

145

Kwasi Owusu Boadi

Environment and Health in the
Accra Metropolitan Area, Ghana



UNIVERSITY OF JYVÄSKYLÄ

JYVÄSKYLÄ 2004

Kwasi Owusu Boadi

Environment and Health in the
Accra Metropolitan Area, Ghana

Esitetään Jyväskylän yliopiston matemaattis-luonnontieteellisen tiedekunnan suostumuksella
julkisesti tarkastettavaksi yliopiston Ambiotica-rakennuksen salissa (YAA303)
marraskuun 27. päivänä 2004 kello 12.

Academic dissertation to be publicly discussed, by permission of
the Faculty of Mathematics and Science of the University of Jyväskylä,
in the Building Ambiotica, Auditorium YAA303, on November 27th, 2004 at 12 o'clock noon.



UNIVERSITY OF JYVÄSKYLÄ

JYVÄSKYLÄ 2004

Environment and Health in the Accra Metropolitan Area, Ghana

JYVÄSKYLÄ STUDIES IN BIOLOGICAL AND ENVIRONMENTAL SCIENCE 145

Kwasi Owusu Boadi

Environment and Health in the
Accra Metropolitan Area, Ghana



UNIVERSITY OF JYVÄSKYLÄ

JYVÄSKYLÄ 2004

Editors

Jukka Särkkä

Department of Biological and Environmental Science, University of Jyväskylä

Pekka Olsbo, Marja-Leena Tynkkynen

Publishing Unit, University Library of Jyväskylä

URN:ISBN 9513919935

ISBN 951-39-1993-5 (PDF)

ISBN 951-39-1972-2

ISSN 1456-9701

Copyright © 2004, by University of Jyväskylä

Jyväskylä University Printing House, Jyväskylä 2004

ABSTRACT

Boadi, Kwasi Owusu

Environment and Health in the Accra Metropolitan Area, Ghana

Jyväskylä: University of Jyväskylä, 2004, 33 p.

(Jyväskylä Studies in Biological and Environmental Science

ISSN 1456-9701; 145)

ISBN 951-39-1972-2

Yhteenveto: Accran (Ghana) suurkaupunkialueen ympäristö ja terveys

Diss.

The study examines household environmental problems in Accra, and the impacts on the health of identifiable different social classes. As a result of rapid increase in the population of Accra, and inadequate provision of facilities, the majority of the city's residents live under deplorable environmental conditions which are detrimental to health. Only 39.8 percent of respondents have indoor private pipe and 30.1 percent depend on vended water to meet their needs. About 35.0 percent of the respondents depend on unsanitary public latrines while 2.5 do not have access to toilets. Access to environmental health facilities is skewed in favour of the few privileged affluent, leaving the poor to bear the brunt of environmental hazards. Whereas 71.1 percent of medium wealth and 94.8 percent of high wealth households have private indoor pipe, only 28.8 percent of poor households have indoor pipe. Due to inadequate access to safe water and high dependence on vended water, the urban poor bear a disproportionately high share of the burden of water borne diseases, particularly childhood diarrhoea. Access to sanitary facilities is wealth dependent. Only 24.1 percent of poor households use flush toilets compared with over 80 percent of wealthy households. About 44.6 percent of poor households use the public latrine whilst 3.2 percent do not have access to toilets. High sharing of sanitation facilities among the poor creates unsanitary conditions at facilities and this facilitates the breeding of pests and disease vectors, thereby exposing the poor to infectious diseases. Poor environmental sanitation, particularly in poor neighbourhoods, results in high incidence of infectious diseases among children. The majority of households depend on solid fuels for cooking in poorly vented kitchens and this leads to indoor air pollution and high incidence of respiratory infections, particularly among the poor. Poverty, inadequate provision of facilities, lack of environmental health awareness and the neglect of the needs of the poor in decision making are the major obstacles to achieving sound environmental health in Accra. Measures to improve environmental health must include improved water supply, sanitation, waste management, proper ventilation, preventive health care services in deprived neighbourhoods and environmental health awareness programmes.

Key words: Accra Metropolitan Area; environmental health; diarrhoea; Ghana; infectious diseases; respiratory health; water and sanitation; wealth.

Author Kwasi Owusu Boadi
University of Jyväskylä
Department of Biological and Environmental Science
P. O. Box 35
FI-40014 University of Jyväskylä, Finland
Email: kwaboad@yahoo.com

Supervisor Professor Markku Kuitunen
University of Jyväskylä
Department of Biological and Environmental Science
P. O. Box 35
FI-40014 University of Jyväskylä, Finland
Email: mkuitune@cc.jyu.fi

Reviewers Professor Alan Gilbert
Department of Geography
University College London
26 Bedford Way, London WC1H 0AP
United Kingdom

Dr Carolyn Stephens
London School of Hygiene & Tropical Medicine
Keppel Street
London WC1E 7HT
United Kingdom

Opponent Dr Timo Vuorisalo
Department of Ecology
University of Turku
FI-20014 Turku, Finland

CONTENTS

ABSTRACT

LIST OF ORIGINAL PUBLICATIONS

1	INTRODUCTION.....	7
2	AIM AND OBJECTIVES.....	10
3	MATERIALS AND METHODS.....	11
4	LIMITATIONS OF THE STUDY	14
5	RESULTS AND DISCUSSION	15
	5.1 Domestic water supply	15
	5.2 Domestic sanitation facilities	16
	5.3 Sullage disposal	18
	5.4 Solid waste handling and disposal	19
	5.5 Pest infestation	21
	5.6 Air pollution and respiratory health.....	23
6	CONCLUSION.....	26
	<i>Acknowledgements</i>	28
	YHTEENVETO (Résumé in Finnish)	29
	REFERENCES.....	31

LIST OF ORIGINAL PUBLICATIONS

- I Boadi, K. O. & Kuitunen, M. 2004. Water Supply and Sanitation in Third World cities: the case of the Accra Metropolitan Area, Ghana. *International Journal of Hygiene and Environmental Health* (submitted).
- II Boadi, K. O. & Kuitunen, M. 2003. Municipal Solid Waste Management in the Accra Metropolitan Area, Ghana. *The Environmentalist* 23: 211–218.
- III Boadi, K. O. & Kuitunen, M. 2002. Urban Waste Pollution in the Korle Lagoon, Accra, Ghana. *The Environmentalist* 22: 301–309.
- IV Boadi, K. O. & Kuitunen, M. 2004. Environmental and Health Impacts of Household Solid Waste Handling and Disposal Practices in Third World cities: the case of the Accra Metropolitan Area, Ghana. *Journal of Environmental Health* (submitted).
- V Boadi, K. O. & Kuitunen, M. 2004. Childhood Diarrheal Morbidity in the Accra Metropolitan Area, Ghana: Socio-economic, Environmental and Behavioural Risk Determinants. *Journal of Health and Population in Developing Countries* (in press).
- VI Boadi, K. O. & Kuitunen, M. 2004. Factors affecting the Choice of Cooking fuel, Cooking Place and Respiratory Health in the Accra Metropolitan Area, Ghana. *Journal of Biosocial Science* (submitted). Boadi,
- VII K. O. & Kuitunen, M. 2004. Environment, Wealth, Inequality and the Burden of Disease in the Accra Metropolitan Area, Ghana. *International Journal of Environmental Health Research* (submitted).

1 INTRODUCTION

Accra the capital of Ghana, like many African cities is urbanising rapidly. Urban population growth rates over the past four decades have ranged between 4.2 and 5.6 percent (World Bank 2002; Ministry of Local Government 1992). The population of Accra increased from 450,000 in 1960 to 1.3 million in the 1984 census (Ghana Government 1984). In 1990, Accra had an estimated population of 1.6 million, and it is currently estimated that the population stands at 2.2 million (Leitman 1993; World Bank 2002). In 1960, Accra had a mean population density of 36 persons per hectare, which increased to 50.8 per person per hectare in 1970 and 69.3 per hectare in 1984 (Stephens et al. 1994). Some low income areas of the city have population densities of more than 370 per hectare (Stephens et al. 1994). Accra contributes an estimated 15–20 percent of Ghana's GDP, 56 percent of national employment in finance, insurance and real estate, 31 percent of employment in construction, 30 percent of employment in transport and communication, 22 percent in sale/retail trades and 18 percent of employment in manufacturing (Ministry of Local Government 1992). Accra's primacy as the administrative, educational, industrial and commercial centre attracts people from all over Ghana and thus, migration accounts for 35 percent of the population increase (Domfeh 1999; Ghana Government 1984). The population of the metropolis is expected to reach 4 million by the year 2010 (Melissa 2000).

The rapid urbanisation in Accra has outstripped inadequate housing and environmental health infrastructure. According to Colan Consult (1998), 80 percent of the population of Accra live in high density unplanned settlements. In 1992, low income areas of the city had between four and seven households living together in each house and nearly 46.3 percent of households lived in only one room each (Stephens et al. 1994; Taylor et al. 2002). A study by Songsore and McGranahan (1993), revealed that 71 percent of the poorest and 34 percent of the wealthiest households in Accra occupied less than 4m² per person in the sleeping room. About 46 percent of Accra's residents live in two most deprived zones which accommodate people with the lowest educational standards, the lowest incomes and the poorest facilities in terms of water,

sanitation and housing (Stephens et al. 1997). Only an estimated 46 percent of the city's residents had access to potable water in 1998 (World Resources Institute et al. 1998). Stephens et al. (1994) reported that the mean water consumption in the high density low-class areas of Accra was less than 60 litres per day. Maxwell et al. (2000), also found that 54 percent of the families of young children in Accra depended on wells and vendors for their water needs, whilst only 7 percent had water piped in their homes. These findings make government estimate that 100 percent of Accra's residents have access to pipe water much more misleading. More than 60 percent of the residents do not have access to solid waste disposal facilities (World Resources Institute et al. 1998). Solid waste collection services cover less than 20 percent of residents and much garbage is dumped in open heaps, which lie uncollected for periods, or in drainage channels which become blocked, with attendant environmental and human health consequences. According to the Economic Commission for Africa (1996), only 30 percent of the population in Accra are connected to the central sewage system. Most urban households depend on public latrines where long queues and unhygienic conditions are particularly problematic for slum dwellers. According to the Ghana Living Standards Survey (GLSS), in 1998–99, about 78 percent of urban families including those in Accra had access to a toilet or latrine (Ghana Statistical Service 2000). However this finding had more to do with the GLSS's definition of 'access' as living within a certain distance of a public latrine or toilet than it did with actual use (Taylor et al. 2002). The majority of the city's residents discharge wastewater in open gutters and empty yards which create breeding grounds for disease pathogens. High dependence on solid fuels and rampant burning of solid waste expose households to air pollution and respiratory infections. Stephens et al. (1994) found that respiratory infections accounted for 12 percent of the most commonly reported causes of death in Accra. A study in 1993 found that out of 16 significant diseases in Accra, 13 are linked to poor housing and ventilation, unsanitary environment, contaminated drinking water, poor drainage and lack of facilities for waste disposal (World Bank 2002).

Inadequate access to water, sanitation and hygiene facilities is closely related to poverty since the urban poor and less educated are the most likely to lack access to basic environmental health facilities and services (Taylor et al. 2002). Only 6 percent of the poorest wealth quintile had indoor piping compared with 78 percent of the wealthiest (Songsore & McGranahan 1993). More than 16 percent of slum residents do not have access to sanitary toilets or latrines (Maxwell et al. 1994). Poor environmental sanitation and inadequate access to facilities, particularly in the low income areas, where the bulk of the labour force lives, has serious health impacts on residents. It is estimated that about 67 percent of deaths in adult resident population in the worst three residential areas of Accra might have been avoided had they lived in the best neighbourhoods (United Nations Centre for Human Settlements 2001). A study by Stephens (1996) on mortality differentials by age for infectious, respiratory and circulatory diseases in Accra revealed that people living in very deplorable socio-economic and environmental conditions were at a higher risk of death for

the cause and age groups. Intra-urban differentials in access to environmental health facilities have created wide differential gaps in morbidity and mortality among the different social classes in the city. Due to their inability to secure the facilities and services which support a healthy living environment, the poor are more susceptible to a range of environment related diseases (McGranahan et al. 1999).

2 AIM AND OBJECTIVES

The aim of the study is to examine environmental problems and health in Accra and draw out the linkages between the two.

The objectives of the research include:

1. to describe the range of interconnected household environmental problems in Accra
2. to compare the severity of these problems in different socio-economic groups
3. to profile wealth, access to environmental facilities and services, sanitation and health across the populations in Accra and thus highlight the disparities among the different social classes
4. to explore the importance of environmental risk factors in determining health and the spread of diseases
5. to draw out the policy implications of the findings.

3 MATERIALS AND METHODS

The study involved a survey of 960 households in Accra. The survey was undertaken between June and August 2003. Interviews were conducted in two local dialects Ga and Twi. The simple random method was employed in the population sampling. This method ensures that each member of the population is chosen completely at random in the study area, with no subjective or bias on the part of the field personnel. Residential communities were randomly selected in a lottery. In each selected community, households were selected randomly for interview. A household was defined as individuals who occupy the same living space and normally share food and amenities. The target population was female household heads since women are responsible for the upkeep and general household environmental management. All respondents above 20 years were included in the study. A detailed structured questionnaire was used to collect information on the household socio-demographic characteristics, access to environmental health facilities and services, pest infestation, and household cooking fuel. Information was also collected on household health, specifically the incidence of acute respiratory infections, and childhood diarrhoea. Data on health is based on a two week recall self reporting of ill health by respondents. Since the interviewees were only women, the interviewers were trained female students selected from the University of Ghana, Legon, in order to enhance cooperation and willingness to provide information. All the data collectors had at least one experience in conducting interview surveys. For the purpose of this study a two day, theoretical as well as practical training was conducted for the data collectors. Households were divided into wealth groups using a weighted criteria based on the ownership of consumer durable commodities and place of dwelling (Table 1). Due to difficulties in assessing income especially in a low income city where the majority of residents are employed in the informal sector and the tendency for respondents to under report their income due to mistrust, proxy indicators of income were used. The ownership of consumer durables is a better indicator of wealth than the inaccurate estimates of income and expenditure which often underestimate the true cost of living (Benneh et al. 1993; Satterthwaite 1997). Place of dwelling was classified as luxury home, moderate apartment and slum. Based on field observation of household

apartments in Accra, a slum apartment was defined as substandard shack or a compound dwelling place occupied by more than two households, moderate apartments are small bungalows, and luxury apartments are large modern western styled homes usually occupied by single households. Based on this criteria 743 (77.4 %) households were classified as poor, 159 (16.6 %) as medium wealth and 58 (6.0 %) as high wealth. Wealthy households are more educated (84.5 percent of high wealth and 62.3 percent of medium wealth respondents have secondary or higher education), and own various consumer durable goods such as refrigerators, colour televisions, video players, and live in luxury or moderate apartments. On the other hand, the poor are less educated (only 25.6 percent have had secondary or higher education) and own very few items and often occupy slum apartments. About 402 of the children covered in the study are from poor homes, 61 from medium wealth and 26 from high wealth homes. Much of the analysis on environmental impacts on health is confined to children under the age of six. Children are seen as the future of a nation, and hence the health of children can be used as an indicator of a country's socio-economic development. Data on childhood morbidity can be used to assess the impacts of child health and survival programmes, identify child populations at risk and devise appropriate intervention measures. Questionnaires were checked for completeness and accuracy by the principal investigator before entry. Data was entered in excel spreadsheet and imported to SPSS 11.0 for windows. The Kruskal-Wallis test and the Spearman's rank correlation were used to measure the association between dependent and independent variables. Multivariate analyses of variance were also performed to evaluate the significance of associations obtained in the univariate test between variables and the incidence of respiratory health infections and childhood diarrhoea. Probability values less than 0.05 were considered statistically significant. The association between different environmental factors and the incidence of diseases has been quantified to reflect their 95% confidence intervals (CI) in the univariate and multivariate analyses.

TABLE 1 The construction of household wealth index.

Consumer appliance	weighted score
Iron	1
Fan	2
Radio	4
Black and white TV	4
Microwave	10
Colour TV	15
Video machine	17
Refrigerator	20
Dwelling place	
Luxury home	60
Moderate apartment	35
Slum apartment	25
Wealth index	weighted score
Poor wealth	<57
Medium wealth	57 – 102
High wealth	>102

4 LIMITATIONS OF THE STUDY

The incidence of diseases is not based on actual data from observations of exposure to hazards, but rather on a two week recall self reporting of ill health by respondents. There is therefore the likelihood of bias reporting in the event of expectation of government support to alleviate the plight people face. Even though the interviewers were made to explain the purpose of the study to respondents as an academic research and not a background study to government initiated project, this does not completely eliminate the tendency of bias in self reporting of events. The data was collected during the rainy season and it is therefore possible for seasonal variations in weather to influence the incidence of diseases. However, despite these shortfalls, the study presents ample analysis of the current environmental problems facing households in Accra.

5 RESULTS AND DISCUSSION

5.1 Domestic water supply

The majority of households do not have access to potable water. Only 39.8 percent of respondents have indoor pipe system whilst 30.1 percent of the population depend on vended water. There are wide differential gaps between the wealthy and the poor regarding access to safe sources of water ($\chi^2 = 169.98$, 2df, $p < 0.0001$). Whereas 71.1 percent of medium wealth and 94.8 of high wealth households have private indoor pipe, only 28.8 percent of poor households have indoor pipe. About 37.3 percent of poor households depend on less reliable and unhygienic vended water. A total of 17 (2.3%) of poor households do not have access to safe water supplies. The importance of adequate water quantity and quality in protecting human health has been recognised for many years (Cairncross 1990; Howard & Bartram 2003). Apart from consumption needs, water is required to maintain personal hygiene through hand washing, bathing, and laundry (Howard & Bartram 2003). The impact of adequate water availability may also be beneficial to child health since the quantity of water used for children's hygiene depends on its availability (Prost & Nigel 1989). It was found that 19.2 percent ($n = 94$) of the children covered in the study have had diarrhoea in the preceding two weeks of the study. Lack of access to good drinking water was found to be associated with high incidence of diarrhoea among children under the age of six ($r = -0.34$, $p < 0.0001$) (Fig. 1). About 37.5 percent ($n = 3$) of children living in homes without access to potable water and 33.1 percent ($n = 51$) of children who drink vended water have had diarrhoea in the preceding two weeks of the study. In the multivariate test, source of drinking water maintained its significant association with the incidence of diarrhoea ($p = 0.002$, 95% CI). Since poor households are least able to afford in-house piping they are the most affected by water borne diseases. About 86.2 percent ($n = 81$) of childhood diarrhoeal cases are from poor households, 10.6 percent ($n = 10$) from medium wealth households and only 3.2 percent ($n = 3$) from high wealth households. Households without adequate access to water are more likely to report of the presence of flies always in the kitchen ($\chi^2 = 73.32$,

3df, $p < 0.0001$). The presence of flies always in the kitchen during food preparation is high among households who buy water (43.3%, $n = 289$), than private indoor pipe (25.7%, $n = 382$), and standpipe 26.8%, $n = 272$). Flies infestation in the kitchen is related to the incidence of childhood diarrhoea ($r = 0.36$, $p < 0.0001$). About 85.7 percent ($n = 24$) of dysentery cases are associated with the presence of flies always in the kitchen during food preparation. Flies infestation in the kitchen maintained its significant association with the incidence of diarrhea in the multivariate analyses ($p = 0.002$, 95% CI). Children from poor households are the worst affected by diarrhoea related to the presence of flies always in the cooking area than their wealthy counterparts ($p < 0.0001$, 95% CI).

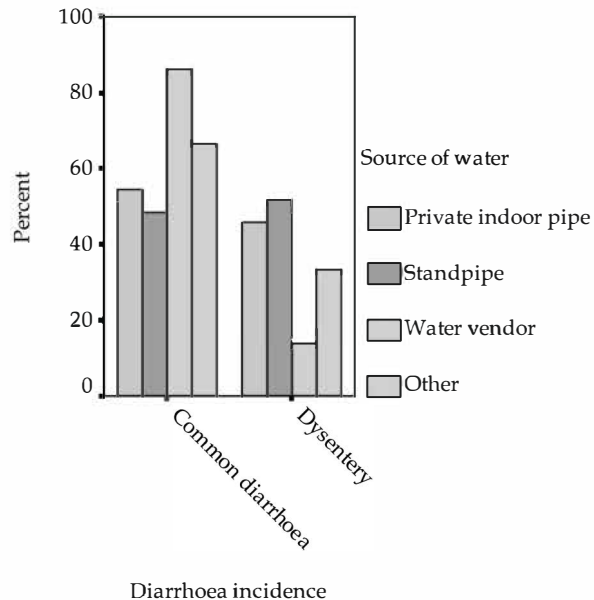


FIGURE 1 The distribution of childhood diarrhoea according to source of drinking water.

5.2 Domestic sanitation facilities

About 35.0 percent of the respondents do not have toilets in the home and thereby rely on public latrines, whereas 2.5 percent of the respondents do not have access to toilets and practice open range defecation. There were differences in access to sanitary toilet facilities among the different social classes ($\chi^2 = 247.50$, 2df, $p < 0.0001$). Whereas 44.6 percent of poor households use the public latrine, only 1.9 percent of medium wealth and 1.7 percent of high wealth households use the same facility. Flush toilets are a luxury and are

usually found in medium wealth and high wealth households. Only 24.1 percent of poor households have flush toilets compared with 79.2 percent of medium wealth and 94.8 percent of high wealth households. A total of 24 (3.2%) of poor households do not have access to toilets. People are much more exposed to faecal pathogens where there is lack of toilet facilities, which can result in diarrhoeal prevalence through the oral route (Kjellen 2001). The availability of a toilet facility showed a significantly negative association with diarrhoea ($r = -0.29$, $p < 0.0001$). Lack of access to a toilet is associated with high diarrhoeal morbidity among children under six years. About 63.6 percent ($n = 7$) of children living in poor homes without access to a toilet have had diarrhoea in the preceding two weeks of the study. A significant association was also obtained between access to a toilet facility and the incidence of diarrhoea in the multivariate analyses ($p < 0.0001$, 95% CI). Crowding at sanitation facilities can compel people to practice open defecation to avoid long queues which are common at public toilets in the early morning rush hours. A total of 241 (25.1%) of respondents reported of neighbourhood open defecation as a serious health problem in their communities. Outdoor defecation is rampant in poor neighbourhoods due to inadequate sanitation facilities. About 29.3 percent of poor respondents reported of neighbourhood open defecation compared with only 14.5 percent of medium wealth respondents. The health hazards this presents is especially obvious for children who play on faecally contaminated grounds (Kjellen 2001). About 24.5 percent ($n = 23$) of childhood diarrhoeal cases live in poor homes where the mothers reported of open defecation in the neighbourhood. Similar studies in the past found more than two-fold increase in childhood diarrhoeal prevalence due to neighborhood outdoor defecation (Songsore & McGranahan 1993).

Many households who have private toilets in the home compound, usually share the facilities with more than five tenant households. Only 29.4 percent of households have private toilets which are not shared with other households. Poor households are also more likely to share toilets with more than five other households ($\chi^2 = 346.91$, 2df, $p < 0.0001$). The high sharing of toilet facilities, particularly among poor households results in unsanitary conditions and flies infestation of toilets due to excessive pressure, and this increases the risk of transmitting diseases among households. Households who share a toilet facility with more than five other households are also more likely to have high incidence of childhood diarrhoea ($\chi^2 = 41.73$, 4df, $p < 0.0001$) (Fig. 2). Households who share a toilet with more than five households also reported of high incidence of dysentery among children under the age of six. About 10.7 percent ($n = 3$) of dysentery cases live in homes sharing toilets with more than five households, 53.6 percent ($n = 15$) in homes sharing toilets with more than ten households, 21.4 percent ($n = 6$) in homes using public latrines, and 14.3 percent ($n = 4$) in homes without access to a toilet facility. Dysentery affected mainly children from poor homes. The relationship between toilet sharing and diarrhoea remained significant in the multivariate analyses ($p < 0.0001$, 95% CI). Poor children are more likely to suffer from diarrhoea related with the sharing of a toilet facility than their wealthy counterparts ($p < 0.0001$, 95% CI).

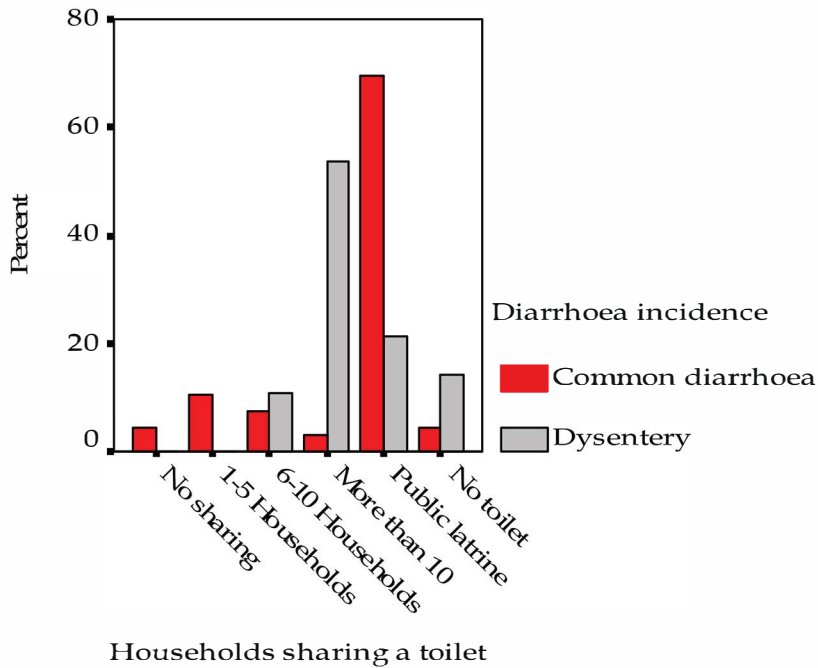


FIGURE 2 The distribution of childhood diarrhoea according to the number of households sharing a toilet.

5.3 Sullage disposal

Sullage is wastewater from domestic and industrial activities which must be properly treated and disposed of to avoid environmental and health hazards. Yet in low income cities like Accra, not much attention is paid to the harmful effects of sullage. Sullage discharge is unregulated and hence there is haphazard discharge of wastewater. Only a few households (8.9%) practice safe disposal of wastewater in septic tanks. The majority of households (51.4%) dispose wastewater in open drains. Poor households are more likely to dispose of wastewater in their yards and in streets ($\chi^2 = 23.53$, 2df, $p < 0.0001$). Access to water correlates with the method of wastewater disposal ($r = 0.29$, $p < 0.001$). Whereas 38.5 percent ($n = 147$) of respondents who have private indoor pipe dispose wastewater in open gutters, more than 73.7 percent ($n = 213$) of those who use vendor water dispose wastewater in open gutters. About 76.5 percent ($n = 65$) of households who dispose wastewater in septic tanks have private indoor pipe, compared with 29.8 percent ($n = 147$) of those who dispose wastewater in open gutters. Indiscriminate disposal of wastewater in the yard is high among households without access to a toilet facility ($\chi^2 = 133.39$, 5df,

$p < 0.0001$). Even in households with flush toilets it is estimated that sullage amounts to 60 percent of total water use (Tahal 1981). The disposal of wastewater in the household yard and streets creates stagnant pools which facilitate the breeding of disease vectors. There is an association between the method of wastewater disposal and the presence of flies in the kitchen ($r = 0.17$, $p < 0.001$). About 22.7 percent of respondents who reported of the presence of flies always in the kitchen during food preparation disposed wastewater in the yard, 3.7 percent in septic tanks, 8.7 percent in waterways, 13.0 percent in roads and 50.7 percent in open gutters ($n = 300$). Stagnant pools are a potent source of malaria infections. Malaria accounted for 39.7 percent of all reported diseases in 1995, and 53 percent in 2001 (Domfeh 1999; Healthy Cities Programme 1999) and it is the major cause of morbidity in Accra. Indiscriminate wastewater disposal does not only pose health threats to residents but also major environmental threats to water resources, since almost every water body in the city have become a receptor of wastewater often containing excreta. The discharge of untreated wastewater into the Korle Lagoon has led to high eutrophication and near extinction of aquatic life in the water body (Boadi & Kuitunen 2002). Wastewater may carry a spectrum of endemic faecal pathogens including helminths, protozoans, bacteria and viruses, the concentration of which can be great enough to create the potential for human infections (Shuval et al. 1986). Often children are the victims of water-borne diseases which have become prevalent in Accra (United Nations Development Programme 1998; Domfeh 1999).

5.4 Solid waste handling and disposal

The majority of households store solid waste in the home with only 22.6 percent of households storing their waste outside the home. Many poor households store waste in open containers in the home than their wealthy counterparts. Whereas 42 percent of the poor stored waste in open containers, only 39.6 percent of medium wealth and 15.5 percent of high wealth households store waste in open containers. The storage of solid waste in plastic bags outside the home is a serious health problem as scavenging animals (dogs, cats, pigs, goats, rats and mice) can break into the bags and scatter the refuse (Thomas et al. 1999). Over 80 percent of respondents do not have home collection of solid waste (Fig. 3). Only 13.5 percent of households have door to door collection of solid waste, while the rest dispose of their waste at communal collection points, in available open spaces or in waterways. The poor are the least served with home collection of solid waste and safe disposal facilities than their wealthy counterparts ($\chi^2 = 273.52$, 2df, $p < 0.0001$). Only 2.2 percent of poor households have home collection of solid waste compared with 38.4 percent of medium wealth and 86.2 percent of high wealth households. About 76.7 percent of poor households and 53.5 percent of medium wealth households dispose their solid

waste at communal collection containers, compared with only 13.8 percent of high wealth households. Unlike services for the wealthy, which are usually undertaken by the Waste Department and private collection firms, home collection services for the poor is mainly undertaken by wastes carriers who are usually migrant women who collect household wastes in baskets for a fee (Boadi & Kuitunen 2003). Whereas the greater majority of poor and medium wealth households dispose their solid waste at communal collection containers, the collection efficiencies in poor neighbourhoods often lag behind medium wealth areas (Boadi & Kuitunen 2003). Waste containers are usually located in the midst of residential areas and this poses health threats to those who live in close proximity to collection points due to infrequent removals and rapid decay of organic waste. Poor neighbourhoods face acute problems of infrequent removals of waste containers and this causes many households to dispose of solid waste in open spaces. About 12.1 percent of poor households who do not have access to dumping facilities dump their waste in any available empty yards compared with only 6.9 percent of medium wealth households. Waste disposal in empty yards and waterways is high among households who store waste in plastic bags ($\chi^2 = 42.07, 3df, p < 0.0001$). Low level of educational attainment is associated with indiscriminate disposal of waste in the open ($\chi^2 = 8.03, 1df, p < 0.0001$). Drainage channels in poor neighbourhoods are usually blocked with solid waste and this creates unsanitary environments and breeding grounds for pests and parasites. A total of 14.3 percent ($n = 137$) burn part of their solid waste while 11.3 percent ($n = 99$) bury part of their waste. Solid waste burning is rampant among poor households who do not have access to waste disposal facilities ($\chi^2 = 18.02, 2df, p < 0.0001$). About 16.7 percent of the poor and 8.2 percent of medium wealth respondents burn solid waste. Waste burning is high among households who store waste in plastic bags ($\chi^2 = 20.14, 3df, p < 0.0001$). About 27.7 percent ($n = 26$) of those who store waste in plastic bags burn part of their waste, compared to only 14.7 percent ($n = 41$) of those who store waste in closed containers and 14.1 percent ($n = 52$) of those storing waste in open containers and 8.3 percent ($n = 18$) of those who do not store waste.

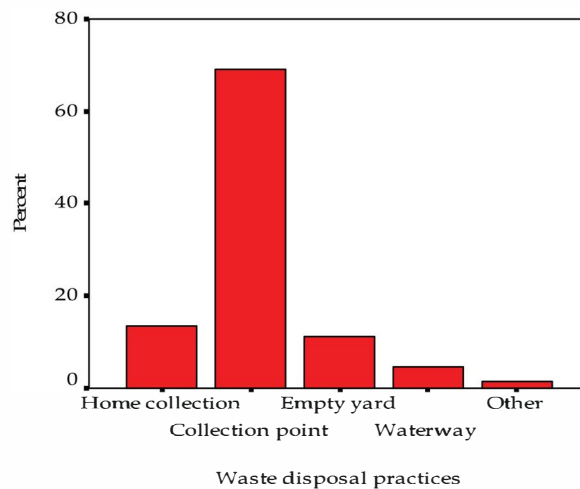


FIGURE 3 The distribution of households according to solid waste disposal practices in the Accra Metropolitan Area.

5.5 Pest infestation

There is an inverse relationship between household wealth and houseflies' infestation in the kitchen ($r = -0.41$, $p < 0.0001$) (Fig. 4). Poor households bear the brunt of pest infestation due to poor hygiene and sanitation both at the household and neighbourhood levels. About 42 percent of poor households store their solid waste in open containers in the home, compared with 30.8 percent of medium wealth and only 15.5 percent of high wealth households. Households who store waste in the home are more likely to report of the presence of flies in the kitchen ($p < 0.0001$). Over 70 percent of household solid waste generated is organic matter (Laryea 1999) which decays rapidly under high tropical temperatures, and if it is not disposed of in time can attract flies to the home and kitchen. Flies infestation in the kitchen is related to the method of solid waste disposal ($r = 0.24$, $p < 0.0001$). More than 33.6 percent ($n = 223$) of respondents who dispose waste at collection points, 32.4 percent ($n = 35$) of those who dispose solid waste in empty yards and 44.4 percent ($n = 20$) of those disposing waste in waterways reported of the presence of flies always in the kitchen. This indicates that solid waste is usually disposed of close to the home. About 70.3 percent of poor households cook outdoors whereas 35.2 percent of medium wealth and only 5.2 percent of high wealth households cook outdoors. Households who cook outdoors are more likely to report of the presence of flies always during cooking ($p < 0.0001$). Flies are known to cause food contamination either by direct contact with food or through their droppings (McGranahan et al. 1999). As mentioned earlier, the presence of houseflies in the kitchen during cooking is associated with high incidence of childhood diarrhoea. About 58.5

percent of diarrhoea cases live in homes where the respondents reported of seeing flies always in the kitchen during food preparation. The high incidence of diarrhoea among poor children (86.2%, $n = 81$), indicates that, children from poor homes are more likely to suffer from food contamination than their wealthy counterparts.

The presence of flies in the toilet is inversely correlated with the household socio-economic status ($r = -0.46$, $p < 0.0001$) (Fig. 5). Whereas 53.6 percent of poor households reported of the presence of flies always in the household toilet, only 15.1 percent of medium wealth, and 3.5 percent of high wealth households reported of the presence of flies always in the toilet. The high number of poor households reporting of flies in the toilet is due to the high patronage of unsanitary public latrines. About 80.1 percent ($n = 269$) of households who use the public latrine reported of the presence of flies always in the toilet. Maintenance of public toilets is a serious problem in poor areas where the population per toilet is much higher (Taylor et al. 2002). There is an association between the number of households sharing a toilet and the presence of flies in the toilet ($r = 0.62$, $p < 0.0001$). Households who share a toilet with more than five other households are more likely to report of the presence of flies always in the toilet. Since poor households are more likely to share toilet facilities ($\chi^2 = 346.91$, 2df, $p < 0.0001$), they are also the worst affected by flies infestation in the toilet. The high sharing of toilets among poor households results in pressure on facilities, unkempt conditions, and rapid degradation of facilities which facilitate flies infestation. Households who reported of seeing flies always in the toilet also reported of high incidence of childhood diarrhoea ($\chi^2 = 41.73$, 4df, $p < 0.0001$). The multivariate test also showed a significant association between the presence of flies in the toilet and the incidence of diarrhoea ($p = 0.006$, 95% CI). About 56.3 percent of childhood diarrhoeal cases live in homes which reported of the presence of flies always in the toilet. Children from poor households are the worst affected, than their wealthy counterparts ($p = 0.006$, 95% CI).



FIGURE 4 The relationship between household wealth and the presence of flies in the kitchen during cooking.

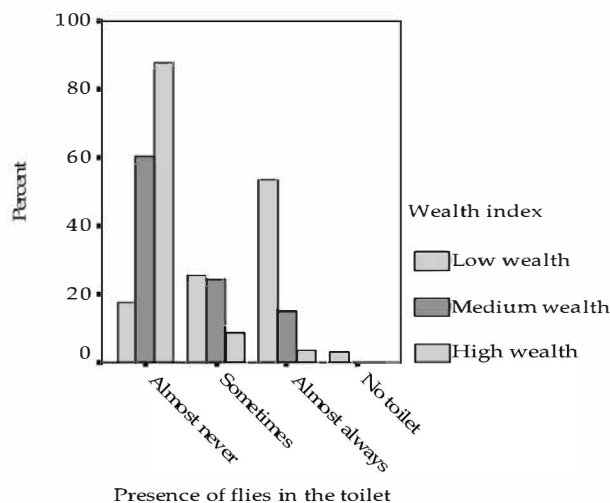


FIGURE 5 The relationship between household wealth and the presence of flies in the toilet.

5.6 Air pollution and respiratory health

The majority of respondents depend on solid fuels (charcoal—65.3% and firewood—4.2%) for cooking. The major factors affecting the choice of cooking fuel are the household economic status ($\chi^2 = 136.82$, 2df, $p < 0.0001$) and level of

education ($\chi^2 = 121.76$, 2df, $p < 0.0001$) of the respondents. The majority of poor households (74.8%) used charcoal, compared with only 41.5 percent of medium wealth and only 8.6 percent of high wealth households. About 5.2 percent of the poor used unprocessed wood compared with only 0.6 percent of the wealthy. About 80.6 percent of those who used charcoal were uneducated, 75.9 have had basic education, and only 42.6 percent among those with secondary or higher education. About 10.3 percent of uneducated respondents used firewood compared with only 3.6 percent of those with basic education and only 0.6 percent of those with secondary or higher education. The combustion of biomass fuels such as firewood are known to produce high levels of pollutants including particulate matter, carbon monoxide, sulphur, nitrogen dioxide and other organic compounds, which pose great danger to respiratory health (Smith 1987; Zhang & Smith 1999; Ezzati & Kammen 2001). A total of 241 (25.4%) of respondents who cook have had respiratory health infections in the preceding two weeks of the study. The incidence of respiratory health infections is high among firewood users (67.5%, $n = 40$), followed by charcoal (31.6%, $n = 627$), kerosene (12.9%, $n = 54$), liquid petroleum gas (4.8%, $n = 168$) and electricity (1.7%, $n = 59$). The relationship between cooking fuel type and the incidence of respiratory infections remained significant in the multivariate test ($p = 0.004$, 95% CI). The place of cooking also bears a significant effect on respiratory health infections ($\chi^2 = 7.61$, 2df, $p < 0.05$). About 61.9 percent ($n = 13$) of those who cook in multiple purpose rooms have had respiratory health symptoms followed by 33.2 percent ($n = 115$) of those who cook in separate kitchens and 19.4 percent ($n = 113$) of those who cook outdoors. The place of cooking maintained its significant association with the incidence of respiratory infections in the multivariate analyses of variance ($p = 0.022$, 95% CI). Those who cook in multiple purpose rooms and indoor kitchens are much more exposed to infections than those who cook outdoors. Households who cook outdoors are less exposed to pollutants, because in the open air pollutants are easily diffused into the atmosphere, thereby minimising the amount of particulate which is directly inhaled. The poor are more at risk of contracting respiratory diseases than the wealthy, because of their greater dependence on charcoal and unprocessed wood in addition to malnutrition, poor housing and overcrowding in homes which make the poor susceptible to infectious diseases. Poor respondents account for 90.5 percent of respiratory health infections among adults who cook, compared to only 8.7 percent of medium wealth and 0.8 percent of high wealth households. The association between wealth and the incidence of respiratory infections remained significant in the multivariate test ($p < 0.0001$, 95% CI).

Women's role as mothers and caregivers draw children closer to them and this often exposes children to indoor pollution during cooking (Pandey et al. 1989; O'Dempsey et al. 1996, Boy et al. 2000). The combination of childcare and cooking activities by mothers pose increased risk of pollutant exposures (Kjellen 2001). Children's presence in the kitchen during cooking hours is associated with the incidence of respiratory health infections among children under the age of six ($r = 0.31$, $p < 0.0001$). Children who are always present in the

kitchen during cooking hours are more affected by respiratory infections, followed by those who usually and occasionally spend time in the kitchen during cooking. The significant relationship between children's presence in the kitchen and the incidence of childhood respiratory infections was maintained in the multivariate test ($p = 0.003$, 95% CI). Children's presence in the kitchen during cooking is inversely related to the household socio-economic status ($r = -0.18$, $p < 0.05$). About 85.6 percent ($n = 119$) of children affected by respiratory infections are from poor households, 12.2 percent ($n = 17$) from medium wealth and 2.2 percent ($n = 3$) from high wealth households. Children's presence in the kitchen maintained its significant association with the incidence of respiratory infections after controlling for wealth. Poor children are exposed to respiratory health infections due to the high dependence on solid fuels among poor households. Poor children often live under septic and crowded housing conditions which can increase the transmission of infections from adults to children.

Many households who do not have access to solid waste disposal facilities burn their waste, and this correlates with the high incidence of respiratory infections among both adults ($r = 0.25$, $p < 0.001$) and children ($r = 0.22$, $p < 0.05$) particularly among poor households. In the multivariate test of variance, solid waste burning showed a significant association with the incidence of respiratory infections in adults ($p = 0.004$, 95% CI), and children ($p = 0.010$, 95% CI). Smoke from burning waste may be detrimental to the health of urban residents through the inhalation of respirable suspended particulates including carbon monoxide, nitrogen dioxide and sulphur dioxide. A similar study of household level environmental problems in Jakarta, found a correlation between uncollected garbage and the occurrence of respiratory diseases in mothers and children probably because households with no collection services burnt their garbage (Surjadi 1993).

6 CONCLUSION

The study has amply demonstrated some of the salient environmental problems facing households in Accra, and the wide disparities among different wealth groups regarding access to environmental health facilities and services. Household environmental problems are closely interrelated and affects mainly less wealthy households. Lack of access to facilities has created severe environmental and sanitation problems such as indiscriminate dumping of refuse, and discharge of sewerage and wastewater into the environment which pose major health hazards, particularly, in poor neighbourhoods. Poor sanitation results in high incidence of infectious diseases including, malaria, diarrhoea and respiratory health infections. Inadequate provision of facilities is detrimental to the health and wellbeing of women and children. Women are responsible for household meals and often spend long hours in smoky kitchens which expose them to high levels of indoor air pollution. They are often uneducated and cannot find wage employment and this means lack of income resources to meet their health needs of adequate water and sanitation. Children are particularly vulnerable to environmental hazards due to their immature physiological systems and this makes them more susceptible to infections. Due to inadequate access to environmental health facilities in addition to overcrowding at sanitation facilities, poor neighbourhood and household sanitation and hygiene, children of poor households face the greatest obstacles to optimal health. It is evident that the major obstacle to achieving a sound environmental health in Accra is poverty, inadequate provision of facilities, and lack of environmental health awareness.

Measures to improve environmental health in Accra must involve the introduction of physical, social, economic and organisational improvements (Johns Hopkins University 2002). This includes improved water supply, sanitation, waste management, proper drainage and preventive health care services in deprived neighbourhoods (Hardoy et al. 1992). The government should reform the existing pricing and provision of water through subsidies for the poor where necessary, to enable the poor afford in-house piping to ensure proper sanitation, hygiene and good health. The metropolitan authority should enact and implement regulations requiring landlords to provide in-house

sanitation facilities for their tenants to ease pressure and congestion on public facilities. Adequate safe water and sanitation are essential for improving children's health. The existing waste collection system should be improved by providing adequate refuse containers in slum areas within easy reach of households, and frequent removal of containers to reduce indiscriminate disposal of solid waste. Adequate drainage channels should be provided in poor neighbourhoods to ensure proper disposal of wastewater to reduce improper sullage disposal, stagnant pools and the spread of preventable infectious diseases. Improving accessibility to slums through the provision of road infrastructure will enhance the extension of facilities and services to deprived areas. Upgrading policies must take cognisance of the need for a change in the supply driven approach to facility provision, which in most cases has favoured meeting the needs of the affluent and neglecting the poor. Attention should focus on demand oriented approaches to meeting the needs of consumers, by providing adequate facilities needed by the people, and requiring users to pay for the full cost of the facilities in order to enhance the efficient and sustainable use of facilities and services. This involves consultation with the people affected by environmental problems, and requires that people participate in the provision and maintenance of facilities.

There is the need for environmental health education programmes to create awareness on the links between poor sanitation, hygiene, and physical wellbeing. People tend to change when they understand the nature of change, and view it as beneficial, so that they make an informed and conscious choice to include it in their list of priorities (UNEP 2000). Health awareness campaigns about poor ventilation in the kitchen and the health impacts of burning solid fuels, would be effective in reducing respiratory infections, particularly among the poor. Parents should be educated about basic child hygiene to reduce children's exposure to disease causing pathogens. Child health care also includes proper feeding and immunisation to enhance children's physiological resistance against diseases.

Acknowledgements

The research was undertaken during the period of 2001–2004 at the Department of Biological and Environmental Science, University of Jyväskylä, Finland.

I am deeply indebted to Professor Markku Kuitunen for supervising the research and for his patience and advice whenever I called on him. Markku introduced me to critical thinking in empirical research. Words alone cannot express my sincere appreciation.

I thank the reviewers Professor Alan Gilbert and Dr Carolyn Stephens for their valuable comments.

My thanks go to the field team, Theresa, Akos and Abigail for their immense support in the survey and data collection for the research.

I thank Mr. S. K. Kpodo (Senior Environmental Health Technologist of the Accra Waste Department) for his valuable time, during the data collection.

I am grateful to Dr. Kolawele Raheem for his kind words and advice, whenever the going seemed tough.

To Docent Kari Hanninen, I say thanks for introducing me to Professor Kuitunen, when I first wrote to you.

My girl friend Dorinda, has shown me the values of love, and I appreciate her sincere kindness and patience.

Matthew Ewurum and Remi Opara taught me the meaning of true friendship and kindness.

My deepest appreciation goes to my brothers Kwaku and Yaw. You have shown me love beyond description.

The research was supported by a travel grant from the Nordic Africa Institute, Uppsala, Sweden.

YHTEENVETO (Résumé in Finnish)

Accran (Ghana) suurkaupunkialueen ympäristö ja terveys

Riittämättömät palvelut ympäristöterveyden alueella rajoittavat kehitysmaiden sosioekonomista kehitystä erityisesti nopeasti kasvavan kaupunkiväestön osalta. Tämä tilanne johtaa helposti kaupunkiympäristön rappeutumiseen ja tähän liittyvien terveyshaittojen lisääntymiseen.

Tässä tutkimuksessa tarkastellaan kotitalouksissa ilmeneviä ympäristöongelmia ja niiden terveysvaikutuksia eri sosiaalisissa ryhmissä. Tutkimuksessa käytettiin esimerkkinä Afrikan ja yleensä kehitysmaiden osalta Accran, Ghanan pääkaupungin väestöä. Accran nopean väestönkasvun ja riittämättömien palveluiden seurauksena suurin osa kaupungin asukkaista elää kurjissa ympäristöolosuhteissa, jotka ovat erityisen haitallisia heidän terveytensä kannalta. Vain 39.8 prosentilla tutkimukseen haastatelluista (n = 960) kotitalouksista on käytettävissään yksityinen vesijohto. Kolmannes kaupungin väestöstä (30.1 %) on riippuvaisia kojuissa myynnissä olevasta vedestä, jotta he saavat riittävän puhdasta talousvettä. Noin 35 prosenttia kotitalouksista on riippuvaisia epähygieenisistä julkisista käymälöistä, kun taas 2.5 prosentilla kotitalouksista ei ole lainkaan käytettävissään käymälää.

Puhtaan veden ja sanitaatiopalveluiden puutteilla on heikentäviä terveysvaikutuksia kotitalouksissa eläviin lapsiin. Tutkimuksen mukaan 19.2 prosentilla (n = 94) tutkittujen kotitalouksien lapsista oli ollut ripulia kahden haastattelua edeltäneen viikon aikana. Pikkulasten ripulin esiintymistiheys liittyi erityisesti puhtaan juomaveden saantiin ja käymäläpalveluiden laatuun. Riittämättömän talousveden saanti ja käymälöiden heikkous liittyvät köyhyyteen, koska erityisesti kaupunkiväestö on köyhää, huonosti koulutettua, ja tältä puuttuvat myös terveydenhuollon peruspalvelut.

Tutkimuksen mukaan 71.1 prosenttia keskituloisista ja 94.8 prosenttia hyvätuloisista kotitalouksista omistaa vesijohdon, kun vesijohto on vain 28.8 prosentilla köyhistä kotitalouksista. Myös käymälöiden saatavuus riippuu tuloistasosta. Vain 24.1 prosenttia köyhistä kotitalouksista omistaa vedellä huuhdottavan käymälän verrattuna hyvätuloisiin, joilla se on yli 80 prosentilla kotitalouksista.

Noin 44.6 prosenttia köyhistä kotitalouksista käyttää julkisia käymälöitä, ja 3.2 prosentilla ei ole lainkaan käytettävissään käymälää. Käymälöiden laajamittainen jakaminen köyhien kotitalouksien kesken synnyttää epähygieenisiiä olosuhteita, jotka luovat elinmahdollisuudet loisille, taudinaiheuttajille ja sairauksia levittäville eläimille altistaen köyhät kotitaloudet sairauksille.

Johtuen köyhän väestönosan kyvyttömyydestä turvata terveellinen elinympäristö se on alttiimpaa suuremmalle joukolle ympäristön laatuun liittyviä sairauksia kuin hyvin toimeentuleva väestö. Erityisesti lapsuusajan ripuli on tyypillinen tällainen sairaus.

Noin 86.2 prosenttia ($n = 81$) lapsuusajanripulitapauksista esiintyy köyhissä kotitalouksissa, noin 10.6 prosenttia ($n = 10$) keskituloisten kotitalouksissa ja vain noin 3.2 prosenttia ($n = 3$) hyvätuloisten kotitalouksissa. Pääosa kotitalouksista tarvitsee ruoan valmistukseen kiinteitä polttoaineita. Ruoka valmistetaan keittiöissä, joissa on huono ilmanvaihto, jolloin sisäilman heikko laatu aiheuttaa hengitysteiden infektioita, erityisesti köyhässä väestöosassa.

Köyhyys, puhtaan veden ja saniteettipalveluiden riittämätön saatavuus, tietämättömyys ympäristöterveyden tärkeydestä ja köyhien ihmisten tarpeiden unohtaminen päätöksenteossa ovat tutkimuksen mukaan suurin este paremman ympäristöterveyden saavuttamiseksi Accrassa. Jotta haitallisia ympäristövaikutuksia voitaisiin pienentää, pitäisi puhtaan veden saantia, jätehuoltoa, asianmukaista talojen tuuletusta ja ennaltaehkäisevää terveydenhuoltoa tehostaa ankeissa kaupunginosissa ja lisätä myös tietoa ympäristö- ja terveysohjelmista.

REFERENCES

- Benneh, G., Songsore, J., Nabila, J. S., Amuzu, A. T., Tutu, K. A., Yangyuoru, Y. & McGranahan, G. 1993. Environmental Problems and the Urban Household in the Greater Accra Metropolitan Area (GAMA)–Ghana. Stockholm: Stockholm Environment Institute.
- Boadi, K. O. & Kuitunen, M. 2002. Urban waste pollution in the Korle Lagoon, Accra, Ghana. *The Environmentalist*, 22, pp. 301–9.
- Boadi, K.O. & Kuitunen, M. 2003. Municipal solid waste management in the Accra Metropolitan Area, Ghana. *The Environmentalist*, 23, pp. 211–8.
- Boy, E., Bruce, N., Smith, K. R. & Hernandez, R. 2000. Fuel efficiency of an improved wood-burning stove in rural Guatemala: implications for health, environment and development. *Energy for Sustainable Development*, 4, pp. 21–9.
- Cairncross, A. M. 1990. Health impacts in developing countries: new evidence and new prospects. *Journal of the Institution of Water and Environmental Management*, 4, pp. 571–577.
- Colan Consult. 1998. Project-wide capacity building and training (Urban Environmental Sanitation Project). Accra, Ghana: Accra Metropolitan Assembly.
- Domfeh, K. A. 1999. Some environmental factors affecting health in the Greater Accra Metropolitan Area, Ghana. *Environments*, 27, pp. 1–13.
- Economic Commission for Africa. 1996. Urban Environment in ECA Member States. Addis Ababa: ECA.
- Ezzati, M. & Kammen, D. M. 2001. Quantifying the effects of exposure to indoor air pollution from biomass combustion on acute respiratory infections in developing countries. *Environmental Health Perspectives*, 109, pp. 481–88.
- Hardoy, J. E., Mitlin, D. & Satterthwaite, D. 1992. Environmental problems in Third World Cities. London: Earthscan Publications.
- Healthy Cities Programme. 1999. Country Reports at the 1st Healthy Cities Workshop. Nairobi, Kenya, 15–19 November.
- Ghana Government. 1984. 1984 population census report. Accra: Ghana Census Office.
- Ghana Statistical Service. 2000. Ghana Living Standards Survey. Report of the Third Round. Accra, Ghana.
- Howard, G. & Bartram, J. 2003. Domestic water quantity, service level and health. Executive Summary. Geneva: WHO.
- John Hopkins University. 2002. Meeting the Urban Challenge. Population Report XXX. Baltimore, Maryland: Johns Hopkins University.
- Kjellen, M. 2001. Health and environment. Stockholm: Swedish International Development Cooperation Agency (Sida).

- Laryea, J. A. 1997. Urban waste management techniques: the case of Ghana. In: E. K. Boon and L. Hens (eds), *Environmental Management in West Africa*. Brussels: Free University of Brussels, pp. 289 – 95.
- Leitman, J. 1993. Rapid urban environmental assessment: lessons from cities in the Developing World. *Urban Management and the Environment*, No. 15. Washington, D. C: World Bank.
- Maxwell, D., Levin, C., Amar-Klemesu, M., Ruel, M., Morris, S. S. & Ahiadeke, C. 2000. Urban livelihoods and food and nutrition security in Greater Accra, Ghana. Research Report 112. Washington D. C: International Food Research Institute.
- McGranahan, G., Lewin, S., Fransen, T., Hunt, C., Kjellen, M., Pretty, J., Stephens, C. & Virgin, I. 1999. *Environmental change and human health in countries of Africa, the Caribbean and the Pacific*. Stockholm: Stockholm Environment Institute.
- Melissa Project. 2000. Improving solid waste management in Accra and four secondary cities of Ghana. LEAP pilot operation in Ghana (draft). Pretoria, South Africa: Melissa.
- Ministry of Local Government. 1992. *Strategic Plan for the Greater Accra Metropolitan Area*. Accra: Department of Town and Country Planning.
- O'Dempsey, T., McArdle, T. F., Morris, J., Lloyd-Evans, N., Baldeh, I., Laurence, B. E., Secka, O. & Greenwood, B. M. 1996. A study of risk factors for pneumococcal disease among children in a rural area of west Africa. *International Journal of Epidemiology*, 25, pp. 885 – 93.
- Pandey, M. R., Neupane, R. P., Gautam, A. & Shrestha, I. B. 1989. Domestic smoke pollution and acute respiratory infections in a rural community of the hill region of Nepal. *Environment International*, 15, pp. 337 – 40.
- Prost, A. & Negrel, A. D. 1989. Water, trachoma and conjunctivitis. *Bulletin of the World Health Organisation*, 67, pp. 9 – 18.
- Satterthwaite, D. 1997. Urban Poverty: Reconsidering its scale and nature. *IDS Bulletin*, 28, pp. 9 – 23.
- Shuval, H. I., Adin, A., Fattal, B., Rawitz, E. & Yekutieli, P. 1986. *Wastewater Irrigation in Developing Countries: Health Effects and Technical Solutions*. Technical Paper No. 51. Washington, D. C: World Bank.
- Smith, K. R. 1987. *Biofuels, air pollution and health*. New York: Plenum Press.
- Songsore, J. & McGranahan, G. 1993. *Environment, Wealth and Health: Towards an Analysis of Intra-Urban Differentials within the Greater Accra Metropolitan Area, Ghana*. *Environment and Urbanization* 5, pp. 10 – 34.
- Stephens, C. 1996. Research on Urban Environmental Health. In: S. Atkinson, J. Songsore & E. Werna (eds), *Urban Health Research in Developing Countries: Implications for Policy*. Wallingford: CAB International, pp. 115 – 134.
- Stephens, C., Timaeus, I., Ackerman, M., Avle, S., Borlina, M., Campanario, P., Doe, B., Lush, L. & Tetteh, D. 1994. *Environment and health in developing countries: an analysis of intra-urban mortality differentials using existing data*. Collaborative studies in Accra, Ghana, Sao Paulo, Brazil and analysis

- of four Demographic Health Surveys. London: London School of Tropical Medicine and Hygiene.
- Stephens, C., Ackerman, C., Avle, S., Maia, P. B., Campanario, P., Doe, B. & Tetteh, D. 1997. Urban equity and urban health: using existing data to understand inequalities in health and environment in Accra, Ghana and Sao Paulo, Brazil. *Environment and Urbanization* 9, pp. 181 – 202.
- Surjadi, C. 1993. Respiratory diseases of mothers and children and environmental factors among households in Jakarta. *Environment and Urbanization*, 5, pp. 78 – 86.
- Tahal, (Consulting Engineers). 1981. Accra-Tema water supply and sewerage project review of master plan. Final Report Vol. 2. Accra.
- Taylor, P., Boussen, C. R., Awunyo-Akaba, J. & Nelson, J. 2002. Ghana urban health assessment. Environmental Health Project Activity Report No. 114. Washington, D. C: USAID.
- Thomas, E. P., Seager, J. R., Viljoen, E., Potgieter, F., Rossouw, A., Tokota, B., McGranahan, M. & Kjellen, M. 1999. Household environment and health in Port Elizabeth, South Africa. Stockholm: Stockholm Environment Institute.
- United Nations Centre for Human Settlements. 2001. State of the world cities 2001. Nairobi, Kenya: UNCHS.
- United Nations Development Programme. 1998. Human Development Report 1998. New York: United Nations.
- United Nations Environment Programme. 2000. Recommendations for decision-making on municipal wastewater: practical policy guidance for implementing the global programme of action for the protection of the marine environment from land based activities on sewage. UNEP Working Document, Version 10. UNEP.
- World Bank. 2002. Upgrading of low income settlements. Country assessment report, Ghana. Washington, D. C: World Bank.
- World Resources, UNEP, UNDP & World Bank. 1998. World Resources 1998 – 99: A Guide to the Global Environment. Oxford: Oxford University Press.
- Zhang, J. & Smith, K. R. 1999. Emission of carbonyl compounds from various cookstoves in China. *Environmental Science and Technology*, 33, pp. 2311 – 20.

ORIGINAL PAPERS

I

**WATER SUPPLY AND SANITATION IN THIRD WORLD
CITIES: THE CASE OF THE ACCRA METROPOLITAN AREA,
GHANA**

Boadi, K. O. & Kuitunen, M. 2004

International Journal of Hygiene and Environmental Health (submitted)

II

**MUNICIPAL SOLID WASTE MANAGEMENT IN THE ACCRA
METROPOLITAN AREA, GHANA**

Boadi K. O. & Kuitunen, M. 2003

The Environmentalist, 23: 211 – 218

<https://doi.org/10.1023/B:ENVR.0000017283.09117.20>

Reproduced with the permission of The Environmentalist

III

**URBAN WASTE POLLUTION IN THE KORLE LAGOON,
ACCRA, GHANA**

Boadi, K. O. & Kuitunen, M. 2002

The Environmentalist, 22: 301 – 309

<https://doi.org/10.1023/A:1020706728569>

Reproduced with the permission of The Environmentalist

IV

**ENVIRONMENTAL AND HEALTH IMPACTS OF
HOUSEHOLD SOLID WASTE HANDLING AND DISPOSAL
PRACTICES IN THIRD WORLD CITIES: THE CASE OF THE
ACCRA METROPOLITAN AREA, GHANA**

Boadi, K. O. & Kuitunen, M. 2004

Journal of Environmental Health (submitted)

<https://www.researchgate.net/publication/7435717>

V

**CHILDHOOD DIARRHEAL MORBIDITY IN THE ACCRA
METROPOLITAN AREA, GHANA: SOCIO-ECONOMIC,
ENVIRONMENTAL AND BEHAVIOURAL RISK
DETERMINANTS**

Boadi, K. O. & Kuitunen, M. 2004

Journal of Health and Population in Developing Countries (in press)

DOI: 10.12927/whp.2005.17646

VI

**FACTORS AFFECTING THE CHOICE OF COOKING FUEL,
COOKING PLACE AND RESPIRATORY HEALTH IN THE
ACCRA METROPOLITAN AREA, GHANA**

Boadi, K. O. & Kuitunen, M. 2004

Journal of Biosocial Science (submitted)

<https://doi.org/10.1017/s0021932005026635>

VII

**ENVIRONMENT, WEALTH, INEQUALITY AND THE BURDEN
OF DISEASE IN THE ACCRA METROPOLITAN AREA,
GHANA**

Boadi, K. O. & Kuitunen, M. 2004

International Journal of Environmental Health Research (submitted)

<https://doi.org/10.1080/09603120500105935>