

The health of people who live in slums 1



The history, geography, and sociology of slums and the health problems of people who live in slums

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Massive slums have become major features of cities in many low-income and middle-income countries. Here, in the first in a Series of two papers, we discuss why slums are unhealthy places with especially high risks of infection and injury. We show that children are especially vulnerable, and that the combination of malnutrition and recurrent diarrhoea leads to stunted growth and longer-term effects on cognitive development. We find that the scientific literature on slum health is underdeveloped in comparison to urban health, and poverty and health. This shortcoming is important because health is affected by factors arising from the shared physical and social environment, which have effects beyond those of poverty alone. In the second paper we will consider what can be done to improve health and make recommendations for the development of slum health as a field of study.

Introduction

Human beings are undergoing a radical transformation in their ecology.¹ During the past two centuries the proportion of the world's population living in cities and towns has grown from about 5% to more than 50%. This process of rapid urbanisation, which started in Europe and North America after the Industrial Revolution in the late 18th century, was accompanied by the development of large slums including famous examples, such as La Chapelle in Paris, France, the Gorbals in Glasgow, Scotland, and Khitrov in Moscow, Russia. The past 50 years has seen massive urban growth in low-income and middle-income countries (LMICs) characterised by sprawling slums that are now home to more than half of the population in cities such as Mumbai, India, Nairobi, Kenya, and Mexico City, Mexico.² This huge growth in slums has provoked increasing international interest, and the United Nations Sustainable Development Goals (SDGs) specify a target to address the "plight of slums".³ The broad purpose of this Series of two papers is to investigate how this goal might be achieved with respect to health. In this first paper in the Series, we first provide some background to slums covering terminology and definitions, the size of slum populations, and the dynamics of their growth. Second, we make a theoretical argument that slum health should be a substantive topic for study, distinct from urban health, and from poverty and health. Third, we examine the extent and nature of previous research in slum health. Fourth, we describe the physical and social factors affecting health in slums. And finally, we describe the particular health problems of people who live in slums, insofar as this can be discerned from the scientific literature.

Terminology and definitions

Concerns have been expressed that the term slum is emotive and pejorative.⁴ The term informal settlement has been suggested as an alternative. However, the United Nations continues to refer to slums, for example

in the SDGs; informal settlement and slum are not synonymous.

The United Nations Educational Scientific and Cultural Organisation (UNESCO) defines a slum in terms of an urban space, as "a contiguous settlement where the inhabitants are characterised as having inadequate housing and basic services".⁵ However, the most widely

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This is the first in a Series of two papers about the health of people who live in slums

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Key messages

- The population of slums has increased massively in the past 60 years and slums now dominate many cities in low-income and middle-income countries (LMICs), and are increasing in total population size, especially in Africa.
- Slum health issues are widely subsumed in urban health and the association between poverty and health. Failure to recognise slums as spatial entities obscures neighbourhood effects that are likely to affect health in slums.
- There is a long and unfortunate history of more than 100 years in which people in slums have been marginalised and even stigmatised with the result that they experience expropriation of property, displacement, and denial of access to basic services.
- People in slums often have just enough money to live on and nothing extra so that if they get ill, they will probably fall into extreme poverty, which in turn leads to worse health leading to extreme inequality and poverty traps.
- Inadequate water supply, sanitation, drainage, and rubbish collection in a crowded environment predisposes to recurrent diarrhoea and diseases such as typhoid, hookworm, and cholera.
- Children are especially vulnerable in slums because of low breastfeeding rates, under-nutrition, and poor sanitation, which predispose children to chronic diarrhoea, stunting, and impaired cognitive development. Several studies have reported worse child health in slums than in poor rural areas within the same country.
- Reservoirs and vectors for infectious diseases such as dengue, leishmaniasis, and leptospirosis flourish in slum environments.
- The shared physical and social environment of slums exposes residents to health risks of injury from fire, extreme weather, and crime.
- Insufficient attention has been paid to mental health and non-communicable diseases in stressful slum environments, or to how slum characteristics can affect health outcomes.
- Slum health should be distinguished from urban health and mainstreamed in the implementation of the Sustainable Development Goals and the New Urban Agenda.

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See Online for appendix

Search strategy and selection criteria

To gauge the relative attention the topic of slum health has received in medical research and to characterise the nature of academic literature on slum health, first we did a bibliometric analysis of the relative volume of research studies concerning rural, urban, and slum settings (appendix p 2) and the number of registered clinical trials in these settings in low-income and middle-income countries (appendix p 4).

To identify key literature for the topic of slum health, we did a systematic overview of reviews covering determinants of health in slum settings or interventions that aim to improve the health of slum dwellers. Because the identified literature on determinants of health mainly draws evidence from cross-sectional studies that are subject to selection effects, we undertook a further systematic review of cohort studies in slums. Acknowledging the important roles that international, governmental, and non-governmental organisations have in this area, we also systematically searched the grey literature and reviewed relevant documents.

Systematic overview of reviews of slum health

We searched the following eight databases in January, 2016: MEDLINE, including in-process and non-indexed citations; Embase; PsycINFO; LILACS; SciELO; WHO Global Health Library; Database of Abstracts of Reviews of Effects, maintained by the NHS Centre for Reviews and Dissemination; and CINAHL (all but two of the reviews detailed here were found in MEDLINE or Embase). We put no limits on dates covered. To make the search as sensitive as possible, we included a wide range of synonyms for slums, derived from a list in a UN-Habitat report and augmented by other terms we have encountered: baladi, bandas de miseria, barraca, barrio marginal, barrio, bidonville, brarek, bustee, chalis, chereka bete, dagatan, estero, favela, galoos, gecekundu, ghetto, hrushebi, informal settlement, ishash, karyan, katras, looban, loteamento, medina achouaia, morro, mudun safi, musseque, shanty town, slum, solares, tanake, taudis, township, tugurio, udukku, umjondolo, watta, and zopadpattis. We further broadened our search by combining free-text synonyms with controlled vocabulary related to slums and, where supported in the database, filters for systematic reviews. No language restrictions were applied. We examined the titles and abstracts of unique records and selected reviews (both systematic and narrative reviews) that: specifically provided results for people who live in slums; specifically included people who live in slums but did not provide specific results for the subgroup; and included the urban poor and hence were likely to have included slum dwellers, although this was not specified. We selected reviews dealing with: the distribution and determinants of health relevant to slum settings, which are

included in the evidence base for paper one (for a summary of identified studies see appendix pp 7–11); and interventions for slum populations, reporting health outcomes, which are included in the evidence base for paper two. Some of the identified reviews reported both on the epidemiology of health conditions and interventions to improve these health conditions, in which case they are included in the evidence base for both papers. A flow diagram for study retrieval and selection is available in the appendix p 5).

Systematic review of primary cohort studies relating to slum health

We searched for primary cohort studies using MEDLINE and Embase (which support the necessary search filter for cohort studies) relating to slum populations, using the same free-text and controlled vocabulary terms for slums as stated in the search for reviews concerned with slum health. After studying the titles and abstracts of the unique records this search returned, we selected relevant studies (studies that prospectively recruited people living in slums and observed them over at least two occasions in time). We located 128 studies meeting this criterion and classified them by key themes (eg, paediatric nutrition and diarrhoea and injury), integrating these throughout the text as appropriate with other relevant studies. There was only one study found in this search that had been picked up by the reviews identified through the previous search. The appendix shows the study retrieval and selection process (appendix p 5).

Systematic review of the grey literature

We searched the grey literature by reviewing official reports from the publication databases of the World Bank, WHO, and UN-Habitat on the basis of expert advice from the authors. We covered the literature from Jan 1, 2010, to Feb 29, 2016. Our search terms included synonyms for slums in searches one and two above. 884 results were returned, and after examining the titles, abstracts, and text of these studies and reports, we selected 245 publications that dealt partly or wholly with issues arising in slums. The appendix provides a breakdown of publications (appendix p 5). Many important articles were found in this search, including those relating to the economic of slum formation, system level interventions (eg, the effect of providing tenure and title), and certain notable large-scale studies, including a randomised trial of home improvement.

We supplement the above three reviews with additional searches as needed on the advice of experts (eg, the searches for literature related to neighbourhood effects in slums, appendix p 6), and further extended these with authors' collections of references and additional papers identified by subject experts.

used definition, promulgated by the United Nations Human Settlements Programme (UN-Habitat), is based on households where a slum household is defined as: "a group of individuals that live under the same roof that lack one or more of the following conditions; access to

improved water, access to improved sanitation, sufficient living space, durability of housing and secure tenure".² Each of these five conditions is defined in more detail, for example by specifying what type of sanitation qualifies as improved.

Two issues arise from these contrasting definitions. First, slum is a construct composed of many dimensions—five in the case of the UN-Habitat definition—such that no one definition can be entirely satisfactory. Second, although people intuitively think of slums as collections of dwellings, this spatial construct is not included in the UN-Habitat definition. The idea of slums as spatial entities is a unifying theme across both papers in this Series.

Population of slums

Panel 1 explains why the measurement of slum populations is not an exact science. The most recent UN-Habitat estimates for slum populations suggest that 881 million people lived in slums in the developing world in 2014,¹¹ an increase from 689 million in 1990. The number of people living in slums is increasing and remains especially high in sub-Saharan Africa (56% of the urban population lives in slums) and southern and southeast Asia.¹¹ It is estimated that by 2030, about 5 billion of the world's projected 8·1 billion people will live in urban areas. Of these, about 2 billion will live in slums, mainly in Africa and Asia.² Most of this growth will occur in smaller (tier two—ie, having a population of 50 000 to 99 999) cities where urbanisation continues without adequate planning or expansion of infrastructure.

Dynamics and underlying causes of slum growth

Urbanisation can be prevented by the restriction of people's movement. For example, so-called pass laws restricted internal migration in many colonial countries, while the Chinese Government went further still by reversing the flow between countryside and city during the Cultural Revolution (1966–76). The removal of restrictions is typically followed by rapid urban migration as happened, for example, after the abolition of slavery in Brazil in 1888.¹²

Once a population is free to move, they will be motivated or constrained by many factors (panel 2). The increase or decrease in slum populations is a dynamic process including flows of people from countryside and other city precincts, flows in the reverse directions, conversion of city districts and peripheral land sites to slums (and vice versa), and the balance of births and deaths (natural growth) in the slum itself. As slums age, the proportion of growth that is natural (ie, the balance of births and deaths) increases, reaching figures as high as 75% in Mexico City.¹⁵ In the figure, we model this dynamic process.

Explaining what motivates individuals or families to move or stay where they are under prevailing conditions does not explain the cause of the prevailing conditions. An explanation does not explain the cause of the prevailing conditions and hence does not explain why slums have become so large, why so many people become trapped in slums,²¹ or why many in the slums sink into ever deepening poverty.^{22,23} Nor does an explanation of motivation clarify the decoupling of

economic and slum population growth—66 countries had 5 years of urbanisation without concurrent national economic growth between 1960 and 1995.²⁴ Many reasons have been given to explain why slums form, persist, and grow including national economic stagnation, failure of redistribution, market distortion in favour of extractive elites, colonial legacies, lack of planning, corruption, clientism, and anti-urban biases by national governments and international agencies. Fox²⁵ provides a sure-footed account of how these factors have played out over time; Roy and colleagues²⁶ offer a systematic review of models of slum growth under sub-optimal international and national policies; and UN-Habitat has published a report²⁷ of factors that are associated with success in reducing slum growth in 100 countries during 20 years. These macro-level factors should be further studied by historians, political scientists, and economists.

Panel 1: Counting people in slums

Data used by UN-Habitat to estimate slum populations emanate from two main sources: population and housing censuses (conducted every 10 years in most countries), and national surveys that are often based on sampling frames from censuses. Making an assessment of the size of slums is not an exact science because:

- There is more than one definition of a slum and any particular definition can be applied inconsistently. A given definition can change over time—eg, the living space threshold of the UN-Habitat definition was increased from more than one to more than two people per room in 2008.
- There are technical difficulties in the enumeration of slum populations; they are a hard to reach group because householders are often absent; people can rent rooms by the night; illegal squatters can avoid surveys; census staff can be afraid to enter slums; and because some countries do not have a census.
- Many slum communities are not officially announced as residential areas and are therefore under-represented in censuses and in national sampling frames.^{6,7} China provides an example where many “城中村” (literally villages in the city) are populated by unregistered migrant workers.^{8,9} In some cases, the exact opposite is reported, when governments over-count slum dwellers either for political motives or support, or for budgetary allocations related to service delivery.
- Even when data for the UN definition of slums are available for a nation, they are only collected every few years, so annual reporting of slum populations has to rely on estimates and projections. Projection of the future size of slums is further complicated by different rates at which slums are upgraded to non-slum across low-income and middle-income countries.
- The threshold for definition of water supply and sanitation is set low, and the worldwide estimates of slum populations would inflate by several hundred million if the threshold were raised to a level sufficient to protect health.¹⁰ Additionally, application of the UN slum definitions to high-income nations might suggest that they have no slums, but these countries might still have significant proportions of their population living in inadequate housing.

The population of slums can be stated as totals or as proportions in which case the denominator can be either national or urban populations. These different methods can yield diverging trends. For example, in most regions of the world the percentage of the urban population living in slums has been declining since 1990, while the total numbers are rising.¹¹

Panel 2: Factors associated with rural and urban migration***Demand (pull) factors**

- Thriving informal economy¹³
- Unrealistic expectations due to optimism bias, inadequate information, or distorted market signals, but people and information travel back and forth between countryside and city so this factor should not be overemphasised¹³
- Informed risk-taking, whereby people consciously trade a small probability of large gains for the status quo, or even ending up worse off³³
- Altruistic desire to make reparations to family in the countryside,¹⁴ and to hedge urban and rural risks over the family¹⁵
- A sense of adventure and the desire to escape the monotony of subsistence farming¹⁶
- Lack of barriers to migration (eg, a large family), and facilitators (eg, an existing social network in the city to provide temporary accommodation, support, and advice)¹⁷

Supply side (push) factors

- Environmental degradation¹⁸
- Famine¹⁸
- Improved agricultural labour productivity through mechanisation¹⁸
- Volatile commodity prices and economic shocks¹⁸
- Ethnic violence¹⁸
- Displacement (eg, from development projects, such as construction of dams)¹⁸
- A desire to escape adverse social conditions, such as rural caste discrimination in India¹⁹

*These factors do not explain growth and persistence of slums.

Why slum health?

Not all people living in slums live in poverty and many who live in urban poverty reside outside of slum areas. More than half of dwellings classified as slum households (according to the UN-Habitat definition) in Chennai, Delhi, and Hyderabad, India fall outside of areas classified as slums (according to the Indian definition of 60 contiguous slum households).²⁸ This situation means that the health of poor city dwellers is not necessarily a reflection of the health of those who live in slums. There are three reasons why living in a slum and living in poverty can produce different health outcomes. First, people who live in slums share environmental risks, such as those arising from poor sanitation—they experience so-called neighbourhood effects.^{29,30} Second, people who live in slums benefit collectively from interventions, such as improved sanitation, in ways that will be explicated in the second paper of the Series.³¹ And third, social and health improvement interventions that work in non-slum localities might not be transferable to slum areas. For example, pit latrines are especially unsuitable for slums (discussed in paper two of the Series).

The concept of neighbourhood effects refer to factors that affect health at the community level independent of individual household level factors, including individual household levels of poverty or deprivation. They encompass pervasive effects operating across the spaces in which people live. The mechanisms by which neighbourhoods exert their effects have been classified in various ways. Table 1 provides examples of

neighbourhood effects based on one such classification system.³² Many researchers^{39–41} have studied slum effects in observational studies across different slums using multivariate modelling techniques in an attempt to separate individual, household, and neighbourhood contributors to health. However, the health effects of the shared environment can be underestimated in this type of observational study.⁴² Neighbourhood effects can be inferred from studies of underlying mechanisms (eg, showing that soil and water are contaminated by faeces, or that overcrowding is associated with stress), and from studies in which the environment is manipulated under experimental (or quasi-experimental) control (discussed in paper two). Rare instances exist in which it has been possible to record the effects of taking part in a lottery that allows some people to move to a new environment while others remain in their original neighbourhood—eg, the Moving to Opportunity experiments in the USA³⁵ and India.⁴³

Given that neighbourhood effects are highly likely in slums, the health of people who congregate in slums should not be subsumed in urban health or in studies of poverty and health. Rather, slums should be studied as spatial entities. However, censuses in most LMICs do not differentiate slum from non-slum urban areas. The result is that national surveys, such as Demographic and Health Surveys (DHS), which are based on sampling frames derived from national censuses, do not distinguish between households that are or are not located in a slum area of a city. Surveys based on such censuses simply replicate the well known association between poverty and health,^{22,31} ignoring the importance of space. We will argue in paper two that this should change and that all countries should identify urban census tracts (enumeration areas) as slum or non-slum.³¹

The idea that slums as spaces is central to the idea of slum health, should not obscure the fact that these spaces are not homogeneous, but vary substantially within and between slums in terms of population density, security of tenure, official recognition, provision of services, topography, and social and economic make-up.⁴⁴ Context can have a large effect on the effectiveness of interventions as we discuss in paper two.

Slum health: a neglected subject?

In the search strategy and selection criteria panel we describe the literature retrieval algorithms we used. We intended to not only obtain literature to assess slum health but also, in view of the importance of neighbourhood effects, to compare and contrast this literature with findings of urban health generally, rural health, and poverty and health. We used a UN-Habitat report to derive synonyms for slums in our search.⁴⁵

The bibliometric analysis supports the hypothesis that slum health has received scant attention compared with rural health, urban health, and poverty and health; studies of slum health make up only a small proportion

of studies of LMICs. For instance, only 2·8% of studies of LMIC on MEDLINE and Embase that stated where the study was done were based in a slum location (appendix p 2). Only 7% of LMIC trials registered on the WHO Clinical Trials Registry Platform that stated where the trial was done were based in a slum location and in many cases slums were chosen as a convenience sample, for instance to study the effects of a new vaccine, rather than to examine slum health or how to improve it (appendix p 4). There is no MeSH term for slum or its synonyms on MEDLINE or Embase.

Further evidence that slum health is a neglected topic can be found by assessing the location of the 38 Demographic Surveillance Sites based in Africa; only one (the Nairobi Urban Health and Demographic Surveillance System) is based entirely in a slum area. Additionally, slums are not identified as a determinant of health in the influential Global Burden of Disease report.⁴⁶

Before we discuss the findings of health and its determinants, we should mention the type of scientific literature retrieved and its possible biases. Most findings of health and welfare in slums are based on cross-sectional studies that are subject to selection effects, such as those who migrate are healthier on average than those who remain in rural settings (healthy mover effect), and those who transition rapidly through the slums are under-represented relative to all who have been exposed to slums (a form of rate bias). These factors can lead to potential bias when seeking to make an inference about the effect of moving to a slum from another place, or the net effect of slums on health or wellbeing. The second factor can be mitigated by use of longitudinal studies; the rationale for a specific search for such studies.

Living and working conditions in slums

Slums are usually formed close to areas where work is available. Population pressures cause the slum to push upwards (ie, storeys are added to dwellings) and outwards. Competition for sites close to places of work causes inflation in rents and land prices so that landlords in central locations can end up quite wealthy, whereas those at the periphery become progressively disadvantaged;^{47,48} the Gini coefficient (a measure of income inequality) in Bangladesh is larger within slums than across the country as a whole.⁴⁹ This is important because increasing poverty generates health inequality, which in turn leads to deeper poverty creating a vicious circle or poverty trap.³⁹

Security of tenure is a key issue for slum households. Slums are often set up on unclaimed or municipal land.⁵⁰ Authorities then decide whether or not to recognise the slum and confer residency rights on citizens—in India, such notified locations make up only about half of all slums.⁵¹ People with no rights have little incentive to invest in healthier homes and can be evicted without compensation to provide more lucrative middle-class

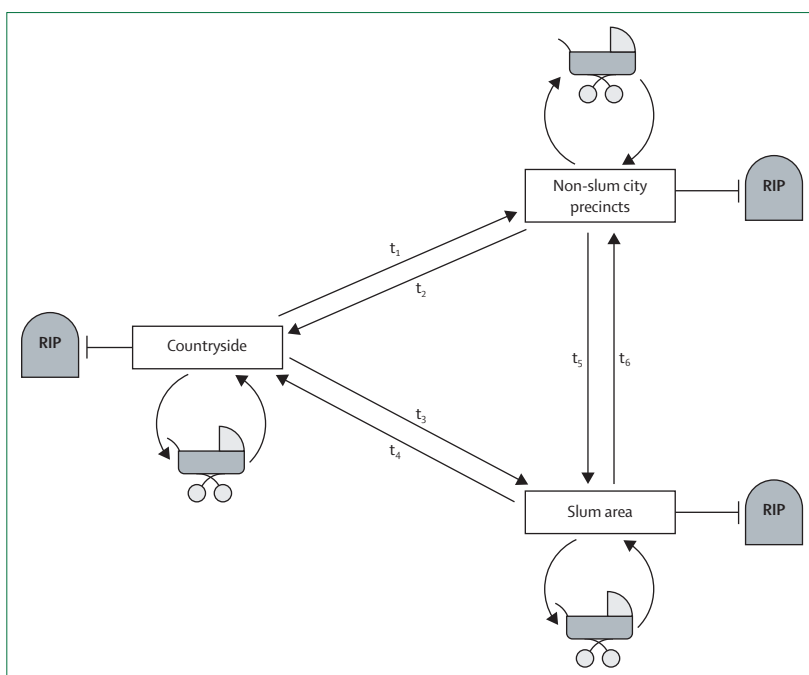


Figure: Population flows between countryside and the city and between formal and slum precincts of the city*

*Use of yearly transition rates enable dynamic flow to be modelled net of seasonal fluctuations. A key transition in the generation of slums is movement between countryside and city— t_1 and t_2 . According to a famous model from Harris and Todaro,³³ migration from the countryside is propelled by surplus labour on the land in the run-up to the demographic transition and a growing demand for labour in the cities, which generates a gap in expected wealth.³³ Transitions from city to countryside are represented by t_3 and t_4 . A sustained period (≥ 5 years) in which migration from city to countryside exceeded migration from countryside to city (t_3 and t_4) > (t_1 and t_2) happened in only five low-income and middle-income countries in 35 years (1960–95) and these include the massive upheavals in China and Cambodia. People move from formal city precincts to slums because of their financial circumstances, but this transition (t_5) also happens when previously better off areas fall into decay through economic recession and middle-class flight, as happened in previously fashionable precincts of Lima, Peru.²⁰ The reverse transition (t_6) can also come about because people move from slum to formal precincts or because a slum is upgraded to a non-slum area. The balance between t_5 and t_6 is crucial to the question of whether slums expand or contract.

housing to the benefit of an extractive elite; government officials can be slum landlords.⁵² Large-scale evictions have taken place under apartheid in South Africa,⁵³ state capitalism in China,⁵⁴ and even democratic local government in Brazil.⁵⁵ The injustice and inhumanity of these evictions is compounded by the plight of the displaced settlers who must move to new locations that are even more disadvantaged, in terms of access to the labour market and environmental safety, than their original slum habitat,⁵⁶ again widening inequalities.

Whether through eviction or a shortage of space, people in slums can inhabit dangerous locations such as ravines, where they are subject to landslides (Caracas, Venezuela), flood plains, where they are subject to drowning and loss of homes (Manila, Philippines), and under power lines increasing the risk of fires (Nairobi). In Quito, Ecuador, people who live in slums have been forced above the 2850 m city limit that marks the highest level that can be serviced by the municipal water distribution system.⁵⁷ People who live in slums are also especially vulnerable to the effects of global warming. For example, poorly constructed homes are ill-equipped

	Example	Example from slum context
Physical environment	The risk of childhood illness in Indian families is more strongly associated with a neighbour's defecation patterns than with the family's defecation behaviour ³³	Slum environment and water supply is heavily contaminated with faeces in many slums ³⁴
Social interactions	Findings of an experimental study in the USA ³⁵ showed that providing vouchers to move to a better-off neighbourhood improved health in the short term, and young children's prospects in the long term	Crime rates vary substantially among slums, reflecting different cultures that have developed within them ³
Geographic factors	Poor people in rich cities in the USA have better health than equally poor people in poor cities ³⁶	Many slums are exposed to geographic hazards, such as flooding, subsidence, and local pollution from factories ³⁷
Institutional factors	Teachers can have lower expectations of pupils who live in poor neighbourhoods ³²	Some slums are stigmatised so that residents' rights are infringed to the point of expropriation ³⁸

Table 1: General and slum-specific evidence of neighbourhood effects³²

to withstand the elements, and mortality risk from tropical cyclones (after controlling for storm intensity) is more than a hundred times greater in low-income than in high-income countries.⁵⁸

Slums provide access to markets for millions of people and provide conditions where micro-enterprises become established.⁵⁹ The informal sector is worth US\$10 trillion per year worldwide and employs 80% of the workforce in LMICs.⁶⁰ But people who have just enough money to live on and nothing extra require out-of-pocket payments, not just for food and accommodation, but for basic amenities, such as water, access to toilets, cooking fuel, transportation, and education. Informal sector workers with minimal statutory rights and who lose income when they are absent from work⁶¹ are at a particular disadvantage if they live in slum areas with long and expensive commutes. Health facilities, if present, are closed when they return from work and they cannot attend appointments for immunisation, antenatal care, or care of long-term conditions. Women earn on average only a third of men's earnings in urban areas of sub-Saharan Africa.⁶⁰

Not only is there an economic and social gradient within slums, but slums themselves can differ from each other, not just economically, but socially. This point is shown with respect to crime where some slums (eg, Kumasi in Ghana and Surabaya in Indonesia²) have low crime rates, while others are dominated by criminal gangs, as in Rio de Janeiro, Brazil and Caracas, Venezuela,^{62,63} leading to the concept of "slums of hope and slums of despair".⁶⁴ It would be useful if high risk localities could be identified on the basis of their characteristics and a study across 48 slum areas in Mumbai, India identified maternal and child health risk areas with high specificity but low sensitivity on the basis of access to water and sanitation, housing quality, and tenancy status.⁶⁵ We have not located studies to identify risk by higher level factors such as size of slums, and have cited limited information suggesting that large established slums have lower social capital than new slums; there is a positive correlation between

average duration of residence in a slum and the prevalence of violence in that slum.³⁹ Strong social pressures in slums can affect drug use and teenage sexual behaviour at the community level. In the appendix, we explore some of these through the words of mothers of teenage children (p 1).

Slum dwellings are loosely fitted together from available materials allowing easy access for vectors of disease. Under the sun corrugated iron dwellings become oppressively hot, while at night temperatures in high altitude cities can plummet to lows of -4.4°C in Mexico City, Mexico and -0.5°C in Addis Ababa, Ethiopia. Many slum households do not have piped water or lavatories. Pit-latrines contaminate the environment and the water supply is prone to contamination at multiple points. Homes are crowded and afford little privacy. Cooking and heating with solid fuels in confined spaces pollutes the air with noxious fumes and particulate matter. Streets and lanes are unpaved with no drainage and are therefore converted to mud and stagnant pools when it rains. Garbage collects in huge, malodorous piles and often contains excrement. There is little open space where children can play safely or where adults can relax.

The determinants of health interact and are highly reinforcing.⁶⁶ For instance, poor maternal mental health postnatally reduces willingness to breastfeed and also affects the mother's bonding to her child, placing the child at risk physically and socially. Early weaning, failure to immunise, exposure to contaminated water, and malnutrition interact producing enteropathy and stunting, which in turn predispose to reduced school performance, and reduced life chances. If a mother does not breastfeed, her fertility will return quickly after childbirth, resulting in reduced spacing between children. As a result less time, money, and loving support can be given to each child. If a parent develops a serious disease, such as recurrent tuberculosis, the family will suffer catastrophic financial loss (due to cost of health care and loss of earnings) reducing educational opportunities. It is time to examine in more detail how slum neighbourhoods predispose their inhabitants to disease.

Health in slums and child mortality

It is difficult to measure the life expectancy of people who live in slums because they move regularly and might return to rural areas to die. However, child mortality is easier to ascertain. While child mortality is similar between rural and urban locations overall,⁶⁷ comparisons between slum areas specifically and the countryside tell a different story. Higher infant and neonatal mortality in slum versus rural areas has been reported in Kenya, Ecuador, Brazil, Haiti, and in the Philippines,⁶⁸⁻⁷⁰ although rural areas with especially high malaria exposures can have even higher child mortality rates than high altitude slums.⁷¹ We have studied this issue further by analysing survey data from Bangladesh and Kenya, two countries

where the census distinguishes between slum and non-slum urban areas (tables 2–5). We noted that slums have worse health outcomes for children than the rural populations of both countries. Even if we define the rural poor as the lowest tertile by socioeconomic status, children have higher mortality rates in the slums of Nairobi. Diarrhoea and pneumonia are the two main worldwide killers of children younger than 5 years^{76,77} and there seems little doubt that young children (<5 years) are at especially high risk in slums.

This study was made possible by slum-specific indicators that are tagged on to residential domains in censuses and surveys in Bangladesh and Kenya. In Kenya, the selection of slums for the survey was informed by 1999 and 2009 census listings that identified slum enumeration areas. A weighted cross-sectional sample was designed, representative of households in all slum clusters of Nairobi in 2000 and 2012. In the Urban Health Survey in Bangladesh slums were defined as areas of concentrated vulnerability. Using satellite images from census 2005 as a starting point, four criteria for identifying slums were used: poor housing conditions, high overall density, poor environmental services, and high prevalence (>75%) of people with income below the poverty level. The rural poor were classified as the lower tertile of the rural population based on wealth scores data from the respective DHS. It is noteworthy that mortality rates are decreasing in both countries in both rural and slum areas. However, in Nairobi the situation of children in the slum areas relative to rural poor children seems to have worsened over time.

When children move to slums from the countryside they are most vulnerable immediately after their arrival, presumably because they have little immunity to the organisms in their new neighbourhood.⁷⁸ When compared with children whose parents do not leave for the city, children left behind in the countryside have unchanged or even improved health—perhaps as the result of remittances.^{79,80}

Infectious diseases

Pit latrines with slabs qualify as improved sanitation in the WHO/United Nations Children's Fund (UNICEF) Joint Monitoring Programme definition.¹⁰ However, such facilities are inappropriate in a crowded slum environment.⁸¹ Even when judged against this low standard, only 40% of the urban population in sub-Saharan Africa had improved sanitation, whereas 33% had piped water in their homes in 2015. The situation in slums specifically can only be worse. Gastrointestinal infections are highly prevalent in slums^{68,82} and children younger than 5 years are especially vulnerable. Two systematic reviews of cholera outbreaks in Africa identified slum neighbourhoods as the usual source of the epidemic.^{83,84} Slum dwellers perceive water and sanitation as their most pressing need.⁸⁵ In fact, slum life might protect children from the effects of polio

	UHS 2006		DHS 2007			
	Urban slums	All rural	Rural poor	All urban	Dhaka	National
Neonatal mortality rate	43.7	41	44.5	33	38	37
Infant mortality rate	63.1	59	65.6	50	55	52
Under-5 mortality rate	80.7	77	85.7	63	69	65

All mortality rates are per 1000 livebirths. Neonatal mortality rate is the probability of dying within the first month of life. Infant mortality rate is the probability of dying before the first birthday. Under-5 mortality rate is the probability of dying between birth and the fifth birthday. For the comparison of early childhood mortality among slums, rural poor, all urban, and national populations, we used data from slum surveys and the DHS. Indicators for slum population were extracted from the UHS 2006 and 2013.⁷² The corresponding indicator data for other residential domains were extracted from Bangladesh DHS 2007 and 2014.⁷³ UHS=Urban Health Survey. DHS=Demographic and Health Survey.

Table 2: Comparison of levels and trends in early childhood mortality in slum and other sub-populations in Bangladesh, 2006–07

	UHS 2013		DHS 2014			
	Urban slums	All rural	Rural poor	All urban	Dhaka	National
Neonatal mortality rate	31	31	41.2	21	25	28
Infant mortality rate	49	40	54	34	35	38
Under-5 mortality rate	57	49	63.9	37	41	46

All mortality rates are per 1000 livebirths. Neonatal mortality rate is the probability of dying within the first month of life. Infant mortality rate is the probability of dying before the first birthday. Under-5 mortality rate is the probability of dying between birth and the fifth birthday. For the comparison of early childhood mortality among slums, rural poor, all urban, and national populations, we used data from slum surveys and the DHS. Indicators for slum population were extracted from the UHS 2006 and 2013.⁷² The corresponding indicator data for other residential domains were extracted from Bangladesh DHS 2007 and 2014.⁷³ UHS=Urban Health Survey. DHS=Demographic and Health Survey.

Table 3: Comparison of levels and trends in early childhood mortality in slum and other sub-populations in Bangladesh, 2013–14

	NCCS 2000		DHS 2003			
	Nairobi slums	All rural	Rural poor	All urban	Nairobi	National
Neonatal mortality rate	30.4	34	35.5	26	32	33
Infant mortality rate	91	79	94	61	67	77
Under-5 mortality rate	151	117	144.2	93	95	115

All mortality rates are per 1000 livebirths. Neonatal mortality rate is the probability of dying within the first month of life. Infant mortality rate is the probability of dying before the first birthday. Under-5 mortality rate is the probability of dying between birth and the fifth birthday. For the comparison of early childhood mortality among slums, rural poor, all urban, and national populations, we used data from slum surveys and the DHS. Data for slums were extracted from the NCCS survey 2000, and 2012,⁷⁴ and for all other residential domains, data were extracted from DHS 2003, and 2014.⁷⁵ NCCS=Nairobi Cross-sectional Slum Survey. DHS=Demographic and Health Survey.

Table 4: Comparison of levels and trends in early childhood mortality in slum and other sub-populations in Kenya, 2000–03

because the virus is likely to be contracted at a particularly early age in slum areas, and hence at a stage when the baby is still protected by maternal antibodies.⁸⁶

Accumulation of rubbish and poor housing provide breeding grounds for parasites and vectors of disease. Leptospirosis is a particular problem, resulting from the proliferation of rats in rubbish and persistence of the bacterium in surface water and mud.^{87,88} Dengue fever is

	NCSS 2012		DHS 2014			
	Nairobi slums	All rural	Rural poor	All urban	Nairobi	National
Neonatal mortality rate	14.4	21	20.5	26	39	22
Infant mortality rate	39.2	40	38.2	43	55	39
Under-5 mortality rate	79.8	56	53.3	57	22	52

All mortality rates are per 1000 livebirths. Neonatal mortality rate is the probability of dying within the first month of life. Infant mortality rate is the probability of dying before the first birthday. Under-5 mortality rate is the probability of dying between birth and the fifth birthday. For the comparison of early childhood mortality among slums, rural poor, all urban, and national populations, we used data from slum surveys and the DHS. Data for slums were extracted from the NCSS 2000 and 2012,⁷⁴ and for all other residential domains, data were extracted from DHS 2003 and 2014.⁷⁵ NCSS=Nairobi Cross-sectional Slum Survey. DHS=Demographic and Health Survey.

Table 5: Comparison of levels and trends in early childhood mortality in slum and other sub-populations in Kenya, 2012–13

one of the few infectious diseases that is increasing worldwide,⁴⁶ and its vector, the *Aedes* mosquito, is adapted to survival in slum areas, in contrast to the *Anopheles* mosquito, which thrives in high sunlight and plentiful vegetation.⁸⁹

Social factors affect transmission of disease. People returning from rural areas bring rural diseases (eg, schistosomiasis) into the city.⁹⁰ Overcrowding contributes to the high prevalence of tuberculosis. Slum residents are a young, highly mobile population contributing to the higher incidence of HIV in slums compared to non-slum city areas.⁹¹ In the recent Ebola epidemic in West Africa, slum conditions amplified spread of the disease.⁹²

Under-nutrition and malnutrition

Under-nutrition is the leading indirect cause of childhood mortality and morbidity in sub-Saharan Africa.⁹³ Recent surveys of food insecurity specifically in slums noted rates of 85% of households in Nairobi,⁹⁴ 77% in northern India,⁹⁵ and 74% in Addis Ababa, Ethiopia.⁹⁶ Three reviews^{68,97,98} assessing diet and nutrition in slums all reported that people who live in slums were at a nutritional disadvantage compared with other urban residents. People who live in slums rely on street vendors of pre-cooked foods for about one-fifth of their calorie intake.⁹⁹

Under-nutrition is associated with recurrent diarrhoea^{100–102} in children, leading to stunted growth.¹⁰³ A systematic review reports that across multiple regions (including the Democratic Republic of Congo, Bolivia, India, Bangladesh, and Kenya) the rate of stunting in children residing in slums is higher than in non-slum urban or rural areas.^{23,78} Early childhood diarrhoea also affects child cognitive development,^{104–107} the economic consequences of which¹⁰⁸ are overlooked in cost-effectiveness studies of slum improvement (as discussed in paper two).

Exclusive breastfeeding to age 6 months and partial breastfeeding from 6 to 23 months reduce incidence of, and mortality from, diarrhoea and pneumonia, and also reduce all-cause mortality in LMICs.¹⁰² Breastfeeding rates are low in slums,¹⁰⁹ partly because of labour market

conditions that make it difficult for mothers to either stay at home or take their babies to work with them.

Injury, accidents, and violence

Trauma accounts for 10% of deaths worldwide and this proportion is increasing.⁴⁶ According to a recent study in Nairobi in slums,¹¹⁰ injury accounted for 22% of all deaths in adults, more than 50% of all deaths in men younger than 35 years, and 69% of deaths in young men aged 15–19 years. More than half of all injury-related deaths resulted from assault. Although data are not available for control areas, we have noted that the social environment differs greatly across slums and this is likely to affect crime and hence injury rates.

A review on child health reported that paediatric burns are more frequent in slums than in non-slum urban, or rural areas,⁷⁸ largely because of cooking methods. A cohort study¹¹¹ of children in the Kibera slum, Kenya found an incidence of burns that was ten times higher than across LMICs as a whole.

Mental health

Neuropsychiatric disorders are, according to one estimate, the leading cause of years of life lost to ill-health, disability, or early death (disability-adjusted life-years [DALYs]) worldwide.¹¹² The living and working conditions in slums predispose to stress, and stress leads to psychological disorders¹¹³ such as those reported in workers in garment factories in Bangladesh.¹¹⁴ We found one systematic review that reported that children living in slums have more behavioural and emotional problems than children living in rural or non-slum urban areas.⁷⁸ Our main finding is that there is very little direct literature on slum mental health or how it might be affected by the social milieu in slum neighbourhoods.

Non-communicable diseases

Non-communicable diseases now outweigh communicable diseases as a cause of loss of life years even in LMICs.⁴⁶ Just two reviews have examined non-communicable diseases in slums, both focused on the high prevalence of childhood asthma.^{115,116} Indoor cooking with solid fuels is a cause of respiratory disease in poor households generally,¹¹⁷ and the unsanitary conditions in slums are associated with up-regulation of inflammatory responses leading to a high prevalence of non-atopic asthma, in contrast to high-income countries where, according to the hygiene hypothesis, allergy results from excessive cleanliness.¹¹⁵

Rates for hypertension were slightly lower in slums than in other populations in both a Kenyan¹¹⁸ and Brazilian study.¹¹⁹ The study in Kenya also assessed treatment and control of hypertension, which was less comprehensive in the slum setting, a finding consistent with the problem of accessing health care in slums. With respect to other major non-communicable diseases, cardiovascular disease, cancer, and diabetes, the risk in

people who live in slums is poorly documented. Cigarettes are unaffordable to many and there is evidence that the number of cigarettes consumed by smokers in slums is very much lower than among smokers in other urban areas.⁹³ Women and men in slums weigh more and exercise less than rural dwellers but do more exercise and are less obese than non-slum urban controls.¹²⁰

Discussion

Nearly 1 billion people live in slums and this number is projected to double by 2030. The massive growth of slums has not been matched by commensurate growth in the scientific literature, which remains rudimentary when compared with the many studies of urban health generally, rural health, and the association between poverty and health. However, slum health should be specifically studied because slums are spaces where neighbourhood effects are likely to exist, mediated through factors such as faecal contamination of the environment, garbage mountains, stagnant ground water, overcrowding, poorly constructed homes, physical hazards (eg, floods, subsidence, and fires), and indoor and outdoor pollution. More generic determinants of health include job insecurity, lack of tenure and title, poor transport networks, stigmatisation, and the social structures within slums that vary from supportive to highly toxic.

In view of these determinants, people in slums have much worse health than those in non-slum urban areas. More controversial is the effect of slum versus rural habitation on health. Here we noted that the so-called urban bias in favour of urban areas does not necessarily extend to slums, and that, at least in some slums and on some dimensions of health, people who live in slums have worse health than the rural poor. This, of course, does not mean that people have made a miscalculation in moving to slums because those with short stay times are under-represented in cross-sectional samples. However, those who remain in slums can enter a downward spiral of ill health and financial distress leading to poverty traps from which escape is difficult, as Jeffrey Sachs has reported.^{23,121}

Another important finding relates to the particular vulnerability of children in slums. Children are more susceptible to infections, such as diarrhoea, and suffer long-term consequences in terms of health and life chances, as studied in a 2013 systematic review.¹⁰⁸ We discuss this topic in paper two.³¹ Another especially stark finding is the high rate of violent death in young men, a topic worthy of further enquiry. The scientific literature on mental health and chronic disease in slum populations is disproportionately small. Current data suggest that hypertension, an enormous emerging problem in sub-Saharan Africa, is, in fact, less prevalent in slums than in other urban areas. Likewise, smokers tend to smoke a substantially smaller number of cigarettes in slums than elsewhere. We have not found

substantial evidence concerning obesity and diabetes in slum populations, although anecdotal reports suggest that this is a rising problem.

In paper two we will turn our attention to what can be done to improve health in slums and to show that neighbourhood effects can be turned to advantage when interventions are promulgated. We will also make positive suggestions to make slums more visible to policy makers and to enhance the depth and breadth of research in support of people who live in slums.

Contributors

This series on slum health has been an international collaboration led by the University of Warwick, African Population and Health Research Centre, United Nations Human Settlements Programme (UN-Habitat), International Institute for Environment and Development, United Nations University, and the Federal University of Minas Gerais. The idea for this Series came from RJL and AE who jointly conceptualised the framework and initial draft of this paper. GJM-T, JS, and Y-FC did the systematic review and OO led on the health aspects. All authors provided references and material and contributed actively to the drafting and reviewing of the report.

Declaration of interests

We declare no competing interests.

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