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# Intra-urban differentials in child health*

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## Abstract

**This paper uses DHS data on the urban populations of Ghana, Egypt, Brazil and Thailand to investigate the effect of poverty and environmental conditions on diarrhoeal disease, nutritional status and survival among children. Differentials in health are moderate in urban Ghana, whereas in Egypt and Brazil reductions in morbidity and, above all, mortality have accrued largely to the better off. In Thailand, the poor fare better and inequalities in mortality are no larger than those in morbidity. Children's health is affected by environmental conditions as well as by their family's socio-economic status.**

By about the turn of the century, for the first time in history most of humanity will be living in urban settlements (UN 1989). In about 2015, this will also become true of the developing world's population. As recently as 1970, only about a quarter of the population of the developing world lived in towns and cities; it has long been realized that, in contrast to the historical experience of the West, those living in the urban sector of developing countries tend to enjoy better health than rural residents (Johnson 1964). Equally, it is well-established that the health of the urban poor may be as bad as that of rural residents, or worse (Basta 1977). As this has become widely recognized, there has been an explosion of research interest in inequalities in health within developing-country cities: a recent review identified over one hundred studies concerned with intra-urban differentials in health and mortality (Harpham and Stephens 1991).

Much of the recent research into inequalities in urban health consists of studies conducted in a single country or city.[1] This study, in contrast, adopts a comparative approach to the investigation of differentials in health within the urban sector of national populations. It

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[1] The literature on Brazil is particularly extensive. Within urban areas large socio-economic differentials have been found in child mortality (e.g. de Carvalho and Wood 1978), nutritional status (e.g. Monteiro et al. 1986) and morbidity (e.g. Benicio et al. 1986). Furthermore, differentials of a comparable size exist between squatter settlements and organized housing areas (e.g. Guimaraes and Fischmann 1985).

is based on secondary analysis of Demographic and Health Surveys (DHS) data collected during the late 1980s in Ghana, Egypt, Brazil and Thailand.[2]

The first objective of the research is to document and compare the scale of socio-economic differentials in child mortality, morbidity and anthropometry within the urban sector of several less developed countries. Second, we investigate the extent to which such differentials in health can be related to the environmental conditions in which different socio-economic groups live. This issue, and in particular the effect of water supplies and sanitation on child health, has attracted the interest of public health engineers, epidemiologists, demographers and other public health specialists. There is a large literature on it,[3] although most studies have been conducted in rural areas and may not apply to urban settings (Esrey and Sommerfelt 1991). The findings suggest that increases in the quantity of water used for personal and domestic hygiene have more effect on health than improvements in water quality and that the provision of a water supply to a dwelling is the crucial step in the improvement of services that leads to substantial increases in water use. Improved sanitation, on the other hand, probably has a particularly strong effect on infection with intestinal parasites. As such infections are rarely fatal, the type of toilet facility used may be associated more closely with morbidity and nutritional status than with mortality.

Improvements in the urban environment appear to have played a major role in the decline in mortality in European cities in the nineteenth century (e.g. Preston and van de Walle 1978; Szreter 1988). Many studies of urban populations in the contemporary developing world have also found that environmental factors are strongly associated with child mortality (e.g. Tek•e and Shorter 1984; Merrick 1985; Victora et al. 1988; Monteiro and Benicio 1989; Crook and Malaker 1992). Despite this evidence, other studies have found that water and sanitation have no effect on mortality after the socio-economic status of households is allowed for (e.g. UN 1985; Pickering et al. 1987). Undoubtedly, one reason for such confused and contradictory findings is the practical and ethical difficulties involved in conducting controlled trials of environmental interventions using experimental designs (Cairncross 1990). In this field, both longitudinal and cross-sectional investigations are subject to methodological problems that could explain the contrasting findings of different studies (Blum and Feachem 1983). Both measurement errors and imperfect study designs are probably important. For example, the use of crude indicators that fail to measure accurately either environmental exposure or outcomes may explain some negative findings, while residual confounding with socio-economic status or hygiene consciousness, even after attempts to control for this, could produce a false impression of a positive effect (Cairncross 1990).

It also seems likely that the influence of the urban environment on health is complex, and conditioned by a wide range of other characteristics and behaviours. For example, the effect of improved water and toilet facilities on child health may vary between individuals and populations depending on parental education (Stephens 1984; Esrey and Habicht 1988), child feeding practices (Butz, Habicht and Da Vanzo 1984), or income. In addition, households with better facilities may obtain few health benefits if the level of environmental contamination in the community is high (Feachem et al. 1983). Thus, differences in environmental conditions between neighbourhoods may be associated with larger differentials

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[2] Details of the questionnaires, sample design and field procedures used in these surveys are published in the survey reports (Arruda et al. 1987; Chayovan, Kamnuansilpa and Knodel 1988; Abdel-Aziz Sayed et al. 1989; Ghana 1989).

[3] A number of good reviews of this field which have been published recently contain comprehensive references to the primary research literature. They include Esrey, Feachem and Hughes (1985), Cairncross (1990), Huttly (1990) and Esrey et al. (1991).

in health than differences in household-level facilities (Koopman, Fajardo and Bertrand 1981; Bapat and Crook 1984; Pickering et al. 1987; Bateman and Smith 1991).

A general-purpose, single-round household survey such as those conducted by the DHS can be used to improve our understanding of only some of these issues. It is not a suitable tool for establishing definitively the degree of effect that various environmental interventions can have on health. It is also of limited use for unravelling the behavioural mechanisms that mediate between service provision and improved health. Instead, we focus several related questions of relevance to urban development policy.

First, because the DHS has conducted comparable surveys in a series of countries at differing levels of development, it can be used to investigate whether the relationship between the urban environment and child health in urban areas differs systematically with the overall standard of living in a population. If environmental services have a significant effect on mortality that is separable from the influence of household socio-economic status, differentials in urban child health should be largest at intermediate levels of provision (Huttly 1990). Where the overwhelming majority of the population either has, or lacks, access to basic services, smaller differentials would be expected. If, on the other hand, the apparent influence of environmental factors on health largely reflects residual confounding with socio-economic status, the degree of inequality in associated health outcomes may remain more or less constant across countries at different levels of development.

A second characteristic of the DHS is that it collects information on mortality, the nutritional status of children and diarrhoea prevalence. Thus, it has potential for exploring the relationship between the pattern of differentials in each of these health outcomes by socio-economic status and aspects of the urban environment. Relationships between morbidity, growth faltering and child mortality are complex and vary between populations. They can nevertheless be seen as successive stages of ill-health (Mosley and Chen 1984). Because the influence of socio-economic status on exposure to infection is likely to be compounded by different care and use of health services, differentials in long-term outcomes, such as stunting and mortality, tend to be larger than those in outcomes related to acute infection, such as diarrhoea prevalence and wasting. However, if environmental factors have a causal effect on infection, then in comparison with long-term outcomes, differentials in acute ill-health by environmental measures should be larger and more consistent than those by socio-economic measures.

Third, many studies of urban child health have been conducted in only one or a few communities in a country. In contrast, the DHS uses clustered sample designs to collect data that represent the entire range of urban environments in the countries surveyed. The surveys can be used, therefore, to investigate the extent to which health differentials associated with water and sanitation distinguish small geographical areas within which children share related risks of infection, rather than differences between households related to their facilities. Household facilities can be viewed as intermediate variables that are shaped by both demand (as a function of household income and education) and supply (as measured by whether neighbouring households have adequate facilities). If the environment of the neighbourhood affects health after controlling for the socio-economic status of the household, supply of services is clearly important. If conditions in the cluster remain important after further controlling for household facilities, this suggests that young children are at risk from the extra-household environment and that there are significant consequent benefits to other households from partial provision of services.

## Data and methods

Several often conflicting criteria influenced the decision to base the research on Ghana, Egypt, Brazil and Thailand (see Table 1). They include the size of the urban sample in each DHS survey, the amount of information collected on child health, our desire to investigate populations with differing levels of mortality from diverse regions of the world and whether the country has granted permission for use of its data in comparative research. We necessarily follow the DHS program in accepting local definitions of an urban area in each country. This approach is most problematic in Thailand where the DHS classified only officially designated municipalities as urban; this administrative definition excludes some areas that have acquired urban characteristics recently. If allowance is made for this, about 22 per cent of the population live in urban areas, compared with 18 per cent according to the DHS results (UN 1992). Brazil is included in the analysis, despite the fact that the DHS survey did not collect anthropometric data in most of the country, partly because it was the location of a linked field study with complementary objectives (Stephens et al. 1994). Unfortunately, very poor countries and those with a very high mortality rate under age five tend to be characterized by low levels of urbanization. No such country participated in Phase I of the DHS program and collected data from a large enough urban sample to be included in this study. According to UNICEF's (1993) classification, the under-five mortality rate is high in Ghana and Egypt and moderate in Brazil and Thailand. Very high mortality countries are those where the rate exceeds 140 per thousand. Thus, our results do not extend to an examination of urban health at its worst.

**Table 1**
**Countries and surveys included in the study**

| Country | GNP per capita (US$ - 1991) | National U5MR - 1991 (per 1000) | Urban U5MR - DHS (per 1000) | Survey date | Urban sample (women) |
|---|---|---|---|---|---|
| Ghana | 400 | 137 | 122 | 1988 | 1523 |
| Egypt | 610 | 85 | 69 | 1988-9 | 4409 |
| Brazil | 2940 | 67 | 67 | 1986 | 4514 |
| Thailand | 1570 | 33 | 27 | 1987 | 2423 |

Sources: GNP: World Bank (1993); National U5MR: UNICEF (1993).

Note: U5MR is mortality rate under age 5

The DHS surveys were undertaken among all women of childbearing age (15 to 49 years) in Ghana and Brazil but only ever-married women in Egypt and Thailand. The core questionnaire includes a detailed birth history from which can be calculated life table measures of the probability of death in a range of age intervals. To minimize misclassification biases arising from changes in environmental and socio-economic conditions between the birth of children and time of interview, all the estimates come from period life tables based on children's experience during the five years immediately before the survey.[4] To reduce sampling errors, all these are smoothed by fitting two-parameter relational model life tables in conjunction with the estimation of the effects of the explanatory variables by logistic regression. The procedure used was proposed first by Boulier and Paqueo (1988) and is

4 Because of our concern with environmental conditions, all our analyses exclude the small number of women who were visiting the household where they were interviewed. In all four countries, about 80 to 90 per cent of residents have been living in the same area for at least five years.

discussed as Method IIIc in Trussell and Preston's (1982) investigation of methods for estimating the covariates of childhood mortality. One reservation about the method expressed in these papers is that it is difficult to distinguish variation in the 'slope' of mortality from variation in the time trend in mortality when analysing data on a sample of children born over a lengthy period of time. This issue is of no concern in this application as we use the approach to model period life tables. The standard life table used is a version of the Ewbank et al. (1983) standard that has been extended to include a measure of neonatal mortality (Blacker, Hill and Timaeus 1985) and the model is fitted to the probabilities of dying by ages one month, one year, five years, 10 years and 15 years.

The morbidity data considered here are based on mothers' reports about diarrhoea and, in particular, on the period prevalence of diarrhoea during the last week in Egypt and a two-week period elsewhere.[5] The surveys of Ghana, Egypt and Thailand collected anthropometric data on the heights and weights of children aged between three months and three years. These data are used to study differentials in the prevalence of moderate and severe stunting (low height for age), as a measure of accumulated health deficits due to infection and inadequate nutrition, and wasting (low weight for height), as a measure of more acute ill-health, reflecting illness and inadequate nutrition recently.[6] Where appropriate, we model the determinants of diarrhoeal disease and malnutrition using logistic regression and present fitted estimates of their prevalence.

Apart from the presentation of detailed estimates of mortality by age, the analysis focuses on children aged between six months and three years. Whereas maternal antibodies provide younger children with some protection from infections, this age group is particularly vulnerable to infectious disease linked to environmental conditions. In addition, use of it circumvents some of the reporting errors that can bias outcome measures for more conventional age groupings, including the rounding of ages at death to one year.

Most DHS surveys have not attempted to collect information about income directly. Instead, respondents were asked about their and their husbands' occupations and levels of schooling and about the consumer durables owned by the household. This information is used to divide families into four ranked socio-economic groups of approximately the same size. Somewhat different variables and weights are used to construct this index in the four countries, reflecting the differing conditions of their populations (see Appendix).

The information about environmental conditions collected in the core questionnaire covers source of drinking water supply[7], toilet facilities and, except in Brazil, data on the materials used to construct dwellings . These data are used both to examine the association between the facilities available to the household and child health, and to divide families into four approximately equal-sized groups according to environmental conditions in the sampling cluster where the household is located (see Appendix). This index allows us to examine the association between the environmental characteristics of the neighbourhood where children live and their health.

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5 Point prevalence data for the last 24 hours are also available. They follow broadly similar patterns and should be reported more accurately but estimates for the urban children are affected badly by sampling errors.

6 Stunted and wasted children are defined as those falling more than two standard deviations below the NCHS/CDC reference standards (WHO 1983). Exploratory analyses using mean Z-scores as an alternative outcome measure yielded very similar patterns of differentials.

7 The source of drinking water indicator yielded by the DHS questionnaire both conflates and imperfectly measures the quantity of water used by households and its quality. Unfortunately, no information is available about water purity or the frequency of interruptions to supply.

In any study of child health and mortality in the developing world, the quality of the data being analysed is open to question. While DHS surveys are conducted to high standards, several potential problems need to be borne in mind when interpreting the results of this study. First, fertility surveys are designed to yield data on the children of women in households but not on orphans or 'street children'; thus, these results fail to reflect the health of some of the most disadvantaged children in the developing world. Second, sampling frames for urban areas in developing countries rapidly become out-of-date and commonly omit newly-settled squatter camps. The relatively high standard of facilities reported in Accra, compared with the conditions identified elsewhere (Stephens et al. 1994), suggest that this may be a problem in at least the Ghana DHS.

A third major data quality issue is reporting and measurement errors. Exact dates of birth may have been forgotten, reported ages at death of children are often rounded to complete years and systematic biases can arise in the measurement of heights and weights. Recall errors are more serious in Ghana than in the other surveys and the data for Brazil seem highly accurate (IRD 1990).[8] Non-response may somewhat affect the representativeness of the anthropometric data. These measures were obtained from only 92 per cent of eligible children in Thailand, 84 per cent in Egypt and 82 per cent in Ghana. No major response biases are evident, though the poor tend to be slightly under-represented. Finally, while nearly all the mothers answered the questions about diarrhoea in their children, respondents' interpretation of these questions almost certainly varies across the four countries and probably also differs according to the level of education of the women and their exposure to the modern health sector (Murray and Chen 1992; van Ginneken 1993).

## Conditions in urban areas

This section describes the socio-economic characteristics of the population and environmental conditions in the urban sector of each of the four countries and discusses the association between families' socio-economic status and housing conditions.

Ghana is a low-income country (World Bank 1993). Some 34 per cent of the population live in urban areas (UN 1992). Two thirds of women in Accra and just over half those in the other urban areas are literate, while a fifth in Accra and 10 per cent in other areas have secondary education. Although Ghana's urban population is the poorest and worst housed of the four considered in this study, most urban dwellers live in fairly soundly constructed dwellings and have access to some basic services. Conditions in Greater Accra are better than elsewhere and all of the quarter of the urban clusters with the worst environmental conditions are located outside Greater Accra.

In Accra, a quarter of women of childbearing age live in dwellings with a water-closet (WC); in other urban areas, this proportion is 13 per cent. While many urban households have a pit latrine, 13 per cent of women lack access to any facility. In Accra, in the areas surveyed by the DHS, access to piped water is universal and over half the women have water piped into their home. In the other urban areas, only 60 per cent of women have access to piped water and only a quarter to a supply within the dwelling. Few urban households still have earth or mud floors or thatched roofs. In urban areas outside Accra, however, 41 per cent of women live in dwellings constructed with earth or burnt brick walls.

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8 Even in Ghana, event reporting seems to have been fairly complete for the 15 years before the survey and both a month and year of birth were reported for about 90 per cent of children born in the last five years. However, rounding of ages at death of older infants up to one year may lead the uncorrected infant mortality rate to be about five percentage points too low (IRD 1990).

Egypt is a low-income country but is approaching 'lower-middle income' status (World Bank 1993). Some 44 per cent of the country's population now live in urban areas (UN 1992). Around 50 per cent of the women are literate, which is a lower proportion than in Ghana, but over 40 per cent of this group have been to secondary school. A high proportion of women have access to basic water supply and sanitation services. According to the survey, practically all urban households have access to a piped water supply and 84 per cent of women have a tap in their dwelling. In Cairo, over half the ever-married women aged 15 to 49 years live in dwellings with a modern WC, though this proportion is lower in Alexandria (48 per cent) and other urban areas (35 per cent). Those households without a WC nearly all have pour flush toilets and 70 per cent of these are attached to a public sewer. Very few women in Cairo live in dwellings that have poor quality (earth or wooden) floors but the proportion is higher in Alexandria and rises to a fifth in other urban areas. Of the quarter of clusters identified as having the worst environmental conditions, only one is located in Cairo.

Brazil is classified as an upper-middle income country by the World Bank (1993) and, according to the DHS data, this is reflected in living conditions in its urban areas. The country is now well on the way to providing basic water and sanitation facilities for its urban dwellers, who make up about 75 per cent of the country's total population (UN 1992). While only a third of women are educated to secondary level, over 90 per cent are literate and half read a newspaper at least once a week.

In Brazil's major cities, nearly two thirds of women live in dwellings that are equipped with a WC. In other urban areas, this proportion is just under 50 per cent. Nevertheless, while 22 per cent of other women have a proper septic tank, about a quarter of women live in households that lack adequate toilet facilities. Over 90 per cent of urban households have access to piped water and about 80 per cent of women have a tap in their dwelling. Of the quarter of the clusters with the best environmental conditions, only one is in the deprived North-East region of the country.

Thailand is a lower-middle income country with a rapidly growing economy (World Bank 1993). Only 18 per cent of ever-married women live in either the only major city, Bangkok, or in other urban areas (see p. 166). In Thailand, 95 per cent of urban women are literate, although 29 per cent of this group say that they can read only with difficulty. Although gross national product per capita in Thailand is lower than in Brazil, the living conditions of the urban poor are at least as satisfactory. Nearly all urban households have access to an electricity supply and an adequate toilet facility. The proportion with a WC is higher in Bangkok (16 per cent) than in other urban areas (6 per cent); most other households have a toilet that drains into a tank. In addition, the homes of 90 per cent of the women in Bangkok and 70 per cent of other urban women have an individual piped water supply. Nevertheless, 18 per cent of women drink bottled water and 12 per cent rainwater. Outside Bangkok, 19 per cent of urban women obtain their drinking water from wells.

Table 2 examines the proportions of women living in dwellings with water piped into them and with a WC according to the four-way socio-economic classification. Access to environmental services is clearly lowest in Ghana. Only 36 per cent of urban women have a domestic piped water supply, compared with about 80 per cent elsewhere. Moreover, fewer of the best-off quarter of women in Ghana have piped water in their dwelling than of the poorest quarter of the population in the other three countries. While the proportion of the urban population with a WC is even lower in Thailand than Ghana, this reflects heavy reliance on septic tanks. Only 10 per cent of the poorest quarter of women in Thailand live in dwellings with neither a WC nor a toilet connected to a tank. In both Egypt and Brazil about half the women living in towns and cities have a WC. Provision is worse for the poor in Egypt than in Brazil.

**Table 2**
**Access to environmental services by socio-economic status.**

| Socio-economic status | Ghana | Egypt | Brazil | Thailand |
|---|---|---|---|---|
| **Women with a piped water supply within the dwelling (%)** | | | | |
| 1 - Low | 18.1 | 66.2 | 64.1 | 73.2 |
| 2 | 26.3 | 82.4 | 76.7 | 79.4 |
| 3 | 39.9 | 91.8 | 89.2 | 86.3 |
| 4 - High | 57.8 | 98.1 | 97.2 | 92.5 |
| Overall | 36.1 | 84.3 | 80.6 | 82.8 |
| Gini Coefficient | 0.23 | 0.08 | 0.09 | 0.05 |
| **Women with a WC (%)** | | | | |
| 1 - Low | 6.1 | 16.3 | 36.8 | 2.6 |
| 2 | 8.3 | 35.8 | 44.8 | 5.1 |
| 3 | 16.9 | 56.4 | 64.0 | 10.4 |
| 4 - High | 34.1 | 85.6 | 76.4 | 29.5 |
| Overall | 17.1 | 48.0 | 54.0 | 11.9 |
| Gini Coefficient | 0.35 | 0.29 | 0.16 | 0.45 |

Table 2 provides some insight into the degree of socio-economic inequality in access to environmental services in these four countries. As the four socio-economic groups considered here are defined to be approximately the same size, inequality between them can be summarized by Gini Coefficients.[9] These coefficients confirm, first, that inequality in access to adequate toilet facilities is greater than that in access to water supplies and, second, that social inequalities in access to basic environmental services are greater in Ghana than in the three more developed countries. The Gini Coefficient for access to either a WC or toilet with a tank in Thailand is just 0.02. Together with the coefficient for access to an individual piped water supply this suggests that there is greater equity in access to water and sanitation services in Thailand than in either Brazil or Egypt.

Even in Ghana, socio-economic status and housing conditions are not very closely related. Some relatively affluent families live in very poor housing and some of the poor are well housed. In all four countries about a fifth of children live in housing that is of a much higher or much lower standard than would be expected from their family's socio-economic characteristics. Thus, the influence of socio-economic status on child health can be distinguished from that of environmental services.

Towns and cities in these four countries are divided into differentiated housing areas: there is a close relationship between overall environmental conditions in a cluster and the facilities in each household. Where the necessary infrastructure exists most dwellings have individual facilities. In Brazil, for example, all the households in the quarter of clusters with

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9 The calculation of Gini Coefficients from aggregate data is somewhat unusual but can be justified when the groups are of the same size. As in more usual applications, the coefficients represent a scale independent measure of inequality in a distribution. The coefficients relate the average absolute difference between every pair of groups to the mean level for the four groups and usually vary between zero, when provision is perfectly equal, and one, when provision is limited to a single member of a large population. Our data are pre-ordered and when the differential is in the counter-intuitive direction the coefficients are accorded a negative sign.

the best services have their own WC but, in the quarter of clusters with the worst sanitation, almost no households have a WC. In contrast to Brazil and, to a lesser extent, Ghana and Egypt, clusters that contain a mix of housing built to different standards are relatively common in Thailand: here environmental conditions differ less between the four cluster environmental groups than elsewhere.

Socio-economic status is also associated only loosely with the type of area in which families live. In all four countries, about a quarter to a third of the poorest quarter of children live in clusters with better than average environmental conditions and a similar proportion of the children from the quarter of households of the highest socio-economic status live in clusters with worse than average environmental conditions. Thus, the degree of residential segregation between socio-economic groups in the urban areas of these countries is limited: some relatively affluent families live in squatter settlements or inner city slum areas and some poor families in areas of planned housing. Some of the well-housed poor are servants, but the diversity of the occupations of this group is striking. Residential segregation is least clear cut in Thailand, reflecting the existence of mixed housing areas, and highest in Egypt, where there is a relatively strong tendency for socio-economic status to be reflected in housing conditions.

## Univariate differentials

Table 3 presents a range of indicators of child health in the age group six months to three years for the four countries, according to sex, place of residence, socio-economic group and cluster environment group. The prevalence of most indicators of ill-health is highest in urban Ghana and lowest in Thailand. For example, the overall probability of death in childhood in urban Ghana is nearly double that in Egypt and Brazil and more than four times that in Thailand (see Table 1). Nevertheless, some exceptions to this pattern exist, notably the high proportion of children in Egypt who are classified as stunted. As the proportion of wasted children is very low in Egypt, there may have been significant biases in the measurement of height in this country (Pelletier 1991). This does not appear to affect our analyses of differentials in stunting within Egypt. It may invalidate comparisons between Egypt and the other countries of the prevalence of stunting.

**Table 3**
**Differential mortality, morbidity and nutritional measures in children aged 6 - 36 months**

| Country | Outcome | Sex | | Place of Residence | | Socio-economic group | | | | | Cluster environment group | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Female | Male | Major city | Other | 1 (low) | 2 | 3 | 4 (high) | Gini | 1 (low) | 2 | 3 | 4 (high) | Gini |
| Ghana | Mortality (per 1000) | 41 | 59 | 32 | 68 | 62 | 39 | 46 | 44 | 0.06 | 65 | 38 | 42 | 51 | 0.05 |
| | % Stunted | 26 | 29 | 21 | 30 | 34 | 29 | 24 | 20 | 0.11 | 37 | 28 | 22 | 18 | 0.15 |
| | % Wasted | 7 | 8 | 5 | 9 | 8 | 9 | 8 | 6 | 0.06 | 8 | 8 | 10 | 5 | 0.06 |
| | % Diarrhoea in last 2 weeks | 37 | 37 | 37 | 36 | 36 | 48 | 33 | 32 | 0.05 | 36 | 41 | 41 | 26 | 0.15 |
| | Number of children | 282 | 263 | 164 | 381 | 195 | 100 | 124 | 126 | | 172 | 141 | 123 | 109 | |
| Egypt | Mortality (per 1000) | 21 | 21 | 21 | 29 | 30 | 24 | 19 | 6 | 0.24 | 34 | 20 | 15 | 7 | 0.28 |
| | % Stunted | 30 | 25 | 22 | 29 | 35 | 25 | 24 | 25 | 0.07 | 34 | 27 | 26 | 18 | 0.12 |
| | % Wasted | 1 | 2 | 0 | 2 | 1 | 0 | 2 | 1 | -0.13 | 3 | 0 | 0 | 0 | 0.75 |
| | % Diarrhoea in last week | 21 | 23 | 21 | 23 | 28 | 23 | 22 | 15 | 0.11 | 22 | 28 | 16 | 19 | 0.06 |
| | Number of children[a] | 832 | 855 | 399 | 1288 | 413 | 419 | 415 | 440 | | 481 | 519 | 374 | 313 | |
| Brazil | Mortality (per 1000) | 18 | 21 | 10 | 20 | 39 | 20 | 9 | 3 | 0.42 | 48 | 11 | 11 | 2 | 0.48 |
| | % Stunted | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| | % Wasted | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| | % Diarrhoea in last 2 weeks | 23 | 19 | 20 | 21 | 28 | 22 | 16 | 14 | 0.15 | 30 | 23 | 15 | 14 | 0.17 |
| | Number of children | 483 | 610 | 380 | 713 | 333 | 291 | 248 | 221 | | 350 | 290 | 297 | 156 | |
| Thailand | Mortality (per 1000) | 5 | 8 | 7 | 5 | 10 | 5 | 6 | 3 | 0.21 | 8 | 6 | 4 | 7 | 0.05 |
| | % Stunted | 9 | 13 | 10 | 13 | 19 | 10 | 7 | 6 | 0.25 | 9 | 10 | 12 | 13 | -0.08 |
| | % Wasted | 5 | 4 | 5 | 3 | 6 | 4 | 5 | 2 | 0.16 | 4 | 5 | 5 | 3 | 0.04 |
| | % Diarrhoea in last 2 weeks | 11 | 14 | 14 | 11 | 20 | 12 | 10 | 9 | 0.16 | 19 | 16 | 5 | 10 | 0.19 |
| | Number of children | 312 | 315 | 345 | 282 | 169 | 160 | 132 | 166 | | 177 | 164 | 145 | 141 | |

[a] In Egypt anthropometric data were collected from every other child.

Looking first at sex differentials, mortality is generally somewhat higher and stunting slightly more common among boys than girls. In Egypt, however, there is no sex differential in mortality in this age group and girls are more likely to be stunted than boys. Sex differentials in the period prevalence of wasting and diarrhoea are small and fluctuate erratically. Table 3 also shows that child health tends to be better in the major cities of Ghana, Egypt and Brazil than in smaller towns and cities.[10] In Thailand, the absolute differentials are small but tend to suggest that child health is worse in Bangkok. This is probably because the socio-economic status of households in Bangkok seems no better overall than that of households in other urban areas of Thailand. In the other three countries, the major cities have marked advantages according to many of the socio-economic indicators considered here. There is much less variation by place of urban residence in acute indicators of child health, such as diarrhoea, than in mortality. Except in Ghana, these differences in child health between the major cities and other urban areas are much smaller than the socio-economic and environmental differentials discussed in the rest of this paper. Thus, the unequal living conditions of different social groups tend to contribute more to differentials in child health within the urban sector than differences between urban areas in environmental and health infrastructure. As differentials in child health by sex and place of residence are fairly small, all the results that follow are presented for the two sexes combined and the entire urban sector to maintain the precision of the estimates.

Among children aged six months to three years, both relative and absolute socio-economic differentials in urban mortality are small in Ghana, increase in size through Egypt to Brazil, but are more moderate in Thailand. Figure 1 examines socio-economic inequality in mortality in the entire age range 0-15 years. The plots express the death rates on a log scale. Thus, constant differences between the lines imply equal relative risks of dying, rather than equal absolute differences in death rates. Socio-economic differentials in mortality are relatively small in the neonatal period but widen rapidly with increasing age. The relative differentials are small in Ghana and are not statistically significant at the 5 per cent level, although there is some suggestion that the urban poor have particularly high mortality. Socio-economic differentials are larger and significant in Egypt, where the best-off quarter of urban children has much lower mortality than the majority. In Brazil, the differential is still wider and rich children enjoy low mortality, the middle 50 per cent have fairly low mortality but poor children still have high mortality. Thus, although overall urban child mortality in Egypt and Brazil is about half that in Ghana, in both countries the poorest quarter of urban children has mortality that is nearly as high as the mortality of the least disadvantaged children in

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10 We classify Accra, Cairo and Bangkok as major cities, together with a number of cities in Brazil. Over half the population of Brazil's major cities live in the metropolises of Rio de Janeiro and S‹o Paulo.

Ghana. In Thailand, the whole of the urban population benefits from relatively low child mortality. Thus the poorest children in Thailand have only slightly higher mortality than the most privileged quarter in Egypt and Brazil. The degree of inequality in mortality by socio-economic group in Thailand lies between that in Egypt and Ghana.

**Figure 1**
**Age-specific death rates at 0 to 15 years by socio-economic group (1=low; 4=high)**

Table 3 also reveals large differences in the health of living children by socio-economic group. In Ghana and Thailand, there is greater socio-economic inequality in stunting than is apparent in the mortality results. Moreover, there is a consistent inverse relationship between the proportion stunted and socio-economic status; in Egypt, however, there is no significant difference between the socio-economic groups (at the 5 per cent level). In both Thailand and Egypt, there is some suggestion that stunting is particularly a problem of the poor. The results for wasting only show clear evidence of a relationship with socio-economic group in Thailand; this probably reflects the large sampling errors of estimates of the prevalence of this relatively uncommon state. There is a large and significant socio-economic differential in the period prevalence of diarrhoea in all countries, including Brazil. However, the poorest quarter of the women in Ghana report rather little diarrhoea in their children and the next quarter much more. To summarize, it appears that inequalities in child health, like those in mortality, are comparatively small in Ghana. Differentials in diarrhoeal morbidity are substantial in the other countries: in Thailand, differentials in nutritional status are also significant. None of these indicators of the health of living children, however, exhibits the five- to thirteenfold socio-economic differentials found in mortality in Egypt and Brazil.

Relationships between the cluster environment and mortality, stunting, wasting and diarrhoea in the two weeks before the survey are also shown in Table 3. There is considerable variation in all outcomes according to environmental conditions. Compared with the socio-economic differentials, environmental disparities in mortality are even greater in urban Brazil but less clear-cut in urban Ghana or Thailand. There are larger cluster-environment than socio-economic differentials for stunting in Ghana and Egypt but smaller ones in Thailand. The prevalence of diarrhoea exhibits a clear trend by cluster-environment group in Brazil and Thailand. Elsewhere the picture is confused. Except in Thailand, the relationship between the environmental characteristics of neighbourhoods and child mortality and morbidity is stronger than that found for socio-economic status.

## Bivariate differentials

Figure 2 shows the joint effects of socio-economic status and cluster environment on mortality, stunting and diarrhoea in the previous two weeks.[11] For mortality, the four-way socio-economic and cluster-environment classifications are collapsed into two categories (1 = poorer; 2 = less poor) so as to obtain reasonably precise results despite the small numbers of deaths reported. In urban Ghana and Thailand the major influence on the probability of dying between ages 6 months and 36 months is socio-economic status and not environmental conditions in the cluster. Nevertheless, the small effect of the environment in Ghana is statistically significant at the 10 per cent level. In Egypt there is a significant interaction between the two sets of influences: those children who both enjoy a good environment and are relatively well off have particularly low mortality. In Brazil the reverse interaction is found: those poor people who also live in bad conditions have much higher mortality than any other group.

While socio-economic group tends to be the more important determinant of urban mortality, cluster environment is more strongly associated than socio-economic group with the prevalence of stunting among young children in Ghana and Egypt; the counter-intuitive direction of the effect of cluster environment in Thailand is not statistically significant. Significant results for wasting (not shown) are obtained only in Egypt: in this country, despite

[11] These are fitted estimates produced using logistic regression. The model of mortality is described on pp. 166-167. Age in months is included in all the models as a covariate. Age squared is included in the models for stunting, so as to model the peak in its prevalence around the time of weaning, but does not improve the fit of the models for diarrhoea prevalence. The fitted odds underlying the graphs for stunting and for diarrhoea are presented as Model 1 in Tables 5 and 6. The statistics shown in Figure 2 refer to the midpoint of the age interval 6-36 months.

small numbers, there is a sharp differential in wasting between clusters (significant at the 10 per cent level) after controlling for socio-economic factors.

Landscape page for figure 2

Both socio-economic status and environmental conditions in the cluster are associated with the period prevalence of diarrhoea at 6 - 36 months; the differentials are larger and clearer in countries in which the prevalence of diarrhoea is lower. This is particularly evident when environmental variation is examined: thus, cluster-environment differentials are larger than socio-economic ones in urban Brazil and Thailand but insignificant in Egypt. In Brazil and Thailand, the cluster environment explains part of the socio-economic effect; in Egypt it does not and, moreover, socio-economic status is more strongly related than the cluster environment to the period prevalence of diarrhoea. In contrast, in Ghana there is limited variation according to either factor (if the lower two socio-economic groups are averaged), with the exception that children with the best cluster environment have significantly lower diarrhoea rates than anyone else. This may be because environmental conditions are so poor in most parts of urban Ghana that children are frequently exposed to infection whatever their socio-economic status.

To summarize, after socio-economic status is controlled for , environmental conditions in the area where young children live are strongly related to their mortality in Egypt and Brazil, to stunting in Ghana and Egypt and to diarrhoea prevalence in Brazil, Thailand and, for the best conditions, Ghana.

Table 4 examines the relationships between household water and sanitation facilities, and mortality, stunting and diarrhoea between six and 36 months of age by socio-economic group. A two-way socio-economic classification is used that distinguishes the poorer and better off halves of each urban population. Thailand is not included in this table because most households have both a toilet draining into a tank and water piped into their home. The small number of households with other types of water supply and toilet, combined with the relative infrequency of adverse health outcomes in Thailand, means that any real variation by household facilities is overwhelmed by sampling errors.

**Table 4**
**Mortality, morbidity and nutritional measures in children aged 6-36 months by household water and sanitation facilities and socio-economic status.**

| | Ghana | | Egypt | | Brazil | |
|---|---|---|---|---|---|---|
| | Socio-economic group | | | | | |
| | Low | High | Low | High | Low | High |
| **Mortality (per 1000)** | | | | | | |
| Water piped in | 68 | 24 | 35 | 13 | 18 | 2 |
| Other water | 65 | 68 | 56 | 121 | 40 | 9 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Flush toilet | 43 | 48 | 13 | 9 | 24 | 0 |
| Other toilet | 80 | 48 | 41 | 23 | 29 | 7 |
| **Percentage stunted** | | | | | | |
| Water piped in | 11 | 18 | 29 | 24 | — | — |
| Other water | 36 | 25 | 32 | 39 | — | — |
| Flush toilet | 32 | 21 | 25 | 22 | — | — |
| Other toilet | 33 | 23 | 32 | 30 | — | — |
| **Percentage with diarrhoea in 2 weeks before study**[a] | | | | | | |
| Water piped in | 46 | 30 | 25 | 19 | 20 | 15 |
| Other water | 39 | 35 | 28 | 15 | 31 | 21 |
| Flush toilet | 39 | 30 | 24 | 17 | 13 | 14 |
| Other toilet | 40 | 36 | 26 | 21 | 30 | 18 |

[a]In Egypt diarrhoea was measured over a one-week period.

In Ghana, the mortality results in Table 4 reveal an interaction between socio-economic status and water facilities. Those children who are of high status and have water piped into their home have much lower mortality than anyone else. On the other hand, those who are of low socio-economic status and have no flush toilet fare much worse than the rest of the urban population. In Egypt, water facilities and socio-economic status also interact: children who are of high status and have water piped into their home have much lower mortality than anyone else. Moreover, there is some suggestion that, as in Ghana, children in poor households that also lack a WC have particularly high mortality. In Brazil, the household’s water and sanitation facilities are both associated with mortality after controlling for socio-economic status.

Stunting is more common among those Ghanaian children living in households that lack access to their own piped water supply (see Table 4). The difference is greater for those of low socio-economic status. Toilet facilities do not affect stunting after controlling for socio-economic status. In Egypt, on the other hand, both toilet and water facilities are related to stunting. Moreover, socio-economic status is not very important after controlling for access to water and sanitation.

In Ghana, according to Table 4, socio-economic status is more strongly associated than either water or sanitation facilities with the prevalence of diarrhoea. Egyptian children are less likely to have diarrhoea if they live in households with access to a flush toilet but gain no such advantage from living in dwellings with an individual piped water supply. In Brazil children from both poor and more wealthy households have higher rates of diarrhoea if they have poor water and sanitation facilities than if they have access to piped water and flush toilets. In all three countries, a socio-economic differential in diarrhoea prevalence in the expected direction persists after household facilities are controlled for .

## Multivariate differentials

In this section, we further examine the net effect of the factors associated with the prevalence of stunting and diarrhoea. Unfortunately, the urban samples available from the DHS surveys are too small for us to analyse differentials in recent mortality in this way. The estimated odds of children aged 6 - 36 months being stunted or having diarrhoea, compared with a baseline category, are presented in Tables 5 and 6. The mediating role of household facilities in the determination of child health is examined by comparing models that exclude them (Model 1) with models that do not (Model 2). The nature of households’ water supply and toilet facilities is linked. The two measures are never both associated significantly with child health after socio-economic status and cluster environment are controlled for. Results are shown only for those indicators of the household environment that are significantly associated with health outcomes.

In urban Ghana, the nature of the household's water supply is strongly associated with stunting after controlling for socio-economic status and the environment of the cluster in which the household is located (Table 5). Adding this indicator to the model greatly attenuates the relationship between the cluster environment and stunting. In contrast, in Egypt, household-level environmental variables do not intervene in the strong relationship between the cluster environment and stunting. Finally, in Thailand, the cluster environment is unrelated to stunting but children in households with poor or no toilet facilities are much more likely to be stunted than other children after socio-economic status is controlled for. This pathway accounts for a small part of the association between socio-economic status and stunting.

**Table 5**
**Odds of moderate or severe stunting (low height for age), children aged 6 to 36 months.[a]**

| | | Ghana | | Egypt | Thailand | |
|---|---|---|---|---|---|---|
| **Explanatory factor** | **Value** | **1/** | **2/** | **1/** | **1/** | **2/** |
| **Socio-economic group** | 1 (low) | 2.0** | 1.8* | 1.2 | 3.6*** | 2.7** |
| | 2 | 1.4 | 1.2 | 0.9 | 1.8 | 1.4 |
| | 3 | 1.1 | 1.1 | 0.8 | 1.2 | 0.9 |
| | 4 (high) | 1 | 1 | 1 | 1 | 1 |
| **Cluster environment group** | 1 (low) | 2.5** | 1.4 | 2.2** | | |
| | 2 | 1.6 | 1.1 | 1.7* | | |
| | 3 | 1.3 | 1.1 | 1.6 | | |
| | 4 (high) | 1.0 | 1 | 1 | | |
| **Water supply** | Piped in | | 1 | | | |
| | Piped out | | 1.8* | | | |
| | Other | | 2.4** | | | |
| **Type of toilet** | WC/tank | | | | | 1 |
| | Other | | | | | 2.7** |
| **Decrease in -2 log likelihood** | | 77.3 | 4.7 | 22.2 | 14.4 | 5.0 |
| **d.f.** | | 8 | 2 | 8 | 5 | 1 |

[a]All the models include age and age squared as covariates.

*P<10%, **P<5%, ***P<1%.

Note: 1/ and 2/ refer to Models 1 and 2 respectively. See text for details.

Turning to diarrhoea prevalence, in Ghana it is the household's toilet facilities, not its water supply, that are more strongly associated with this aspect of child health (Table 6).

However, controlling for this relationship does not greatly attenuate the cluster environment differentials. In Egypt, children in households that share toilet facilities are more likely to have diarrhoea than other children but controlling for this has little effect on socio-economic differentials in diarrhoea prevalence. In Thailand, children in households that do not drink piped water are less likely to suffer from diarrhoea than those in households that do: in this country, most such children drink bottled or rainwater, not surface or well water. Controlling for this does not reduce socio-economic differentials in diarrhoea prevalence but somewhat attenuates the cluster environment differentials.

In Brazil, household toilet facilities are associated strongly with diarrhoea but here, only those children in dwellings with poor toilet facilities who also live in poorer areas have higher diarrhoea rates (Table 6). This interaction is analogous to that between socio-economic status and cluster environment for mortality (see Figure 2). While about half the children in the group suffering a high prevalence of diarrhoea live in the deprived North-Eastern region of Brazil, further analyses (not shown) make it clear that it is poor environmental conditions that explain the high prevalence of diarrhoea in urban areas of the North-East, rather than confounding with region that produces the interaction.

**Table 6**
**Odds of diarrhoea in the previous two weeks, children aged 6 to 36 months.[a]**

| | | Ghana | | Egypt[b] | | Thailand | | Brazil | |
|---|---|---|---|---|---|---|---|---|---|
| **Explanatory factor** | **Value** | **1/** | **2/** | **1/** | **2/** | **1/** | **2/** | **1/** | **2/** |
| **Socio-economic group** | 1 (low) | 1.1 | 1.0 | 2.4*** | 2.2*** | 1.9* | 1.8 | 1.7** | 1.4 |
| | 2 | 2.0** | 1.9** | 1.7*** | 1.6** | 1.1 | 1.2 | 1.3 | 1.2 |
| | 3 | 1.1 | 1.0 | 1.5** | 1.5** | 1.0 | 1.0 | 1.0 | 1.0 |
| | 4 (high) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **Cluster environment group** | 1 (low) | 1.5 | 1.2 | 0.8 | 0.7 | 1.9** | 1.6 | 2.1*** | |
| | 2 | 1.8** | 1.6 | 1.3 | 1.2 | 1.6 | 1.2 | 1.6* | |
| | 3 | 2.0** | 1.8* | 0.7 | 0.7 | 0.5 | 0.4* | 1.0 | |
| | 4 (high) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |
| **Type of toilet** | WC | | 1 | | | | | | |
| | Pan/KVIP | | 1.3 | | | | | | |
| | Pit latrine | | 1.2 | | | | | | |
| | None | | 2.2* | | | | | | |
| **Shared toilet** | Yes | | | | 1.6** | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | No | | | | 1 | | | | |
| **Water** | Piped in | | | | | | 1 | | |
| | Bottled | | | | | | 0.3** | | |
| | Other | | | | | | 0.6 | | |
| **Cluster** | 1 or 2 / Other | | | | | | | | 2.6* |
| **environment** | / WC or tank | | | | | | | | 1.1 |
| **group by type** | 3 or 4 / Other | | | | | | | | 0.9 |
| **of toilet** | / WC or tank | | | | | | | | 1 |
| **Decrease in - 2 log likelihood** | | 32.1 | 4.3 | 109.7 | 7.4 | 30.9 | 7.0 | 40.2 | 57.3 |
| **d.f.** | | 7 | 3 | 7 | 1 | 7 | 2 | 7 | 0[c] |

[a]All the models include age as a covariate.

[b]In Egypt diarrhoea was measured over a one-week period.

[c]In Brazil, Model 2 is not nested in Model 1 but Model 2 is a significantly better fit than that for socio-economic group and a two-way cluster environmental grouping, while Model 1 is not.

*P<10%, **P<5%, ***P<1%.

Note: 1/ and 2/ refer to Models 1 and 2 respectively. See text for details.

## Discussion

The first aim of this analysis of DHS data has been to document socio-economic differentials in child mortality and morbidity within the urban sector of several developing countries. The pattern of differentials varies between countries according to both their overall degree of development nationally and their particular history of urban development. Thus, socio-economic differentials in child mortality within the urban sector of Ghana are modest and those in Thailand moderate, whereas the equivalent differentials are large in Egypt and very large in Brazil. In general, these differentials are larger than those recorded by the DHS surveys according to urban-rural residence or mother's education (Arruda et al. 1987; Chayovan et al. 1988; Abdel-Aziz Sayed et al. 1989; Ghana 1989). Even in urban Ghana, 18 per cent of the children of the poorest quarter of women die before age 15, compared with only 12 per cent of the children of other women. Moreover, except in Egypt, the mortality of the children of the urban poor is at least as high as that of the rural population as a whole.

In the four countries studied, a link exists between the overall level of child mortality in the urban population and the size of socio-economic differentials in mortality within the urban sector. In Ghana, overall urban child mortality is fairly high because the whole of the urban sector experiences high mortality, except perhaps for an elite that is too small to identify using these data. In Thailand, overall child mortality is low because even the urban poor have fairly low mortality. In contrast, in Egypt and Brazil, intermediate levels of urban child mortality reflect low mortality among the children of relatively affluent urban residents but high mortality among the urban poor. Thus, the benefits of development have accrued disproportionately to better-off urban dwellers in these two countries, while the basic needs of the urban poor manifestly remain unmet. The extent to which the wide differentials found in Egypt and Brazil are typical of other countries in the intermediate stages of mortality transition could only be established by a much larger-scale study. Elsewhere, economic and urban development policy may have ensured that the benefits of increasing national wealth are distributed more evenly across the urban sector.

Socio-economic differentials in young children's nutritional status and diarrhoeal morbidity are usually much smaller than those in mortality. As for mortality, differentials in the prevalence of diarrhoea are small in Ghana and larger in Egypt and Brazil. In Thailand, there are large socio-economic differentials in the prevalence of diarrhoea, wasting and stunting. Thus, in these four countries, better child health on average is associated with greater socio-economic inequalities in health. These findings suggest that the middle classes act more effectively to prevent their children's death than to preserve their children's health. In addition, it is only in the more developed of these countries that relatively affluent urban residents are able to protect their children from infection more successfully than the poor.

Thailand is characterized by relatively large socio-economic differentials in child morbidity but small ones in mortality. This implies that, although the poor remain more exposed to infectious disease, care for sick children is sufficiently effective that it usually prevents ill-health among poorer children progressing to death. Equally, the fact that modest socio-economic differentials in diarrhoeal disease in Egypt and Brazil lead on to larger differentials in stunting in Egypt and very large mortality differentials in both countries, suggests that differential use of health services and other forms of care is compounding the effect of differential exposure to infection between the urban poor and those who are better off.

The contrast between the pattern of child health and mortality in urban Thailand and urban Brazil is striking. Although GNP per capita is lower in Thailand than in Brazil, urban child mortality is much lower in Thailand. The fact that Brazil is much more urbanized than Thailand is probably pertinent; nevertheless, within their urban populations the health of the poorest quarter of children in Thailand is only slightly worse than that of the most affluent quarter in Brazil. This strongly suggests that greater equity within urban areas in provision of environmental services, health care and other aspects of social development not only reduces differentials in health outcomes among children, but can greatly affect the overall level of urban child health in a country.

The second aim of this study has been to investigate the role of the urban environment in shaping socio-economic differentials in child health and mortality. It focuses on the age range six months to three years as the determinants of health differ between early infancy and later childhood. The analysis compares patterns of socio-economic and environmental differentials in different outcome measures to try to separate the direct effect of the urban environment on child health from the effect of the socio-economic profile of the population living in areas with differing levels of facilities. As for socio-economic differentials, the relationship between the environment and child health varies between the countries.

In Brazil and Thailand, net cluster environment differentials in diarrhoea prevalence among children are larger than net socio-economic differentials, whereas the reverse is true for mortality. As was discussed above, this pattern suggests that living in an area with good facilities reduces diarrhoeal disease by limiting exposure. The clusters are less clearly differentiated in Thailand than elsewhere; this suggests that it is not the degree of inequality in environmental conditions that explains the size of the associated differentials in childhood diarrhoea, but whether they straddle an epidemiologically significant threshold. In Brazil, these cluster environment differentials in morbidity are precursors to differentials in mortality and part of the gross socio-economic differential in mortality is explained by environmental conditions. In addition, the negative effect of bad housing on mortality is much greater for the children of the poor than for those of the better-off, suggesting that only the latter have the resources to provide their sick children with the health and other care needed to stop a history of infections proceeding to death. In Thailand, however, the cluster environment differentials in diarrhoea are not mirrored in stunting or mortality after controlling for socio-economic status. Thus, in this country, while children living in areas of poor-quality housing experience a relatively high prevalence of diarrhoea, residence does not prevent parents from preserving their children from long-term ill-health and death. This may reflect either the more equitable housing conditions that prevail in urban Thailand or more widespread access to and use of health services.

In Ghana and Egypt, cluster environmental differentials in diarrhoea prevalence among young children are modest after socio-economic status is controlled for, and explain few of the corresponding socio-economic differentials. Thus, urban environmental conditions in low-income countries may fall below the threshold at which exposure to diarrhoeal infections begins to decline: the lower prevalence of diarrhoea among better-off children in these countries reflects the household's resources, not its location. In Egypt, however, children in households that share toilets are 60 per cent more likely to have diarrhoea than other children. Sharing a toilet clearly increases the exposure of children to infection from the environment outside the household. It is unclear why the cluster environment is associated with mortality and stunting in both countries. Perhaps there is a relationship between poor environmental conditions and diarrhoeal disease that is masked by differential misreporting of diarrhoea; or perhaps environmental conditions affect other forms of morbidity, such as respiratory disease or accidents (Ramasubban and Crook 1985). Alternatively, the cluster environmental index may be associated with use of health services or aspects of socio-economic status that are not captured by the socio-economic index, leading to problems of confounding between these two groups of explanatory factors.

Our data suggest that the overall quality of water and sanitation services in Egypt is similar to that in Brazil or Thailand. Nevertheless, child health remains worse and the only clear evidence that environmental conditions are associated with diarrhoeal disease is the adverse effect of sharing a toilet. This may be because aspects of the urban environment that we are unable to measure are poorer in Egypt than the other two countries. For example, sewage flooding may be more common or population densities higher. Alternatively, lower levels of income and literacy and poorer health services may mean that mothers in Egypt are less able to realize the potential of basic services for preserving their children's health.

We concluded that the quality of the urban environment does have an important effect on the health of children aged six months to three years. However, differences in the urban environment are not the main explanation of variation in the relative size of socio-economic differentials in mortality and child health across these four countries. Thus, environmental factors account for much of the univariate socio-economic differential in nutritional status in Ghana and Egypt but not Thailand. They only account for a significant part of gross socio-economic differentials in diarrhoea and mortality in Brazil.

The third issue that has been investigated here is the relative effect of environmental conditions in the neighbourhood and household on diarrhoea prevalence and nutritional status. After socio-economic status and cluster environment are controlled for, the minority of children in households with the worst facilities have much worse health than other children. This may mean that these indicators identify a group of very poor families with particularly poor health or it may reflect the adverse effect of an unhygienic household environment.

If the only important factor were sanitation in the dwelling where children live, the association between living in a more sanitary neighbourhood and child health would exist only because neighbourhood services are a precondition for installation of running water and modern toilets in individual dwellings. In fact, controlling for household facilities does attenuate the association between the cluster environment and stunting and diarrhoea. To a much lesser extent, the association between socio-economic status and child health is attenuated in the same way. This confirms that one way these two determinants influence child health is through households' adoption of sanitation services. On the other hand, the pattern of the effects suggests that the cluster environment in Thailand and Ghana and sharing a toilet in Egypt continue to exert a direct influence on diarrhoea prevalence. In Brazil, however, cluster environment only improves the explanation of the prevalence of diarrhoea in households with very poor toilet facilities. This may be because the environment in the cluster influences exposure to diarrhoeal infections directly but adequate household toilet facilities are indicative of the family's ability to shield children from such risks. In this multivariate analysis most of the cluster environment differentials in diarrhoea prevalence are statistically insignificant. Nevertheless, taken together, the pattern of effects strongly suggests that children six months to three years old who live in neighbourhoods with a poor environment have worse health than other children of the same age, after the characteristics of their households are controlled for.

The main limitation of this study is its inability to consider all the important characteristics of different urban populations that may influence child health and mortality. This partly reflects the restricted information on the characteristics of urban communities collected by DHS surveys. In addition, as the samples of urban children are fairly small, it is impossible to explore the role of all the factors that may condition the influence of the urban environment on child health. Thus, mothers' education is treated as a facet of socio-economic status and we do not explore whether the large differences between the four countries in the proportion of women with dependent children who are married modifies the effect of socio-economic and environmental factors on child health. Moreover, differential access to effective health services may lead to variation between countries and urban areas in individual countries in patterns of child health and mortality. An in-depth study of Brazil, that links the DHS data to city-level information on the provision of health and other services, suggests that such considerations are important (Sastry, Goldman and Moreno 1993). More such research, based on the synthesis of national data sets, could be very illuminating. The current study demonstrates that both socio-economic status and the environment in the urban sector greatly affect child health. Further investigation is needed, however, to clarify why these relationships differ between countries in the ways identified here.

This analysis of DHS data emphasizes two issues to be borne in mind when interpreting other investigations of urban child health. First, differentials in morbidity may differ from those in the more commonly measured health outcome, mortality. In Thailand, at least, fairly small intra-urban differentials in child mortality coexist with substantial inequality in other aspects of health. Second, the nature of intra-urban differentials in child health differs greatly between countries. Thus, over-generalization from particular case studies must be avoided. Equally, however, such international differences emphasize that appropriate economic and urban development policies can benefit the health of the urban poor even if resources remain very constrained.

## Conclusions

There are major socio-economic differentials in child health and mortality within the urban sector of all four countries investigated here. These differentials are at least as large as those by other socio-economic indicators, such as urban or rural residence or mother's education, yet have received less attention from both researchers and policy makers. Our results confirm that the mortality of the children of the urban poor is often as high as that of rural children.

In the developing world, socio-economic status, access to health services and environmental conditions all affect the health and mortality of children living in towns and cities. These factors are inter-related in their effects. Their relative importance, and the size of intra-urban differentials in child health, vary greatly between countries, reflecting both their overall national income and their particular histories of economic and urban development. By implication, appropriate development policies can improve urban child health. Equally, the scale of differentials in child health does not depend only on the degree of socio-economic inequality within a population; it also depends on whether there is a division in the urban population between families that live in environmental conditions that enable them to rear healthy children and families that do not.

While the results of this analysis emphasize the importance of a sanitary environment in the control of diarrhoeal disease, they suggest that other factors sometimes substitute for environmental improvements in the reduction of mortality. Furthermore, in countries where environmental conditions in urban areas remain very poor, investment in water and sanitation projects may not immediately affect child health. Nevertheless, it represents the foundation for future progress as well as benefiting human welfare in other respects.

Finally, we have argued that the health of children in urban areas is influenced by the wider social and physical environment of the household. Child health is not determined solely by disposable household income and the way that it is spent. Access to effective primary health care services is widely acknowledged to benefit health. Our results support the view that, as in late-nineteenth century Europe, concern for the public health also must extend to encompass the urban environment.

## Appendix

The socio-economic index is intended to differentiate between better-off and poor households, in the absence of income data, using data on educational background, men's and women's occupations and ownership of consumer durables. The environmental index is intended to distinguish clusters with better and worse environments using data on the construction of dwellings, drinking water supplies and toilet facilities. As there is no usual order in which durables are acquired or improvements made to the dwelling, these scales were constructed by summing the variables employed. Because televisions cost more than radios, for example, the characteristics contributing to each scale are weighted on the basis of their prevalence. These weights are assigned on a logarithmic scale. Thus, if 25 per cent of women have one characteristic and 50 per cent another, somebody with both characteristics is assigned a weight equivalent to that for a characteristic possessed by 12.5 per cent of women. Using their individual scores, women are divided into four approximately equal sized groups along each axis of variation.

Before construction of the socio-economic scales, some consumer durables are dropped in each country because hardly anybody owns them. Data on female occupations are treated differently in the four countries reflecting variation in the proportion of women who are economically active, and evidence from their association with other variables that some occupations, especially sales, differed greatly in status between countries. For women, only occupations that are clearly high-status contribute to the socio-economic scales: women involved in other forms of economic activity are grouped with the inactive.

The average size of the urban clusters ranges from 193 to 304 households between the countries. The mean number of women interviewed in each urban cluster ranges from 21 in Ghana to 62 in Brazil survey: it is thus possible to estimate the environmental characteristics of each cluster fairly accurately. In Brazil, nearly all households have a piped water supply.

Thus, as no information is available on the construction of dwellings, the cluster environmental scale for Brazil is based on data on toilet facilities alone. In all countries, the cluster scale for each woman was constructed using information on all the sampled dwellings in the cluster except the one in which she lives, to avoid conflating the influences of neighbourhood and household characteristics on child health.

The variables and weights used to construct the scales are shown in Tables A.1 to A.4 on the following pages.

**Table A.1**
**Construction of the socio-economic and environmental scales, Ghana.**

| Socio-economic scale | | Environmental scale | |
|---|---|---|---|
| **Woman's education** | | **Dwelling construction** | |
| None | 0.000 | Thatch roof | 0.000 |
| Primary | 0.315 | Other roof | 0.036 |
| Secondary + | 1.923 | Earth or mud floor | 0.000 |
| **Husband's education** | | Other floor | 0.064 |
| None | 0.000 | Burnt brick or mud walls | 0.000 |
| Primary/No husband/n.k | 0.149 | Other walls | 0.361 |
| Secondary+ | 1.467 | **Source of drinking water** | |
| **Husband's occupation** | | Other | 0.000 |
| Agriculture/Unskilled/None | 0.000 | Stand pipe outside plot | 0.308 |
| Skilled/No husband/n.k. | 0.197 | Piped to dwelling | 1.019 |
| Sales/Service | 1.178 | **Toilet facilities** | |
| Professional/Technical/Managerial | 1.687 | None | 0.0 |
| **Ownership of durables** | | Pit latrine | 0.134 |
| None | 0.000 | Pan/KVIP/Other | 0.653 |
| Radio | 0.599 | Water closet | 1.766 |
| Electricity | 0.416 | | |
| Electricity + Television | 1.441 | | |
| Car | 2.245 | | |

**Table A.2**
**Construction of the socio-economic and environmental scales, Egypt**

| Socio-economic scale | | Environmental scale | |
|---|---|---|---|
| **Woman's education** | | **Dwelling construction** | |
| None | 0.000 | Earth floor | 0.000 |
| Primary | 0.412 | Cement floor | 0.067 |
| Secondary | 1.254 | Other floor | 0.148 |
| Higher | 2.394 | **Source of drinking water** | |
| **Husband's education** | | Other | 0.000 |
| None | 0.000 | Stand pipe outside plot | 0.036 |
| Primary/No husband/n.k | 0.240 | Piped to dwelling | 0.171 |
| Secondary | 0.985 | **Toilet facilities** | |
| Higher | 1.768 | Other | 0.000 |
| **Husband's occupation** | | Pour flush (attached to a sewer) | 0.232 |
| Agriculture/Unskilled | 0.000 | Water closet | 0.814 |
| Skilled/Service/No husband/n.k. | 0.139 | **Shared toilet** | |
| Sales | 0.859 | Yes | 0.000 |
| Professional/Technical/Managerial | 1.433 | No | 0.103 |
| **Woman's occupation** | | | |
| Other/None | 0.000 | | |
| Clerical/Sales | 1.801 | | |
| Professional/Technical/Managerial | 2.503 | | |
| **Ownership of durables** | | | |
| None | 0.000 | | |
| Television | 0.094 | | |
| Refrigerator | 0.227 | | |
| Car | 1.941 | | |

**Table A.3**
**Construction of the socio-economic and environmental scales, Brazil**

| Socio-economic scale | | Environmental scale | |
|---|---|---|---|
| **Woman's education** | | **Toilet facilities** | |
| None | 0.000 | None/Pit latrine | 0.000 |
| Lower Primary/n.k. | 0.055 | Tank | 0.065 |
| Upper Primary | 0.476 | Water closet | 0.616 |
| Secondary | 1.121 | | |
| Higher | 2.470 | | |
| **Husband's education** | | | |
| None | 0.000 | | |
| Lower Primary/No husband/n.k | 0.047 | | |
| Upper Primary | 1.153 | | |
| Secondary | 1.851 | | |
| Higher | 2.753 | | |
| **Husband's occupation** | | | |
| Domestic/Agriculture/Other | 0.000 | | |
| Skilled/No husband/Never worked | 0.069 | | |
| Sales/Service | 1.208 | | |
| Professional/Technical/Managerial/n.k. | 2.029 | | |
| **Ownership of durables** | | | |
| None | 0.000 | | |
| Television | 0.167 | | |
| Car | 1.222 | | |
| Employs maid | 2.286 | | |

**Table A.4**
**Construction of the socio-economic and environmental scales, Thailand**

| Socio-economic scale | | Environmental scale | |
|---|---|---|---|
| **Woman's education** | | **Dwelling construction** | |
| None | 0.000 | Earth floor | 0.000 |
| Primary | 0.062 | Other floor | 0.526 |
| Secondary | 1.038 | **Source of drinking water** | |
| Higher | 2.097 | Other | 0.000 |
| **Husband's education** | | Piped to dwelling | 0.278 |
| None/ | 0.000 | Bottled water | 1.692 |
| Primary/No husband/n.k | 0.022 | **Toilet facilities** | |
| Secondary | 0.699 | None/Pit latrine | 0.000 |
| Higher | 1.844 | Septic tank | 0.044 |
| **Husband's occupation** | | Water closet | 2.132 |
| Domestic/Agric. labourer/Unskilled | 0.000 | | |
| Skilled/No husband/Never worked | 0.072 | | |
| Sales/Service/Farmer | 0.549 | | |
| Professional/Clerical/n.k. | 1.325 | | |
| **Woman's occupation** | | | |
| Other/None | 0.000 | | |
| Professional/Clerical | 1.899 | | |
| **Ownership of durables** | | | |
| None | 0.000 | | |
| Television | 0.176 | | |
| Refrigerator | 0.446 | | |
| Motorbike | 0.967 | | |
| Car | 1.432 | | |

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