Journal of Health & Population in Developing Countries

Childhood diarrheal morbidity in the Accra Metropolitan Area, Ghana: socio-economic, environmental and behavioral risk determinants

KWASI OWUSU BOADI and MARKKU KUITUNEN

Abstract

Diarrhea has been identified as a major cause of childhood morbidity in Sub-Saharan Africa. The study examines two weeks incidence of diarrhea among children under six years in Accra. The results indicate that the household economic status and education of the mother are significant determinants of diarrhea. There is a significant association between diarrhea morbidity and access to water and sanitation facilities, hygiene practices, flies infestation and the regular consumption of street food. Integrated child health intervention programs including provision of facilities, maternal hygiene education and environmental health awareness have to be strongly implemented in order to reduce the high incidence of childhood diarrhea.

KEYWORDS: childhood diarrhea, water and sanitation, hygiene, street food, maternal education, Accra Metropolitan Area.

The ***Journal of Health and Population in Developing Countries (ISSN 1095-8940)***
is a publication of the Department of Health Policy and Administration, School of Public Health
University of North Carolina at Chapel Hill.

UNC SCHOOL OF PUBLIC HEALTH
DEPARTMENT OF HEALTH POLICY AND ADMINISTRATION

Childhood diarrheal morbidity in the Accra Metropolitan Area, Ghana: socio-economic, environmental and behavioral risk determinants

INTRODUCTION

Diarrhea is a major cause of morbidity and mortality among children in the developing world. Kosek et al. (2003) estimate that diarrhea accounts for 21 percent of all deaths of children under five years of age and causes 2.5 million deaths per year. Bern et al. (1992) have also documented diarrhea morbidity of 2.6 per child per year. Diarrhea has been estimated to account for 25—75 percent of all childhood illnesses in Africa (Kirkwood, 1991; Huttly et al., 1987; Freij and Wall, 1979). According to Kirkwood (1991), diarrhea episodes lead to 14 percent of outpatient visits, 16 percent of hospital administrations and account for 35 days of illness per year in children under five years in Sub-Saharan Africa. A report by the WHO (1996) stated that 0.8 million children die from diarrhea each year in Sub-Saharan Africa. The etiological factors associated with diarrhea disease in children include microbial agents which are usually transmitted through food and water contaminated with human feces (Kung'u et al., 2002). Studies indicate that factors such as age of the child, quality and quantity of water, availability of toilet facilities, housing conditions, level of maternal education, household economic status, place of residence, feeding practices, and the general level of hygiene in the home affects the exposure to diarrhea pathogens (Teran, 1991; Diame et al., 1990; Timaeus and Lush, 1995). Diarrhea diseases are prevalent among poor households living under conditions of poor personal and domestic hygiene (McGranahan et al., 1999). Some studies indicate lower diarrhea morbidity and mortality among children from wealthy homes in the developing world (Timaeus and Lush, 1995). In Ghana, statistics from the Ministry of Health indicate that diarrhea accounts for 84,000 deaths annually with 25 percent being children under five years (*Ghana News Agency*, 2003).

MATERIALS AND METHODS

The study involved random selection of 489 children under the age of six from households in the Accra Metropolitan Area. 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. The greatest advantage of this method is 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. A detailed structured questionnaire was used to collect baseline socio-economic information on household ownership of consumer durable commodities. Information was also collected on the mother's level of education, household source of drinking water, sanitation facilities, hygiene practices such as hand washing with soap before cooking, and after using the toilet, and children's consumption of street food. All mothers above 20 years were included in the study. Mothers were interviewed about their children's daily stool and the presence of blood in stool in the preceding two weeks as the main variable outcome. Diarrhea was defined as the passing of three or more loose, watery or bloody stool within a 24 hour period (Martines et al., 1993). The passing of bloody stool was further defined as dysentery, an acute form of diarrhea. Data on health is based on a two week recall self reporting of ill health by respondents.

The children were divided into wealth groups using a weighted criteria based on the household ownership of durable consumer commodities and the place of dwelling (Table 1), to examine whether the incidence of diarrhea varied across them. 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, 402 children were classified as poor wealth, 61 as medium wealth and 26 as high wealth.

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
Color 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

Trained female students selected from the University of Ghana, Legon, administered the questionnaires. 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. The time taken to complete each questionnaire was between 25 and 30 minutes. Respondents were generally cooperative in providing information. 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 significance of associations between variables was determined with the Spearman's rank correlation and the Kruskal-Wallis test. Multivariate analyses of variance were performed to evaluate the significance of associations obtained in the univariate analysis between variables and the incidence of diarrhea. Probability values less than 0.05 were considered statistically significant. Data has also been presented in percentage cross tabulations and graphs.

RESULTS

It was found that 19.2 percent (n = 94) of the children covered in the study have had diarrhea in the preceding two weeks of the study. Dysentery accounted for 29.8 percent (n = 28) of diarrhea cases. The incidence of childhood diarrhea is negatively correlated with the household economic status (r = -0.26, p<0.05) **(Fig. 1)**, and the mother's education (r = -0.33, p<0.0001). About 20.1 percent (n = 81) of children from poor wealth homes have had diarrhea compared to 16.4 percent (n = 10) from medium wealth and 11.5 percent (n = 3) from high wealth homes. Children of uneducated mothers account for 60.6 percent (n = 57) of diarrhea cases, 25.5 percent (n = 24) were of mothers with basic education and 13.8 percent (n = 13) of mothers with secondary or higher education. The incidence of diarrhea maintained a significant association with the household economic status (p = 0.040, 95% CI) and maternal education (p =0.004, 95% CI) in the multivariate analyses of variance. Maternal education influences hand washing before cooking (p< 0.0001, 95% CI) and after using the toilet (p = 0.013, 95% CI). Whereas 75.4 percent of uneducated mothers did not wash their hands with water or soap before cooking, only 29.2 percent of mothers with basic education, and 7.7 percent of those with secondary or higher education failed to wash their hands before preparing meals. Only 7.0 percent of uneducated mothers washed their hands with soap after using the toilet, compared with 16.7 percent of those with basic education and 46.2 percent of mothers with secondary or higher education. More than 82.5 percent of diarrhea cases who live with uneducated mothers are poor, 15.8 percent are medium wealth, and only 1.7 percent are high wealth.

There is a negative correlation between the mother's hygiene practices of hand washing with water or soap before preparing meals (r = -0.39, p<0.0001), and after using the toilet (r = -0.43, p<0.0001), and the incidence of diarrhea. In the multivariate test, the incidence of diarrhea maintained a significant association with mother's hand washing before cooking (p< 0.0001, 95% CI) and after using the toilet (p< 0.0001, 95% CI). About 78.4 percent of diarrhea cases associated with mother's failure to wash the hands with water or soap before cooking are poor, 15.7 percent are medium wealth and only 5.9 percent are high wealth. Also, 89.3 percent of diarrhea cases associated with mother's failure to wash the hands with water or soap after using the toilet are poor, 6.4 percent are medium wealth and only 4.3 percent are high wealth. The household source of drinking water showed a negative association with the incidence of childhood diarrhea (r = -0.34, p<0.0001). Lack of or inadequate access to potable water is associated with high incidence of diarrhea. Childhood diarrhea decreases with a standpipe and private indoor pipe **(Table. 2)**. About 86.3 percent of diarrhea cases associated with vended water, and all cases associated with lack of access to potable water are poor children. In the multivariate test, source of drinking water maintained its significant association with the incidence of diarrhea (p = 0.002, 95% CI).

Table 2. The association between source of drinking water and two weeks incidence of childhood diarrhea.

Source of drinking water	No. of children (n)	Incidence of diarrhea (%)
Private indoor pipe	157	7.0
Shared standpipe	170	17.1
Water vendor	154	33.1
Other	8	37.5
Total	489	19.2

Fig. 1. The distribution of childhood diarrhea according to household wealth.

The availability of a toilet facility is inversely related with the incidence of diarrhea (r = -0.29, p<0.0001). A significant association was also obtained between access to a toilet facility and the incidence of diarrhea in the multivariate analyses (p< 0.0001, 95% CI). Children living in homes without access to toilet have high incidence of diarrhea **(Table. 3)**. Access to a toilet facility maintained its significant negative association after controlling for wealth. All the diarrhea cases associated with lack of toilet facility and the bucket latrine are poor children. The incidence of diarrhea is also affected by neighborhood open defecation. About 24.5 percent (n = 23) of diarrhea cases live in homes where the mothers reported of outdoor defecation in the neighborhood. Households who share a toilet facility with more than five other households are more likely to have high incidence of childhood diarrhea (χ^2 = 41.73, 4df, p<0.0001) **(Fig. 2)**. Poor children are more likely to suffer from diarrhea resulting from toilet sharing (χ^2 = 16.67, 2df, p<0.0001). The relationship between toilet sharing and diarrhea remained significant in the multivariate analyses (p< 0.0001, 95% CI). High sharing of toilet was also found to be associated with dysentery which affected mainly children from poor households. About 53.6 percent (n = 15) of dysentery cases live in homes sharing toilets with more than ten households.

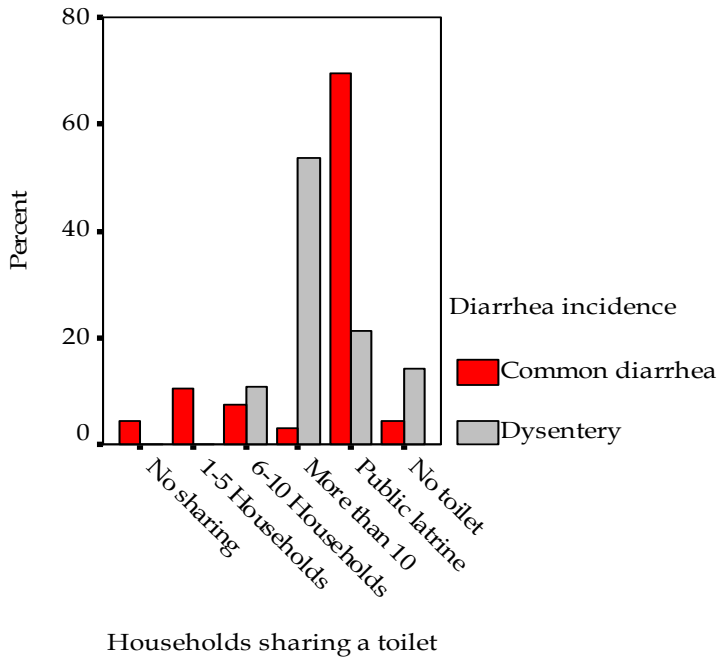
The presence of houseflies in the household kitchen during cooking is positively correlated with diarrhea morbidity (r = 0.36, p<0.0001). The risk of childhood diarrhea increases with the presence of flies always in the kitchen during cooking **(Fig. 3)**. A total of 24 (85.7%) of dysentery cases live in homes where the mothers reported of the presence of houseflies always in the kitchen. Flies infestation in the kitchen maintained its significant association with the incidence of diarrhea in the multivariate analyses (p = 0.002, 95% CI). Poor children are more likely to suffer from diarrhea related with the presence of flies always in the cooking area than their wealthy counterparts (p< 0.0001, 95% CI). Children from poor households account for 86.2 percent of diarrhea cases associated with the presence of flies always in the kitchen and this indicates that the poor suffer from food contamination than their wealthy counterparts.

Table 3. The relationship between type of toilet facility and the incidence of childhood diarrhea.

Type of toilet	No. of children (n)	Incidence of diarrhea (%)
Flush	163	4.9
KVIP*	41	24.4
Pit latrine	76	11.8
Bucket latrine	27	29.6
Public latrine	171	30.4
No toilet	11	63.6
Total	489	19.2

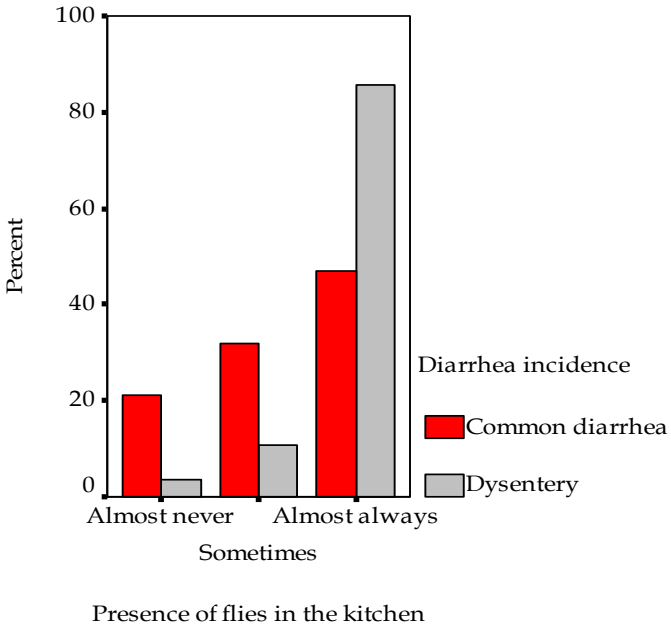
* (Kumasi ventilated improved pit latrine).

Fig. 2. The distribution of childhood diarrhea according to the number of households sharing a toilet.



The regular consumption of street food by children showed a positive association with the incidence of diarrhea ($r = 0.36$, $p<0.0001$). Children who are regularly fed on street food are at a much higher risk of contracting diarrhea **(Fig. 4)**, and also account for 78.6 percent ($n = 22$) of dysentery cases. The consumption of street food showed an association with the incidence of diarrhea in the multivariate test ($p< 0.0001$, 95% CI). There is no correlation between maternal education and children's consumption of street food ($p = 0.95$), and this indicates that uneducated as well as educated mothers feed their children with street food. Many poor children are regularly fed on street food than children form medium and high wealth households ($p = 0.048$, 95% CI). Poor children account for 92.2 percent of diarrhea cases associated with the regular consumption of vendor food, 5.8 percent are medium wealth and only 2.0 percent are high wealth.

Fig. 3. The distribution of diarrhea according to the presence of flies in the kitchen during food preparation.



DISCUSSION

The Household Socio-economic Status

The household socio-economic variables of wealth and education of the mother bear significant impacts on diarrhea morbidity. Children living in poor households have higher rates of diarrhea than their wealthy counterparts, probably due to inadequate access to environmental facilities, unsanitary environments in the home and poor child hygiene. The relationship between the household socio-economic characteristics and childhood diarrhea has been amply demonstrated in the literature (Martines et al., 1993; Alam, 1995; Ketema and Lulseged, 1997; Timaeus and Lush, 1995). Timaeus and Lush (1995) found a strong association between the socio-economic status of the household and the incidence of childhood diarrhea in urban areas of Ghana. Lower levels of maternal education are associated with high incidence of diarrhea. The incidence of diarrhea reduces with basic and secondary or higher levels of maternal education. The findings confirm earlier studies which found lower incidence of childhood diarrhea among children of educated mothers than among children of mothers with no formal education (Tagoe, 1995). Educated mothers practice good hygiene and better child feeding, all of which increase a child's resistance against infectious diseases. Education enables caregivers to avoid health threats and deal with illness more easily (World Resources Institute, 1998). Experience in Sri Lanka and India, has led to the suggestion that for every year of schooling for girls, a 10 percent reduction in infant mortality be reasonably expected (Amonoo-Lartson, et. al., 1985). Education enhances the opportunities for wage employment and income and increases access to household amenities and facilities including those related to better hygiene and environmental health (Togunde, 1999; Cerrutti, 2000; Ehiri, 1993)

Fig. 4. The distribution of diarrhea according to children's consumption of street food.

Availability of Safe Drinking Water

The availability of safe drinking water significantly affects the incidence of diarrhea. Low incidence of diarrhea is associated with private indoor pipe and standpipe but increases with vended water and lack of access to safe water. Shier et al. (1996), also found high incidence of diarrhea morbidity and mortality associated with untreated water among young children in northern Ghana. Bacteriological studies in rural Nigeria have shown consistent contamination of traditional water sources with fecal coliforms and *streptococci* (Blum et al., 1987). The risk of contamination of vended water is high due to poor storage and mishandling. Usually clients are allowed to fetch water from storage tanks or directly from the tap. As different clients handle water from the same storage container or from the same standpipe, the possibility of transmitting pathogenic organisms on the hands of clients increases with each client. Also, due to the intermittent flow of water in many parts of the city, water vendors have to store water for longer periods in order to meet the demands of their clients. The contamination of water resulting from long periods of storage has been amply demonstrated in the literature (Benneh et al., 1993; Roberts et al., 2001). The high incidence of diarrhea associated with vended water confirms earlier studies, which found the contamination of household water from a source outside the home, to pose a greater risk of diarrhea than any contamination within the household (VanDerslice and Briscoe, 1993). The availability of water makes hand washing easier (Favin et al., 1999). Children whose mothers fail to wash their hands with soap before preparing meals or after defecating are at much higher risk of contracting diarrhea. Han et al. (1986) showed that hands readily became contaminated after defecation, even with the use of toilet paper. In a study in Thailand, enterotoxigenic *Escherichia coli* (ETEC) was detected in the hands of 6 of 42 mothers selected from homes where children were suffering from ETEC diarrhea. The type isolated from diarrhea corresponded to that isolated from hands (Echeverria et al., 1987). Many studies have shown that because water availability facilitates hand washing and hygiene behaviors, in-house water supplies are associated with reduced rates of childhood diarrhea (Boot and Cairncross, 1993). Increased water availability and quantity associated with improved hygiene, may reduce fecal contamination of the hands, proper cleaning of utensils, food, and the home environment (Esrey et al., 1985). A 30 percent reduction in diarrhea was reported in Burma when mothers and children were

provided with soap and encouraged to wash their hands before preparing meals and after defecating (Aung and Thein, 1989).

Access to Toilet Facilities

The household access to a toilet facility showed a significant association with diarrhea morbidity. Lack of access to a toilet facility is associated with high incidence of diarrhea. The greatest reductions in diarrhea are associated with flush toilets and pit latrines. Daniels et al. (1990) also found a reduction of 24 percent diarrhea incidence associated with latrines in Lesotho. Esrey et al. (1990; 1991) found some reductions in diarrhea disease in 21 out of 30 studies. The greatest reductions were associated with flush toilets, although pit latrines also had positive impacts. Compared with flush toilets and pit latrines, public latrines, bucket latrines and the Kumasi ventilated improved pit latrine (KVIP) still show high incidence of diarrhea. Public latrines are generally unhygienic and unhealthy for children due to the presence of flies and dirty floors. Children who are not accompanied by adults to public latrines may be tempted to pick used tissues on the dirty floors for cleaning after defecating. Bucket latrines are associated with operational deficiencies, poor hygiene, repugnant smells and flies. The incidence of childhood diarrhea is high for households who share their toilets with more than five other households. High sharing of toilet creates unsanitary and unkempt conditions which provide conducive environments for vectors and pathogenic organisms associated with diarrhea infection, and also increases the possibility of transmitting pathogens from one infected household to others. Songsore and McGranahan (1993) also found that sharing toilet with more than five households increased childhood diarrhea by more than two-fold. Neighborhood outdoor defecation creates potential dangers of infections from fecal pathogens in contaminated grounds. Children who play on grounds contaminated with fecal matter risk contracting diarrhea. Similar studies in the past found more than two-fold increase in childhood diarrheal prevalence due to neighborhood outdoor defecation (Songsore and McGranahan, 1993).

Street Food Consumption

The incidence of diarrhea was found to be high among children who regularly eat street food but reduces with non-regular consumption of street food. An epidemiological link between vended food and diarrhea morbidity has been amply demonstrated (Benneh et al., 1993; Mensah, 1997, report submitted to Japan International Cooperation Agency; Henzie and Yackovich, 1988). Esrey and Feachem (1989) estimate a 50—70 percent incidence of childhood diarrhea involving food contamination. Most often, vendor prepared food are left uncovered in unhygienic environments with flies hovering around in addition to indiscriminate disposal of feces and garbage which increase the risk of food contamination. Other studies found a 2.6 times increase in childhood diarrhea in Accra, related to vendor prepared food (Songsore and McGranahan, 1993). Usually food is sold in leaves which are not disinfected and as such the possibility exist that microflorae on leaves and microbes acquired through poor handling could be transferred to foods (Mensah et al., 2002). Under such conditions the likelihood of a vendor transmitting pathogenic organisms to buyers is high. Mensah et al. (2002) found a large proportion of vendor prepared food in Accra to be contaminated with unacceptable levels of bacteria. There are health risks associated with the use of fingers to feel foodstuffs and ingredients for texture to ascertain the adequacy of manual grinding since this can contribute to the microbial load of food (Ehiri et al., 2001). This traditional food preparation method produces an environment that inhibits various diarrhea pathogens (Mensah et al., 1991). Failure to wash the hands with soap before preparing meals can increase the risk of food contamination. Vendors who serve with their bare hands can easily transmit diarrhea pathogens present on their hands to children. Enteropathogens can survive on the hands for about three hours or longer, and thereby increase the risk of transmitting diarrhea pathogens on the hands of vendors to food

buyers (Mensah et al., 2002; Mensah, 1997, report submitted to Japan International Cooperation Agency). Food vendors in Accra have been found to carry a variety of bacterial enteropathogens, including *Salmonella typhi* (Mensah et al., 1999). There is evidence that children in Accra who ate less street foods grew better than those whose diet included a greater percentage of street foods (International Food Research Policy Institute, 2003). Poor household sanitation and hygiene practices also create conducive environments that attract houseflies to the household kitchen. The presence of houseflies in the kitchen increases the risk of food contamination through direct contact with food by walking on the food or through their droppings. *Salmonella typhimurium* and *shigella* can multiply in the gut of houseflies and can be excreted for weeks or even longer (Levine and Levine, 1991).

CONCLUSION

The observed differences in the incidence of diarrhea among different social classes show the importance of wealth and affordability of facilities in the spread of diseases. Wealthy households are more able to afford environmental health facilities and practice good hygiene and childcare all of which increase a child's physiological resistance against infectious diseases. Poor households often live under deplorable and crowded conditions without access to basic sanitation and health facilities, which make poor children susceptible to infections. Other important factors affecting diarrhea include poor neighborhood sanitation and hygiene and the household behavioral patterns of child feeding with street food which expose children to contamination outside the household. Even households with better access to environmental facilities are unlikely to gain any health benefits if the neighborhood environmental conditions are unhygienic and poor. The study also indicates that maternal education bears a significant impact on diarrhea morbidity. Educated mothers are more exposed to the importance of hygiene, better childcare and feeding practices, and are more aware of disease causation factors and preventive measures. The present study indicates that there is an urgent need for effective intervention measures to curtail the incidence of diarrhea among children. Potable water and sanitation facilities should be provided within easy reach of the needy. Also, health intervention programs, including proper child feeding to enhance children's physiological resistance against diseases, household and community level environmental health awareness, and maternal hygiene education should be implemented in order to reduce the incidence of diarrhea. It is hoped that the results of the study will provide guidance for policy makers in formulating strategies to improve child health in Accra.

REFERENCES

Alam, N. (1995) Predictors of diarrhoea in young Bangladeshi children. *J. Trop. Paediatr*. **41**, 7—14.

Amonoo-Lartson, R., Ebrahim. G.J. and Lovel, H.J. (1985) *District health care: challenges for planning, organisation and evaluation in developing countries*. Hong Kong: MacMillan.

Aung, M.H. and Thein, H. (1989) Prevention of diarrhoea and dysentery by handwashing. *Trans. R. Soc. Trop. Med. Hyg*. **83**, 123—31.

Benneh, G., Songsore, J., Nabila, J.S., Amuzu, A.T., Tutu, K.A., Yangyuoru, Y. and McGranahan, G. (1993) *Environmental Problems and the Urban Household in the Greater Accra Metropolitan Area (GAMA)—Ghana*. Stockholm: Stockholm Environment Institute.

Bern, C., Martines, J., de Zoysa, I. and Glass, R.I. (1992) The magnitude of the global burden of dirrhoeal disease: a ten-year update. *Bulletin of WHO*. **70**, 705—14.

Blum, D., Huttly, S.R.A., Okoro, J.I., Akujobi, C., Kirkwood, B.R. and Feachem, R.G. (1987) The bacteriological quality of traditional water sources in north-eastern Imo State. *Epidemiol. Infect*. **99**, 429—37.

Boot, M.T. and Cairncross, S. (eds) (1993) *Actions speak: the study of hygiene behaviour in water and sanitation projects*. The Hague: IRC International Water and Sanitation Centre.

Cerrutti, M. (2000) Intermittent employment among married women: a comparative study of Buenos Aires and Mexico. *J. Compar. Fam. Stud*. **31**, 19—45.

Daniels, D.L., Cousens, S.N. and Makoae, L.N. (1990) A case-control study of the impact of improved sanitation on diarrhoea morbidity in Lesotho. *Bulletin of WHO*. **68**, 455—63.

Diame, E.-H.M., Ndiaye, S. and Airey, P. (1990) Diarrhoeal morbidity among young children: findings from the DHS survey of Senegal 1986. In: A.G. Hill (ed.) *Determinants of health and mortality in Africa, DHS Surveys, Further Analysis*. Columbia, Maryland: Macro International Inc: 47—72.

Echiverria, P., Taylor, D.N., Seriwatana, J., Leksomboon, U., Chaicumpa, W., Tirapat, C. et al. (1987) Potential sources of enterotoxigenic *Escherichia coli* in homes of children in Thailand. *Bulletin of WHO*. **65**, 207—15.

Ehiri, J.E. (1993) Infant and child mortality in Nigeria: the role of socio-economic factors (Dissertation), Swansea: University of Wales.

Ehiri, J. E., Azubuike, M.C., Ubbaonu, C.N., Anyanwu, E.C., Ibe, K.M. and Ogbonna, M.O. (2001) Critical control points of complementary food preparation and handling in eastern Nigeria. *Bulletin of WHO*. **79**, 423—35.

Esrey, S.A., Feachem, R.G. and Hughes, J.M. (1985) Interventions for the control of diarrhoeal diseases among young children: improving water supplies and excreta disposal facilities. *Bulletin of WHO*. **63**,757—72.

Esrey, S.A., Potash, J.B. and Roberts, L. (1991) Effects of improved water supply and sanitation on ascariasis, diarrhoea, dracunculiasis, hookworm infection, schistosomiasis, and trachoma. *Bulletin of WHO*. **69**, 609—21.

Esrey, S.A, Potash, J., Roberts, L. and Shiff, C. (1990) *Health benefits from improvements in water supply and sanitation: survey and analysis of the literature on selected diseases*. Technical Report No. 66. Washington, D. C: Water and Sanitation for Health Project.

Esrey, S.A. and Feachem, R.G. (1989) *Interventions for the control of diarrhoeal diseases among young children: promotion of food hygiene*. WHO/CDD No. 89.30. Geneva: WHO.

Favin, M., Yacoob, M. and Bendahmane, D. (1999) *Behaviour first: a minimum package of environmental health behaviours to improve child health*. Environmental Health Project Applied Study No. 10. Washington, D.C: USAID.

Freij, L. and Wall, S. (1979) Quantity and variation in morbidity: THAID-analysis of the occurrence of gastroenteritis among Ethiopian children. *Intl. J. Epidemiol*. **8**, 313—25.
Ghana News Agency. (2003) Hand washing with soap could prevent death. GNA, September 25, Accra, Ghana.

Han, A.M., Oo, K.N., Aye, T.A. and Hlaing, T. (1986) Personal toilet after defecation and the degree of hand contamination according to different methods used. *J. Trop. Med. Hyg*. **89**, 237—41.

Heinze, J.E. and Yackovich, F. (1988) Washing with contaminated bar soap is unlikely to transfer bacteria. *Epidemiol. Infect*. **101**, 135—42.

Huttly, S.R.A., Blum, D., Kirkwood, B.R. and Emeh, R.N. (1987) The epidemiology of acute diarrhoea in a rural community of Imo State, Nigeria. *Trans. R. Soc. Trop. Med. Hyg*. **81**, 865—70.

International Food Research Policy Institute. (2003*) Women and children getting by in urban Accra. IFPRI City Profiles*. Washington, D.C: International Food Research Policy Institute.

Ketema, L. and Lulseged, S. (1997) Persistent diarrhoea: socio-demographic and clinical profile of 264 children seen at a referral hospital in Addis Ababa. *Ethiopian Med. J*. **35**, 161—68.

Kirkwood, B.R. (1991) Diarrhoea. In: R.D. Feachem and D.T. Jamison (eds) *Disease and mortality in Sub-Saharan Africa*. New York: Oxford University Press, pp. 134-57.

Kosek, M., Bern, C. and Guerrant R.L. (2003) The magnitude of the global burden of dirrhoeal disease from studies published 1992—2000. *Bulletin of WHO*. **81**, 197—204.

Kung'u, W.N., Musau, P.M., Ochieng, A., Wachira, E.G., Omol, R.T.A., Rakwar, J. et al., (2002) Diarrhoea prevalence and risk factors in slums. *J. Nat. Inst. Public Health* **51**, 73—76.

Levine, O.S. and Levine, M.M. (1991) Houseflies (*Musca domestica*) as mechanical vectors of shigellosis. *Rev. Infect. Dis*. **13**, 688—96.

Martines, J., Phillips, M. and Feachem, R. G. (1993) Diarrheal diseases. In: Jamison D.T., Mosley W.H., Measham A.R., Bobadilla J.L. (eds) *Disease Control Priorities in Developing Countries*. Oxford: Oxford University Press: 91—116.

McGranahan, G., Lewin, S., Fransen, T., Hunt, C., Kjellen, M., Pretty, J., Stephens, C. and Virgin, I. (1999). *Environmental change and human health in countries of Africa, the Caribbean and the Pacific*. Stockholm: Stockholm Environment Institute.

Mensah, P., Owusu-Darko, K., Yeboah-Manu, D., Nkrumah, F.K. and Kamiya, H. (1999) The role of street food vendors in the transmission of enteric pathogens. *Ghana Med. J*. **33**, 19—29.

Mensah, P., Tomkins, A.M., Drasar, B.S. and Harrison, T.J. (1991) Antimicrobial effect of fermented Ghanaian maize dough. *J. Applied Bacteriol*. **70**, 302—10.

Mensah, P., Yeboah-Manu, D., Owusu-Darko, K. and Ablordey, A. (2002) Street foods in Accra, Ghana: how safe are they? *Bulletin of WHO*. **80**, 546—54.

Roberts, L., Chartier, Y., Chartier, O., Malenga, G., Toole, M. and Rodka, H. (2001) Keeping water clean in a Malawi refugee camp: a randomised intervention trial. *Bulletin of WHO*. **79**, 280—7.

Satterthwaite, D. (1997) Urban Poverty: Reconsidering its scale and nature. *IDS Bulletin* **28**, 9—23.

Shier, R.P., Dollimore, N., Ross, D.A., Binka, F.N., Quigley, M. and Smith, P.G. (1996) Drinking water sources, mortality and diarrhoea morbidity among young children in Northern Ghana. *Trop. Med. Int. Health* **1**, 334—41.

Songsore, J. and McGranahan, G. (1993). Environment, Wealth and Health: Towards an Analysis of Intra-Urban Differentials within the Greater Accra Metropolitan Area, Ghana. *Environ. Urban*. **5**, 10—34.

Tagoe, E. (1995) Maternal education and infant/child morbidity in Ghana: the case of diarrhoea. Evidence from the Ghana DHS. In: Makinwa, P. and An-Magritt, J. (eds) *Women's position and demographic change in Sub-Saharan Africa*. Liege: IUSSP: 169-200.

Teran, M.M. (1991) Early feeding patterns and children's health in Mexico. DHS World Conference, August 5—7, Proceedings Vol. 1, Washington, D. C. pp. 451—74.

Timaeus, I.M. and Lush, L. (1995) Intra-urban differentials in child health. *Health Trans. Rev*. **5**, 163—90.

Togunde, O.R. (1999) Determinants of women's employment in urban Nigeria: the impact of socio-economic factors. *J. Asian Afr. Studies* **34**, 279—97.

VanDerslice, J. and Briscoe, J. (1993) All coliforms are not created equal: a comparison of the effects of water source and in-house water contamination on infantile diarrhoeal disease. *Water Resour. Res*. **29**, 1983—1995.

World Health Organisation. (1996) Childhood diseases in Africa: Fact Sheets. (www.who.int/inf-fs/en/fact_109.html) (Assessed on January 10, 2004).

World Resources Institute. (1998) *World Resources 1998-99: A guide to global environment. Environmental change and human health*. New York: Oxford University Press.