. Community members should be taught the risk factors and serious health conditions associated with HIV infection.

Improvements to environmental conditions at the On-Nooch Community are also needed. Monitoring programs for air particulates and water contamination on a routine basis should be implemented to constantly assess the situation. Levels of air particulates (TSP and RSP) should be lowered to meet the ambient air quality standards. The main recommendation for air particulate control is source reduction such as particulate emission control from the incinerators, removal of smoldering waste combustion at the dump, prohibition of metal reclaiming by burning off insulator coatings in the community, and development of paved lots and walkways for the community.

The quality of the water supply needs to be improved to meet the standards. Coliform bacteria indicators should be absent from the drinking water supply. Piped water from the

City water supply should be provided with an optimum chlorine residual to maintain the quality of water. Furthermore, the practice of storing water in storage containers should be improved to meet basic sanitation standards since water storage contaminations are frequently induced. Storage containers should be cleaned before each use. Containers with covers and pour spouts are recommended. Interventions for residential and environmental sanitation improvement are needed.

2) Open Dump

Toxic and hazardous waste from industries, infectious waste from hospitals and medical clinics, and research laboratory wastes should be separated from the waste stream and disposed of separately from the open dump. Alternatively, contaminated medical wastes could be sterilized before disposal. Consumer products containing toxic substances should be separated from regular waste and disposed of appropriately. The Department of Public Cleansing is developing regulations for the separation and disposal of hospital and medical clinic wastes from other open-dump wastes. Future plans call for separate incinerator facilities for the treatment and disposal of infectious wastes.

Scavengers working on the dump are very much in need of low cost hand, foot, and respiratory protective gear. The use of gloves and boots to prevent cuts and injuries while working is encouraged. Scavengers should also be educated to avoid picking materials from or contacting contaminated, toxic, or infectious wastes. Washing facilities at the dump site are also needed.

Adequate first aid measures and an immunization program for tetanus, tuberculosis, and hepatitis vaccines would be most beneficial for solid waste scavengers.

Improvements of food sanitation for food stalls and food vendors on the dump are also recommended.

3) Future Research

Further study of air particulate composition and levels including research on the possible relationship of air particulates with respiratory health is warranted. Viable particles also warrant investigation in the On-Nooch Community and on the dump where high levels of microbial air contaminants are likely to be present due to the unsanitary environment and conditions.

The conditions of the solid waste scavenger community at the On-Nooch Dump Site are not freak. Similar conditions can be expected to be present in other parts of Bangkok or other large cities as well as in other parts of the world. The above recommendations may be applicable and useful to other solid waste scavenger communities.

APPENDIX I

QUESTIONNAIRES

QUESTIONNAIRE FOR SCAVENGER INFORMATION

1. ID # ____________

2. Name ____________________________________

3. Sex:
   [ ] MALE [ ] FEMALE

4. Age: ____________ YEARS

5. Education ______________________________

6. Please notice how the interviewee dresses:

   6.1 Hat [ ] WITH [ ] WITHOUT

   6.2 Protective covering for nose/mouth [ ] WITH [ ] WITHOUT

   6.3 Shirt sleeves [ ] LONG [ ] SHORT

   6.4 Gloves [ ] WITH [ ] WITHOUT

   6.5 Slack
   [ ] UNTUCKED LONG PANTS
   [ ] TUCKED LONG PANTS
   [ ] SHORTS

   6.6 Shoes
   [ ] WITH SOCKS
   [ ] WITHOUT SOCKS
   [ ] BOOTS
   [ ] SLIPPERS

7. You work at the garbage pile for ____________ HR/DAY

8. What time do you work at the garbage pile ?
   FROM __________ TO ______________

9. You have been working at the garbage pile for ____ YRS.

10. Do you work every day?
   [ ] YES
   [ ] NO, NOT ON _______________________ (LIST DAYS)

11. Do you work all year round?
[ ] YES
[ ] NO, NOT IN ____________________ (LIST MONTHS)

12. A. If it is raining, do you keep on working?
[ ] YES
[ ] NO

13. Have you had any accidents or injuries working at the pile?

[ ] INJURED FROM NEEDLES AND SYRINGES.
[ ] INJURED FROM BROKEN GLASS.
[ ] OTHER INJURIES :
INJURED FROM ____________________
INJURED FROM ____________________

14. Do you usually have any of the following symptoms?
[ ] HEADACHE
[ ] DIARRHEA
[ ] RESPIRATORY SYMPTOMS
[ ] SKIN DISEASES
[ ] OTHER SYMPTOMS SPECIFY ____________________
[ ] NEVER

15. Do you take appine tab?
[ ] YES,
HOW MANY TIMES A DAY? ____________________
HOW MANY TABLETS EACH TIME? ____________________
[ ] NO

Where do you take them?
[ ] AT THE GARBAGE SITE
[ ] AT HOME
[ ] BOTH PLACES

16. How often do you bath?
[ ] ONCE EVERY 2-3 DAYS
[ ] EVERY OTHER DAY
[ ] EVERYDAY AND ________ TIMES/DAY

17. Where do you bath?
[ ] AT HOME
[ ] AT THE GARBAGE SITE
[ ] OTHER LOCATIONS

18. Your income per day ____________ BAHT
(Your income per month ____________ BAHT)

19. Is collecting refuse your only occupation ?
[ ] YES
[ ] NO, WHAT OTHER JOB DO YOU HAVE? ______________

QUESTIONNAIRE FOR CHILDHOOD RESPIRATORY ILLNESS

(For households which have children 0-5 years old)

Category 1. Basic Information

Household ID #____________________

Address #_______________ (Flat #____ Floor # _____)

# of families which have children ages 0-5 in this household _______________

(Use separate questionnaire per family which have children of age)

1. Interviewee's name__________________Sex _____________

Age______________

Education__________

2. Interviewee's relation to the child (ren)

[ ] Father [ ] Relative Specify _______

[ ] Mother [ ] Guardian

3. Father of the child (ren)'s occupation___________________

income_______________baht/mo.

education____________________

4. Mother of the child (ren)'s occupation___________________

income_______________baht/mo.

education___________________

5. # of all members in the household________________

6. # of school-aged children who are over 5 to 12 yr old in the household____________

Category 2. Child Information

7. # of newborn babies till 5 yr old children of this family_____

* Following is the detail information specifically to the child (0-5).

(Attach more of category 2. for additional child (ren))

8. The child's name_________________________

9. Age______________________________________

10. Birth-Date______________________________

11. Sex_____________________________________

12. Birth-Weight [ ] 2,500 g or more

[ ] less than 2,500 g

13. Breastfed [ ] Yes for________months

[ ] No

14. The child stays home all day long

[ ] Yes

[ ] No Then, where_________for____hr/d

15. Measured Weight_____________________Kg

16. Measured Height_____________________cm

17. The child has lived in this house since newborn

[ ] Yes

[ ] No, has lived here for only_______ months.

18. Does the child usually have a cough with colds

[ ] Yes

[ ] No

19. Does the child usually have a cough apart from colds?

[ ] Yes

[ ] No

20. Does the child cough on most days (4 or more days/wk) for as much as 3 months of the year?

[ ] Yes

[ ] No

21. Does the child usually bring up phlegm, sputum, or mucus with colds?

[ ] Yes

[ ] No

22. Does the child usually bring up phlegm, sputum, or mucus apart from colds?

[ ] Yes

[ ] No

23. Does the child bring up phlegm, sputum, or mucus on most days (4 or more days/wk) for as much as 3 months a year?

[ ] Yes

[ ] No

24. Has the child ever had attacks of shortness of breath with wheezing?

[ ] Yes

[ ] No

25. Has the child ever had attacks of shortness of breath when walking up level ground or playing/exercising hard?

[ ] Yes

[ ] No

26. How often has the child been troubled by respiratory illness?

[ ] Less than once/mo.

[ ] Once to twice/mo.

[ ] Three times or more/mo.

27. During which month is the child usually troubled by respiratory illness________________

28. Was the child ever hospitalized for a severe chest illness before the age of 2 years?

[ ] Yes

[ ] No

29. Has the child ever had asthma or allergies diagnosed by a doctor?

[ ] Yes

[ ] No

30. Has the child ever had bronchitis or pneumonia diagnosed by a doctor?

[ ] Yes

[ ] No

31. Has the child ever had whooping cough diagnosed by a doctor?

[ ] Yes

[ ] No

32. Has the child ever had sinusitis diagnosed by a doctor?

[ ] Yes

[ ] No

33. Does the child's family have the following conditions:?

	Father	Mother	Other	Specify...
Chronic cough	______	______	_____	
Chronic phlegm	______	______	_____	
Bronchitis	______	______	_____	
Asthma or Allergies	______	______	_____	
Tuberculosis	______	______	_____	
Other specify ...	______	______	_____	

Category 3. Environmental Information

34. Smoking habit while being in the house

Father of the child [ ] No [ ] Yes How many/day__

Mother of the child [ ] No [ ] Yes How many/day__

Other members of the household [ ] No

[ ] Yes How many/day__

35. Type of fuels used for cooking

[ ] Gas How many_________meal/day, for_________hr/meal

[ ] Charcoal How many_________meal/day, for_____hr/meal

[ ] Fire wood How many_______meal/day, for_____hr/meal

[ ] Electricity How many______meal/day, for_____hr/meal

[ ] Other specify......How many______meal/day, for____ hr/meal

[ ] None

36. Pet in the household

[ ] No

[ ] Yes Specify...........How many..........

QUESTIONNAIRE FOR LUNG FUNCTION TEST

The following information is requested from participant who perform the lung function test.

1. ID # ____________________

2. Name ____________________

3. Address ____________________

4. Age ________________

5. Sex [ ] Male

   [ ] Female

6. Measured Height ______________ cm.

7. Occupation ____________________

8. Self-Smoker

   [ ] YES, CURRENT smoker with ______ cigarettes smoked/day

   [ ] YES, PAST smoker with _______ cigarettes smoked/day

   [ ] NO

9. Smoking in the household by household members

   [ ] YES, TOTAL # of cigarettes smoked/day in the household ____________

   [ ] NO

10. Length of residency in the community ___________ years

QUESTIONNAIRE FOR THE HIV AND HBV SEROLOGIC TEST

The following information is requested from participant whose blood is drawn for HIV and HBV test.

1. Name ____________________ ID # ____________

2. Birthplace ____________________

3. Have been living in Bangkok for __________ years

4. Age ___________ years

5. Sex [ ] Male

   [ ] Female

6. Marital Status [ ] Single [ ] Widow/Widower

   [ ] Married [ ] Separated

   [ ] Divorced

7. Education ________________

8. Occupation [ ] Waste retrieving based job for ________ years.

   [ ] Other, specify ______________

9. Average income/month

   [ ] 1000-2000 baht

   [ ] 2000-3000 baht

   [ ] 3000-4000 baht

   [ ] Over 4000 baht

10. In the past 6 months, have you ever slept with a prostitute(s)?

[ ] No

[ ] Yes and using condom <u>everytime</u>

[ ] Yes and using condom <u>sometimes</u>

[ ] Yes but <u>never</u> use condom

11. In the past 6 months, have you ever become infected with a sexually-transmitted disease?

[ ] Yes, specify __________ (if know)

[ ] No

12. In the past 6 months, have you ever shared a hypodermic needle with another person?

[ ] Yes [ ] No

13. In the past 6 months, have you ever been pricked by a needle?

[ ] Yes [ ] No

14. In the past 6 months, have you ever received a blood transfusion from the hospital?

[ ] Yes [ ] No

15. In the past 6 months, have you ever injected a drug, other than a prescribed drug, into your veins?

[ ] Yes [ ] No

16. In the past, have you ever been jaundiced?

[ ] Yes [ ] No

17. In the past, have you ever slept with gays or homosexuals?

[ ] Yes [ ] No

APPENDIX II

ILLUSTRATIONS

Description for Illustrations

Illustration 1-22 : On-Nooch Dump Site, Scavengers and Their (On-Nooch) Community

23-26: Measurements

27 : Din-Dang Community

1. The planked runway up to the tipping area of the open dump. Scavenger shelters and stalls are present.

2,3. Municipal garbage truck going up to the tipping spot and wastes being unloaded there. Waste is scavenged immediately upon unloading.

4,5. Scavenger with his tool & collecting baskets. The tools have two teeth hooks.

6. Scavengers at the mountain of garbage. A bulldozer is compacting the wastes.

7. Young scavenger.

8. Cows present on the dump. The structure behind is the incineration facility.

9. Hypodermic needle wastes are frequently found due to the disposal of hospital and medical clinic wastes at the dump.

10. The collection depot of this man. He retrieved bottles, plastics, metals, electrical wire, and other recyclable materials.

11. Shelters for shade, rest, and storing belongs are present on the dump.

12,13. Food vendor and food stall on the dump.

14. Reclaiming wire by burning off the coating.

15. Scavenger with head lamp (attached to the hat) and small battery (tied to his waist) for working at night.

16. Smoldering combustion of wastes in the dump.

In the Community :

17. Retrieved plastics are being washed and then hang to dry after being split into sheets. It is common to use stagnant water and small ponds around the community to clean this plastic.

18. Children have already learnt how to reclaim metal from electrical cords. In the picture, they are cleaning off the residual coating after burning it from the wire.

19. Multiple hoses have been connected by households with water service to provide water to whose who do not have piped water. Storing water in big jars is a common practice.

20. Purchasing water by container and then haul it back home is common.

21. Rain water is collected. Various containers are used for storing water.

22. Unhygienic conditions and poor sanitation are present.

Measurements:

23. Questionnaire interviewing on the dump.

24. Collecting an air sample using a sampling bag.

25. A NO_2 filter badge is attached to the child's shirt for personal air sampling.

26. Lung function test using a spirometer.

27. Din-Dang Community: The project apartment complexes situated on a main street in the inner-city.

ON-NOOCH DUMP SITE, SCAVENGERS, AND THEIR COMMUNITY

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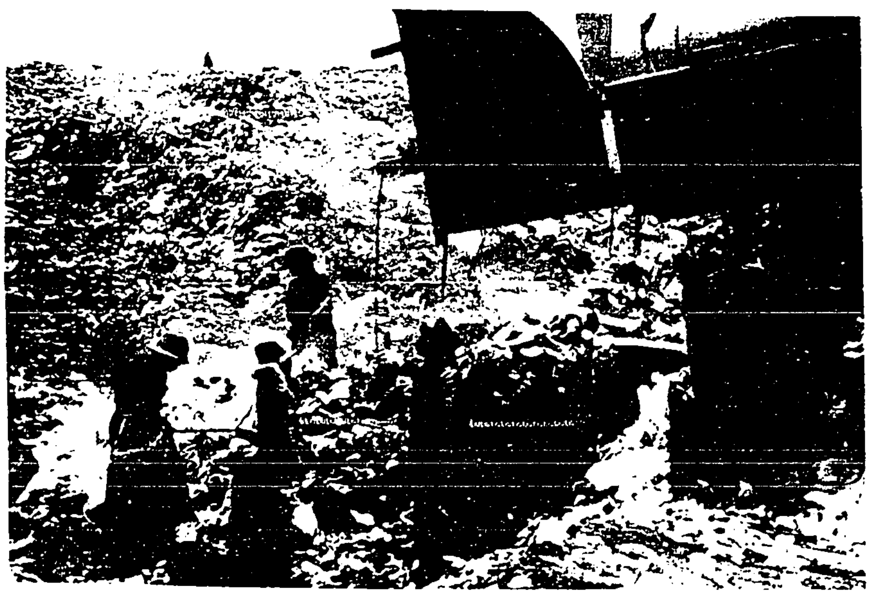

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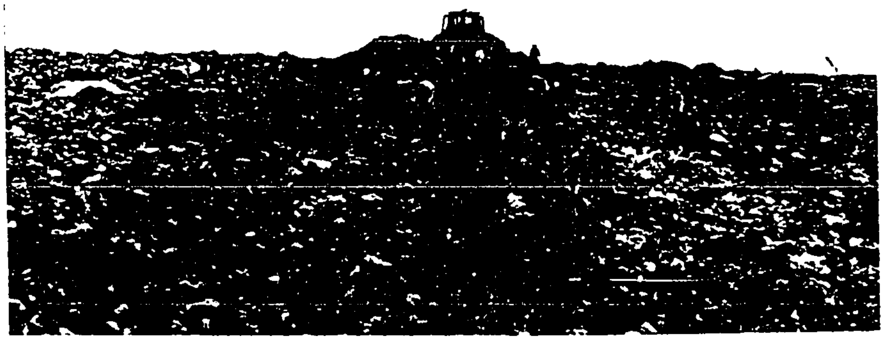

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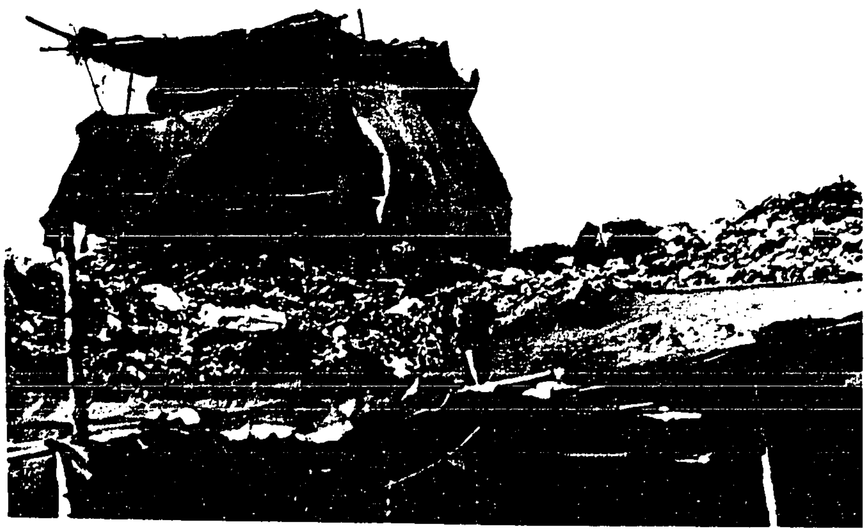

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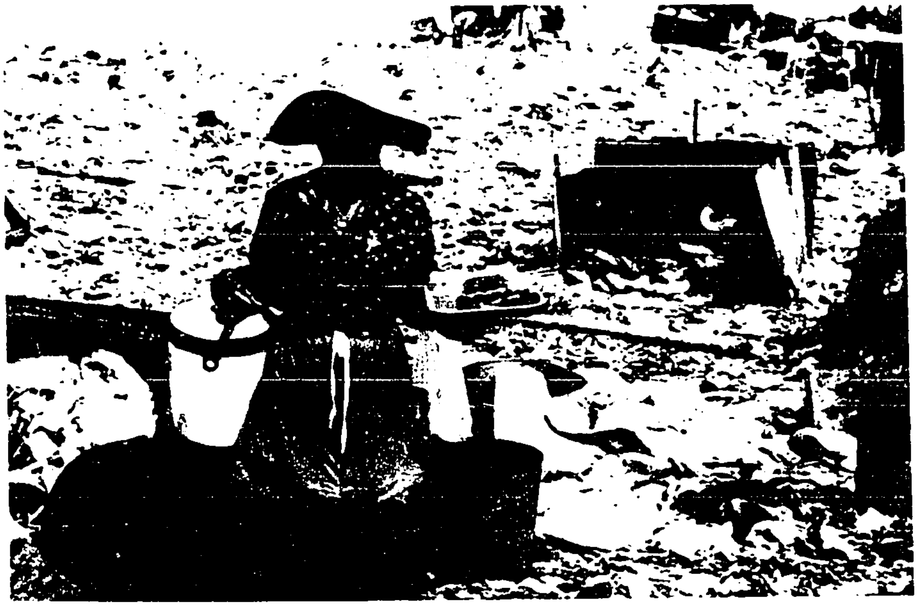

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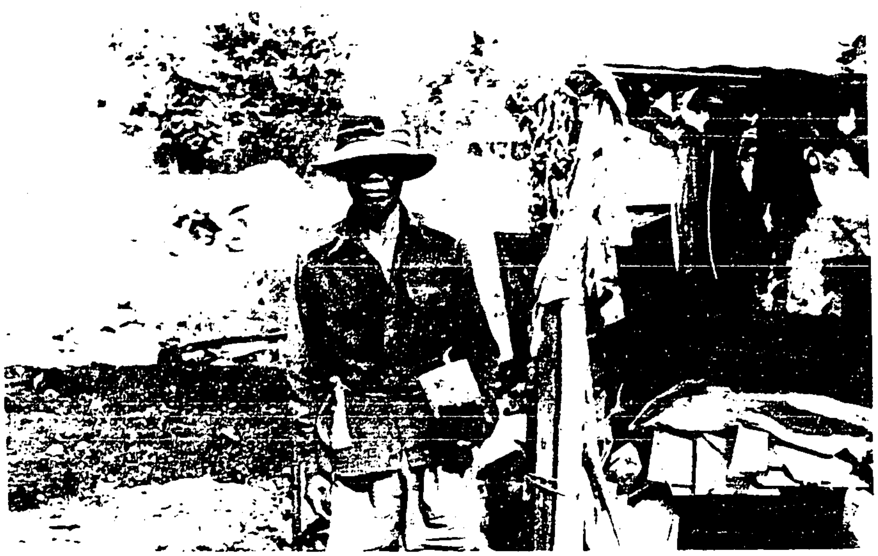

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In the Community :

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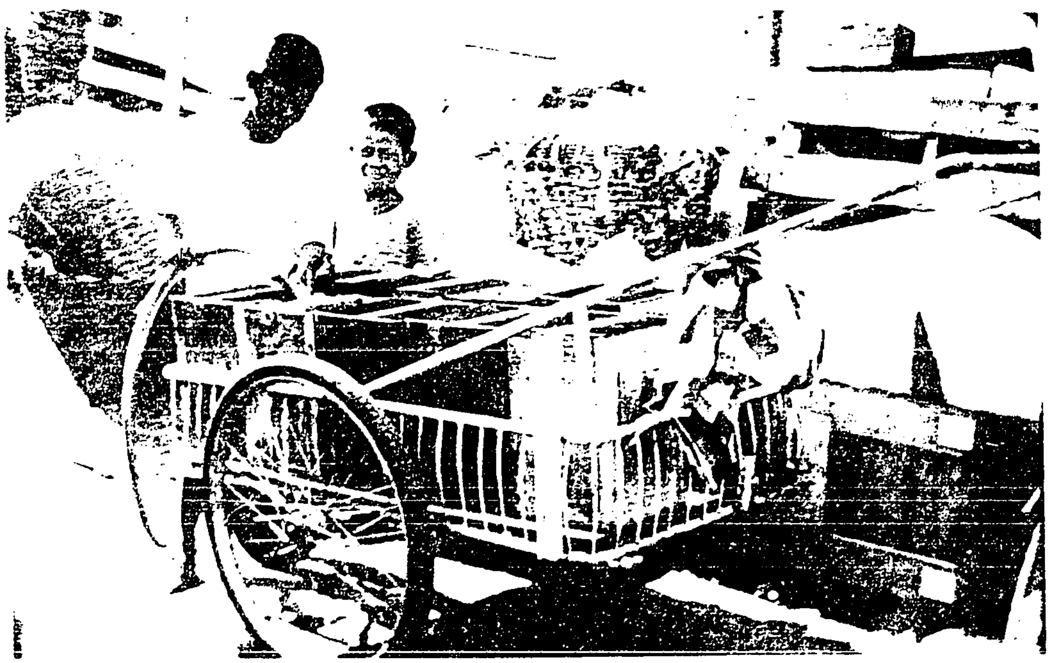

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21

22

MEASUREMENTS :

23

24

25

26

DIN-DANG COMMUNITY

27

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