

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

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42 **Summary**

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

53

54 **Introduction**

55 *Homo sapiens* is undergoing a radical transformation of its ecology.¹ During the last two
56 centuries the proportion of the world's population living in cities and towns has grown from
57 about 5% to more than 50%. This process of rapid 'urbanisation', which started in Europe
58 and North America following the Industrial Revolution, was accompanied by the
59 development of large slums including famous examples, such as La Chapelle in Paris,
60 France, the Gorbals in Glasgow, Scotland, and Khitrov in Moscow, Russia. The last fifty
61 years has seen massive urban growth in low- and middle-income countries (LMICs)
62 characterised by sprawling slums that are now home to more than half of the population in
63 cities such as Mumbai, India, Nairobi, Kenya, and Mexico City, Mexico.² This dramatic
64 growth in slums has provoked increasing international interest, and the United Nations
65 Sustainable Development Goals (SDGs) specify a target to address the 'plight of slums'.³
66 The broad purpose of this series of two articles is to investigate how this might be achieved
67 with respect to health. This, the first paper in the series, is organised as follows. First, we

68 provide some background to slums covering terminology and definitions, the size of slum
69 populations, and the dynamics of their growth. Second, we make a theoretical argument that
70 slum health should be a substantive topic for study, distinct from urban health, and from
71 poverty and health. Third, we examine the extent and nature of previous research in slum
72 health. Fourth, we describe the physical and social factors affecting health in slums. Fifth, we
73 describe the particular health problems of people who live in slums, insofar as this can be
74 discerned from the literature. Finally, we conclude.

75

76 **Background**

77 **Terminology and Definitions**

78 Concerns have been expressed that the term '*slum*' is emotive and pejorative.⁴ The term
79 '*informal settlement*' has been suggested as an alternative. However, the United Nations
80 continues to refer to '*slums*', for example in the 'Sustainable Development Goals'; '*informal*
81 *settlement*' and '*slum*' are not synonymous.

82 The United Nations Educational Scientific and Cultural Organisation (UNESCO) defines a
83 slum in terms of an urban space, as "*a contiguous settlement where the inhabitants are*
84 *characterised as having inadequate housing and basic services*".⁵ However, the most widely
85 used definition, promulgated by the United Nations Human Settlements Programme (UN-
86 Habitat), is based on households where a slum household is defined as: "*a group of*
87 *individuals that live under the same roof that lack one or more of the following conditions;*
88 *access to improved water, access to improved sanitation, sufficient living space, durability of*
89 *housing and secure tenure*".² Each of these five conditions is defined in more detail, for
90 example by specifying what type of sanitation qualifies as 'improved'. Two issues arise from
91 these contrasting definitions. First, 'slum' is a construct composed of many dimensions – five
92 in the case of the UN-Habitat definition – such that no single definition can be entirely
93 satisfactory. Second, while people intuitively think of slums as collections of dwellings, this

94 spatial construct is not included in the UN-Habitat definition. The concept of slums as spatial
95 entities is a unifying theme across both papers in this series.

96

97 **Population of Slums**

98 Measuring slum populations is not an exact science for reasons given in Panel A. The most
99 recent UN-Habitat estimates for slum populations suggest that 881 million people lived in
100 slums in the developing world in 2014,⁶ up from 689 million in 1990. The number of people
101 living in slums is increasing and remains particularly high in sub-Saharan Africa (56% of the
102 urban population lives in slums) and Southern and Southeast Asia.⁶ It is estimated that by
103 2030, approximately 5 billion of the world's projected 8.1 billion people will live in urban
104 areas. Of these, about 2 billion will live in slums, primarily in Africa and Asia.² Most of this
105 growth will occur in smaller (tier two) cities where urbanisation continues without adequate
106 planning or expansion of infrastructure. What is driving this growth in slum populations?

107

108 **Panel A: Counting people in slums**

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

- 113 1. There is more than one definition of a slum and any particular definition may be applied
114 inconsistently. A given definition may change over time; for example, the living space
115 threshold of the UN-Habitat definition was increased from over one to over two persons
116 per room in 2008.
- 117 2. There are technical difficulties in the enumeration of slum populations; they are a 'hard
118 to reach' group since householders are frequently absent; people may rent rooms by the

119 night; illegal squatters may avoid surveys; census staff may be afraid to enter slums;
120 and because some countries do not have a census.

121 3. Many slum communities are not officially gazetted as residential areas and are therefore
122 underrepresented in censuses and in national sampling frames.^{7, 8} China provides an
123 example where many “城中村” – literally villages in the city – are populated by
124 unregistered migrant workers.^{9, 10} In some cases, the exact opposite is witnessed, where
125 governments over-count slum dwellers either for political motives/support, or for
126 budgetary allocations related to service delivery.

127 4. Even where data for the UN definition of slums are available for a nation, they are only
128 collected every few years, so annual reporting of slum populations has to rely on
129 estimates and projections. Projecting the future size of slums is further complicated by
130 different rates at which slums are upgraded to non-slum across LMICs.

131 5. The threshold for definition of water supply and sanitation is set low, and the worldwide
132 estimates of slum populations would inflate by several hundred million if the threshold
133 were raised to a level sufficient to protect health.¹¹ In addition, applying the UN slum
134 definitions to high-income nations may suggest that they have no slums – but they may
135 still have significant proportions of their population living in ‘inadequate housing’.

136 The population of slums can be stated as totals or as proportions in which case the
137 denominator can be either national or urban populations. These different methods can yield
138 diverging trends. For example, in most regions of the world the percentage of the urban
139 population living in slums has been declining since 1990, while the total numbers are rising.⁶

140

141 **Dynamics and Underlying Causes of Slum Growth**

142 Urbanisation can be prevented by restricting people’s movement. For example, ‘pass laws’
143 limited internal migration in many colonial countries, while the Chinese government went

144 further still by reversing the flow between countryside and city during the Cultural Revolution.
 145 Removal of restrictions is typically followed by rapid urban migration as happened, for
 146 example, following the abolition of slavery in Brazil in 1888.¹²

147 Once a population is free to move they will be motivated or constrained by many factors
 148 (Table 1.1). The increase or decrease in slum populations is a dynamic process involving
 149 flows of people from countryside and other city precincts, flows in the reverse directions,
 150 conversion of city districts and peripheral land sites to slums (and vice versa), and the
 151 balance of births and deaths (natural growth) in the slum itself. As slums age, the proportion
 152 of growth that is natural (balance of births and deaths) increases, reaching figures as high as
 153 75% in Mexico City.¹³ We model this dynamic process in Figure 1.1.

154

155 **[Figure 1.1]**

156

157 **Table 1.1. Factors associated with rural/urban migration***

Demand (pull) factors	Supply side (push) factors
1. Thriving informal economy. ¹⁴ 2. 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 over-emphasised. ¹⁴ 3. Informed risk-taking, whereby people consciously trade a small probability of large gains for the status quo, or even ending up worse off. ¹⁴ 4. Altruistic desire to make reparations to family in the countryside, ¹⁶ and to hedge urban and rural risks over the family. ¹³ 5. A sense of adventure and the desire to escape the monotony of subsistence farming. ¹⁷	1. Environmental degradation. ¹⁹ 2. Famine. ¹⁹ 3. Improved agricultural labour productivity through mechanisation. ¹⁹ 4. Volatile commodity prices and economic shocks. ¹⁹ 5. Ethnic violence. ¹⁹ 6. Displacement, for example from 'development' projects, such as construction of dams. ¹⁹ 7. A desire to escape adverse social conditions, such as

6. Lack of barriers to migration (such as a large family), and facilitators (such as an existing social network in the city to provide temporary accommodation, support, and advice). ¹⁸	rural caste discrimination in India. ²⁰
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158 *These factors do not, of course, explain growth and persistence of slums – see text.

159

160 Explaining what motivates individuals or families to move or stay where they are under
161 prevailing conditions, does not explain why the prevailing conditions are as they are. It does
162 not account for the enormous size of slums, the number of people who become ‘trapped’ in
163 slums over generations,²¹ or the deepening poverty into which many people sink.^{22, 23} Nor
164 does it explain decoupling of economic and slum population growth – no less than 66
165 countries experienced a five year period of urbanisation without concurrent national
166 economic growth between 1960 and 1995.²⁴ Many reasons have been proposed to explain
167 why slums form, persist, and grow including: national economic stagnation, failure of re-
168 distribution, market distortion in favour of extractive elites, colonial legacies, lack of planning,
169 corruption, ‘clientism’, and anti-urban biases by national governments and international
170 agencies. Fox provides a sure-footed account of how these factors have played out over
171 time;²⁵ Roy et al. offer a recent systematic review of models of slum growth under sub-
172 optimal international and national policies;²⁶ and UN-Habitat has published a report on
173 factors that are associated with success in reducing slum growth among 100 countries over
174 a 20 year period.²⁷ These macro-level factors must be left to further enquiry by historians,
175 political scientists, and economists while we will focus on the slums themselves.

176

177 **Why Slum Health?**

178 Not all people living in slums live in poverty and many who live in urban poverty reside
179 outside of slum areas. Over half of dwellings classified as ‘slum households’ (according to
180 the Un-Habitat definition) in Chennai, Delhi and Hyderabad, India fall outside of areas

181 classified as slums (according to the Indian definition of 60 contiguous slum households).²⁸

182 This means that the health of poor city dwellers is not necessarily a reflection of the health of
183 those who live in slums. There are three reasons why living in a slum and living in poverty
184 may produce different health outcomes:

185 1. People who live in slums share environmental risks, such as those arising from poor
186 sanitation – they experience ‘neighbourhood effects’ (Panel B).^{29, 30}

187 2. Likewise they benefit collectively from interventions, such as improved sanitation, in
188 ways that will be explicated in paper two.

189 3. Social and health improvement interventions that work in non-slum localities may not
190 be transferrable to slum areas. For example, pit latrines are particularly unsuitable for
191 slums (see paper two).

192 The health of people who congregate in slums should not be subsumed in urban health or in
193 studies of poverty and health. Rather, slums should be studied as spatial entities. Yet,
194 censuses, in all but a small number of LMICs, do not identify slum from non-slum urban
195 areas. The result is that national surveys, such as Demographic and Health Surveys (DHS),
196 which are based on sampling frames derived from national censuses, do not distinguish
197 between households that are or are not located in a slum area of a city. Surveys based on
198 such censuses simply replicate the well-known association between poverty and health,^{22, 31}
199 ignoring the salience of space. We will argue in paper two that this should change and that
200 all countries should identify urban census tracts (enumeration areas) as slum or non-slum.

201

202 **Panel B: Neighbourhood effects**

203 A large body of literature attests to the existence of ‘neighbourhood effects’ on health.

204 Neighbourhood effects refer to factors that influence health at the community level

205 independent of individual household level factors, including individual household levels of

206 poverty/deprivation. They encompass pervasive effects operating across the spaces in

207 which people live. The mechanisms by which neighbourhoods exert their effects have been
 208 classified in various ways. We provide examples of neighbourhood effects based on one
 209 such classification system ³² in the Table.

210

211 **Table: General and slum-specific evidence of neighbourhood effects**

Type of neighbourhood effect ³²	Example	Example from slum context
Physical environment	The risk of childhood illness in Indian families is more strongly correlated 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	An experimental study in the USA 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. ³⁵	Crime rates vary considerably among slums, reflecting different cultures that have developed within them. ²
Geographic factors	Poor people in rich cities in the USA have better health than equally poor people in poor cities. ³¹	Many slums are exposed to geographic hazards, such as flooding, subsidence, and local pollution from factories. ³⁶
Institutional factors	Teachers may 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. ³⁷

212

213 Many authors ³⁸⁻⁴⁰ have examined slum effects in observational studies using multi-variate
 214 modelling techniques to separate individual, household, and neighbourhood contributors to
 215 health. However, identification of neighbourhood effects from observational studies is fraught
 216 with difficulty that might lead to under- and/or over-estimation.⁴¹ The study of neighbourhood
 217 effects thus leans heavily on studies of underlying mechanisms (for example, showing that
 218 soil and water are contaminated by faeces, or that overcrowding is associated with stress),
 219 and studies where the environment is manipulated under experimental (or quasi-
 220 experimental) control (discussed in paper two). Rare instances exist where it has been

221 possible to observe the effects of taking part in a lottery that allows some people to move to
222 a new environment while others remain in their original neighbourhood – the Moving to
223 Opportunity experiments in the USA ³⁵ and India,⁴² for example.

224

225 The idea of slums as spaces is central to the notion of slum health. That said, it is also the
226 case that while slums exist in space, these spaces are not homogenous but vary
227 considerably within and between slums in terms of population density, security of tenure,
228 official recognition, provision of services, topography, and social and economic make-up.⁴³
229 Context can have a large effect on the effectiveness of interventions as we discuss in paper
230 two.

231

232 **Slum Health – a Neglected Subject?**

233 We describe our literature retrieval algorithms in Panel C. Our intention was not only to
234 obtain literature to examine slum health but also, given the salience of neighbourhood
235 effects, to compare and contrast this literature with the literature on urban health generally,
236 rural health, and poverty and health.

237 **Panel C: Search strategy and selection criteria**

238 To gauge the relative attention the topic of slum health has received in medical research and
239 to characterise the nature of academic literature on slum health, we firstly carried out
240 bibliometric analyses of the relative volume of research studies concerning rural, urban and
241 slum settings (Web Appendix 1.2.1) and the number of registered clinical trials in these
242 settings in low- and middle-income countries (Web Appendix 1.2.2).

243 In order to identify key literature for the diffuse topic of slum health, we conducted a
244 systematic overview of reviews covering determinants of health in slum settings and/or
245 interventions that aim to improve the health of slum dwellers. Given that the identified

246 literature on determinants of health mainly draws evidence from cross-sectional studies that
247 are subject to selection effects as described in the text, we undertook a further systematic
248 review of cohort studies in slums. Acknowledging the important roles that international,
249 governmental and non-governmental organisations play in this area, we also systematically
250 searched the grey literature and reviewed relevant documents. Details of literature search
251 and study selection criteria for these reviews are provided in the text below.

252

253 **1. Systematic overview of reviews concerned with slum health**

254 We searched the following eight databases in January 2016: MEDLINE, including in-process
255 and non-indexed citations, Embase, PsycINFO, LILACS, SciELO, WHO Global Health
256 Library, Database of Abstracts of Reviews of Effects, maintained by the NHS Centre for
257 Reviews and Dissemination, and CINAHL (all but two of the reviews detailed here were
258 found in MEDLINE or Embase). We put no limits on dates covered. In order to make the
259 search as sensitive as possible we included a wide range of synonyms for slums, derived
260 from a list in a UN-Habitat report ⁴⁴ and augmented by other terms we have encountered:
261 baladi, bandas de miseria, barraca, barrio marginal, barrio, bidonville, brarek, bustee, chalis,
262 chereka bete, dagatan, estero, favela, galoos, gecekondou, ghetto, hrushebi, informal
263 settlement, ishash, karyan, katras, looban, loteamento, medina achouaia, morro, mudun safi,
264 musseque, shanty town, slum, solares, tanake, taudis, township, tugurio, udukku,
265 umjondolo, watta, and zopadpattis. We further broadened our search by combining free-text
266 synonyms with controlled vocabulary for slums and, where supported in the database, filters
267 for systematic reviews. No language restrictions were applied. We examined the titles and
268 abstracts of unique records and selected reviews (both systematic and narrative reviews)
269 that: 1) specifically provided results for people who live in slums; 2) specifically included
270 people who live in slums but did not provide specific results for the sub-group; and 3)
271 included the urban poor and hence were likely to have included slum dwellers, although this

272 was not specified. We selected reviews dealing with: a) the distribution and determinants of
273 health relevant to slum settings, which are included in the evidence base for paper one (for a
274 summary of identified studies see Web Appendix 1.4, Table A5); and b) interventions for
275 slum populations, reporting health outcomes, which are included in the evidence base for
276 paper two (for a summary of identified studies see Table 2.2, paper two). Please note that
277 some of the identified reviews reported both on the epidemiology of health conditions, *and*
278 interventions to improve these health conditions, in which case they are included in the
279 evidence base for both papers. A flow diagram for study retrieval and selection is available in
280 Web Appendix 1.3.1

281

282 **2. Systematic review of primary cohort studies relating to slum health**

283 We searched for primary cohort studies using MEDLINE and Embase (which support the
284 necessary search filter for cohort studies) relating to slum populations, using the same free-
285 text and controlled vocabulary terms for slums as stated in search one above. After
286 examining the titles and abstracts of the unique records this search returned, we selected
287 relevant studies (studies that prospectively recruited people living in slums and observed
288 them over at least two occasions over time). We located 128 studies meeting this criteria
289 and classified them by key themes (e.g. paediatric nutrition and diarrhea; injury), integrating
290 these throughout the text as appropriate with other relevant studies. There was only one
291 study found in search two that had been picked up by the reviews identified through search
292 one. The study retrieval and selection process is also shown in the flow diagram in Web
293 Appendix 1.3.1

294

295 **3. Systematic review of the grey literature**

296 We searched the grey literature by reviewing official reports from the publication databases
297 of the World Bank, World Health Organization, and UN-Habitat on the basis of expert advice

298 from the authors. We covered the literature from January 2010 to February 2016. Our search
299 terms included synonyms for slums in searches one and two above. Eight hundred and
300 eighty-four results were returned, and after examining the titles, abstracts, and text of these
301 studies and reports we selected 245 publications that dealt partially or wholly with issues
302 arising in slums. For a breakdown of publications see Web Appendix 1.3.2. Many important
303 articles were found in this literature, including those relating to the economics of slum
304 formation, system level interventions (such as the effect of providing tenure/title), and certain
305 notable large scale studies, including a randomised trial of home improvement.

306 We supplement the above three reviews with additional searches as needed on the advice
307 of experts (such as the searches for literature related to neighbourhood effects in slums,
308 Web Appendix 1.3.3), and further extended these with authors' collections of references and
309 additional papers identified by subject experts.

310

311 The bibliometric analysis supports the hypothesis that slum health has received scant
312 attention compared with rural health, urban health, and poverty and health:

- 313 1. Studies on slum health make up only a small proportion of the LMIC literature. For
314 instance only 2.8% of LMIC papers on MEDLINE and Embase that stated where the
315 study was carried out were based in a slum location (Web Appendix 1.2.1).
- 316 2. Only 7% LMIC trials registered on the WHO Clinical Trials Registry Platform that
317 stated where the trial was carried out were based in a slum location and in many
318 cases slums were chosen as a convenience sample, for instance to study the effects
319 of a new vaccine, rather than to examine slum health or how to improve it (Web
320 Appendix 1.2.2).
- 321 3. There is no MeSH term for 'slum' or its synonyms on MEDLINE or Embase.

322 Further evidence that slum health is a neglected topic can be found by examining the
323 location of the 38 Demographic Surveillance Sites based in Africa; only one (the Nairobi

324 Urban Health and Demographic Surveillance System) is based *entirely* in a slum area. In
325 addition, slums are not identified as a determinant of health in the influential Global Burden
326 of Disease report.⁴⁵

327 Before moving on to discuss the findings on health and its determinants it is worth
328 mentioning the type of literature retrieved and its possible biases. Most literature on health
329 and welfare in slums is based on cross-sectional studies that are subject to selection effects,
330 including:

- 331 1. Those who migrate are healthier on average than those who remain in rural settings
332 (healthy mover effect).
- 333 2. Those who transition rapidly through the slums are under-represented relative to all
334 who have been exposed to slums (a form of 'rate bias').

335 These factors may lead to potential bias when seeking to make an inference about the effect
336 of moving to a slum from another place, or the net effect of slums on health or wellbeing.

337 The second factor can be mitigated by use of longitudinal studies; the rationale for a specific
338 search for such studies (Panel C).

339

340 **Living and Working Conditions in Slums**

341 Slums are usually *formed* close to areas where work is available. Under population
342 pressures the slum pushes upward (stories added to dwellings) and outward. Competition
343 for sites close to places of work causes inflation in rents and land prices so that landlords in
344 central locations may end up quite well-off, while those at the periphery become
345 progressively disadvantaged;^{46, 47} the Gini coefficient (a measure of income inequality) in
346 Bangladesh is larger *within* slums than across the country as a whole.⁴⁸ This is important
347 because increasing poverty generates health inequality, which in turn leads to deeper
348 poverty creating a vicious circle (or poverty trap).³⁸

349 Security of tenure is a key issue for slum households. Slums are often set up on unclaimed
350 or municipal land.⁴⁹ It is then up to the authorities to decide whether or not to recognise the
351 slum and confer residency rights on citizens – such ‘notified’ locations make up only about
352 half of all slums in India, for example.⁵⁰ People with no rights have little incentive to invest in
353 healthier homes and may be evicted without compensation to provide more lucrative middle-
354 class housing to the benefit of an ‘extractive elite’; slum landlords and local government
355 officials may be one and the same.⁵¹ Large scale evictions have taken place under apartheid
356 in South Africa,⁵² state capitalism in China,⁵³ and even democratic local government in
357 Brazil.⁵⁴ The injustice and inhumanity of these evictions is compounded by the plight of the
358 displaced settlers who must move to new locations that are even more disadvantaged, in
359 terms of access to the labour market and environmental safety, than their original slum
360 habitat,⁵⁵ again widening inequalities.

361 Whether through eviction or a shortage of space, people in slums may inhabit dangerous
362 locations such as ravines, where they are subject to landslides (Caracas, Venezuela), flood
363 plains, where they are subject to drowning and loss of homes (Manila, Philippines), and
364 under power lines increasing the risk of fires (Nairobi). In Quito, Ecuador, people who live in
365 slums have been forced above the 2850 metre city limit that marks the highest level that can
366 be serviced by the municipal water distribution system.⁵⁶ People who live in slums are also
367 especially vulnerable to the effects of global warming. For example, poorly constructed
368 homes are ill-equipped to withstand the elements and mortality risk from tropical cyclones
369 (after controlling for storm intensity) is over a hundred times greater in low-income compared
370 to high-income countries.⁵⁷

371 Slums provide access to markets for millions of people and provide conditions where micro-
372 enterprises become established.⁵⁸ The informal sector is worth US\$10 trillion per year
373 globally and employs 80% of the workforce in LMICs.⁵⁹ But people live hand to mouth as
374 day-to-day existence requires out-of-pocket payments, not just for food and accommodation,
375 but for basic amenities, such as water, access to toilets, cooking fuel, transportation, and

376 education. Informal sector workers with minimal statutory rights and who lose income when
377 they are absent from work ⁶⁰ are at a particular disadvantage if they live in slum areas with
378 long and costly commutes. Health facilities, if present, are closed when they return from
379 work and they cannot attend appointments for immunisation, antenatal care, or care of long-
380 term conditions. Women, earn on average only a third of men's earnings in urban areas of
381 sub-Saharan Africa.⁶⁰

382 Not only is there an economic and social gradient within slums, but slums themselves may
383 differ from each other, not just economically, but socially. This is illustrated with respect to
384 crime where some slums (e.g. Kumasi in Ghana and Surabaya in Indonesia ²) have low
385 crime rates, while others are dominated by criminal gangs, as in Rio de Janeiro, Brazil and
386 Caracas, Venezuela ^{61, 62} leading to the concept of 'slums of hope and slums of despair'.⁶³ It
387 would be useful if high risk localities could be identified on the basis of their characteristics
388 and a study across 48 slum areas in Mumbai, India identified maternal and child health risk
389 areas with high specificity but low sensitivity on the basis of access to water and sanitation,
390 housing quality, and tenancy status.⁶⁴ We have not located studies to identify risk by higher
391 level factors such as size of slums, and have cited limited information suggesting that large
392 established slums have lower social capital than newer slums. There is a positive correlation
393 between average duration of residence in a slum and the prevalence of violence in that
394 slum.³⁸ Strong social pressures in slums can affect drug use and teenage sexual behaviour
395 at the community level. We explore some of these through the words of mothers of teenage
396 children in Web Appendix 1.1.

397 Slum dwellings are loosely fitted together from available materials allowing easy access for
398 vectors of disease. Under the sun corrugated iron dwellings become oppressively hot, while
399 at night temperatures in high altitude cities can plummet to lows of -4.4°C in Mexico City,
400 Mexico and -0.5°C in Addis Ababa, Ethiopia. Many slums households do not have piped
401 water or lavatories. Pit-latrines contaminate the environment and the water supply is prone
402 to contamination at multiple points. Homes are crowded and afford little privacy. Cooking

403 and heating with solid fuels in confined spaces pollutes the air with noxious fumes and
404 particulate matter. Streets and lanes are unpaved with no drainage and are therefore
405 converted to mud and stagnant pools when it rains. Garbage collects in huge, malodourous
406 piles and often contains excrement. There is little open space where children can play safely
407 or where adults can relax.

408 The determinants of health interact and are highly reinforcing.⁶⁵ For instance, poor maternal
409 mental health postnatally reduces willingness to breastfeed and also affects the mother's
410 bonding to her child, placing the child at risk physically and socially. Early weaning, failure to
411 immunise, exposure to contaminated water, and malnutrition interact producing enteropathy
412 and stunting, which in turn predispose to reduced school performance, and reduced life
413 chances. If a mother does not breastfeed, her fertility will return quickly after childbirth,
414 resulting in reduced spacing between children. As a result less time, money, and loving
415 support can be given to each child. If a parent develops a serious disease, such as recurrent
416 tuberculosis, the family will suffer catastrophic financial loss (due to cost of healthcare and
417 loss of earnings) reducing educational opportunities. It is time to examine in more detail how
418 slum neighbourhoods predispose their inhabitants to disease.

419

420 **Health in SlumsChild Mortality**

421 It is difficult to measure the life expectancy of people who live in slums because they move
422 to and fro and may return to rural areas to die. However, child mortality is easier to ascertain.
423 While child mortality is similar between rural and urban locations overall ⁶⁶ comparisons
424 between slum areas specifically and the countryside tell a different story. Higher infant
425 and/or neonatal mortality in slum versus rural areas has been found in Kenya, Ecuador,
426 Brazil, Haiti, and in the Philippines ⁶⁷⁻⁶⁹, although rural areas with particularly high malaria
427 exposures may experience even higher child mortality rates than high altitude slums.⁷⁰ We
428 have examined this issue further by analysing survey data from Bangladesh and Kenya; two

429 countries where the census distinguishes between slum and non-slum urban areas (Table
430 1.2). We find that slums have worse health outcomes for children than the rural populations
431 of both countries. Even if we define the rural poor as the lowest tertile by socioeconomic
432 status, children have higher mortality rates in the slums of Nairobi. Diarrhoea and
433 pneumonia are the two main worldwide killers of children under five years ^{71, 72} and there
434 seems little doubt that young children (under five years) are at particularly high risk in slums
435 as discussed below in more detail.

436

437

438 **Table 1.2: Comparison of levels and trends in early childhood mortality among slum**
 439 **and other sub-populations in Bangladesh and Kenya**

BANGLADESH CHILD MORTALITY - 2006/07

	UHS* 2006	Demographic and Health Survey 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-five mortality rate	80.7	77	85.7	63	69	65

BANGLADESH CHILD MORTALITY - 2013/14

	UHS* 2013	Demographic and Health Survey 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-five mortality rate	57	49	63.9	37	41	46

KENYA CHILD MORTALITY - 2000-2003

	NCSS** 2000	Demographic and Health Survey 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-five mortality rate	151	117	144.2	93	95	115

KENYA CHILD MORTALITY - 2012/13

	NCSS** 2012	Demographic and Health Survey 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-five mortality rate	79.8	56	53.3	57	22	52

440 *Urban Health Survey

441 **Nairobi Cross-sectional Slum Survey

442 All mortality rates are per 1,000 live births.

443 Neonatal mortality rate: the probability of dying within the first month of life.

444 Infant mortality rate: the probability of dying before the first birthday,

445 Under-five mortality rate: the probability of dying between birth and the fifth birthday.

446

447

448

449 **Table 1.2 Legend:** For the comparison of early childhood mortality among slums, rural poor,
450 all urban, and national populations, we used data from slum surveys and the DHS. For
451 Kenya, data for slums were extracted from the Nairobi Cross-sectional Slum survey 2000,
452 and 2012,⁷³ and for all other residential domains, data were extracted from DHS 2003, and
453 2014.⁷⁴ In Bangladesh, indicators for slum population were extracted from the Urban Health
454 Survey 2006, and 2013.⁷⁵ The corresponding indicator data for other residential domains
455 were extracted from Bangladesh DHS 2007, and 2014.⁷⁶

456 This study was made possible by slum-specific indicators that are tagged on to residential
457 domains in census and surveys in Bangladesh and Kenya. In Kenya, the selection of slums
458 for the survey was informed by 1999 and 2009 census listings that identified slum
459 enumeration areas. A weighted cross-sectional sample was designed, representative of
460 households in all slum clusters of Nairobi in 2000 and 2012. In the Urban Health Survey in
461 Bangladesh slums were defined as areas of concentrated vulnerability. Using satellite
462 images from census 2005 as a starting point, four criteria for identifying slums were used:
463 poor housing conditions, high overall density, poor environmental services, and high
464 prevalence (over 75 percent) of people with income below the poverty level. The rural poor
465 were classified as the lower tertile of the rural population based on wealth scores data from
466 the respective DHS.

467 It is noteworthy that mortality rates are declining in both countries in both rural and slum
468 areas. In Nairobi, however, the situation of children in the slum areas relative to rural poor
469 children appears to have worsened over time.

470

471

472

473

474 When children move to slums from the countryside they are most vulnerable immediately
475 following their arrival, presumably because they have little immunity to the organisms in their
476 new neighbourhood.⁷⁷ When compared to children whose parents do not leave for the city,
477 children left behind in the countryside have unchanged or even improved health – perhaps
478 as the result of remittances.^{78, 79}

479

480 **Infectious diseases**

481 Pit latrines with slabs qualify as ‘improved sanitation’ in the World Health Organization
482 (WHO) / United Nations Children’s Fund (UNICEF) Joint Monitoring Programme definition.¹¹
483 Yet such facilities are inappropriate in a crowded slum environment.⁸⁰ Even when judged
484 against this low standard, only 40% of the urban population in sub-Saharan Africa had
485 ‘improved sanitation’, while 33% had piped water in their homes in 2015. The situation in
486 slums specifically can only be worse. Gastrointestinal infections are highly prevalent in slums
487 ^{67, 81} and children under five years old are particularly vulnerable (see below). Two
488 systematic reviews of cholera outbreaks in Africa identified slum neighbourhoods as the
489 usual source of the epidemic.^{82, 83} Slum dwellers perceive water and sanitation as their most
490 pressing need.⁸⁴ Interestingly, slum life may protect children from the effects of polio
491 because the virus is likely to be contracted at a particularly early age in slum areas, and
492 hence at a stage when the baby is still protected by maternal antibodies.⁸⁵

493 Accumulation of rubbish and poor housing provide breeding grounds for parasites and
494 vectors of disease. Leptospirosis is a particular problem, resulting from the proliferation of
495 rats in garbage and persistence of the bacterium in surface water and mud.^{86, 87} Dengue
496 fever is one of the few infectious diseases that is increasing globally,⁴⁵ and its vector, the
497 *Aedes* mosquito, is particularly adapted to survival in slum areas, in contrast to the
498 *Anopheles* mosquito, which thrives in high sunlight and plentiful vegetation.⁸⁸

499

500 Social factors affect transmission of disease. Sojourns in rural areas bring 'rural' diseases
501 (e.g. schistosomiasis) into the city.⁸⁹ Overcrowding contributes to the high prevalence of
502 tuberculosis. Slum residents are a young, highly mobile population contributing to the higher
503 incidence of HIV in slums compared to non-slum city areas.⁹⁰ In the recent Ebola epidemic in
504 West Africa, slum conditions amplified spread of the disease.⁹¹

505

506 **Under-nutrition and malnutrition**

507 Under-nutrition is the leading indirect cause of childhood mortality and morbidity in sub-
508 Saharan Africa.⁹² Recent surveys of food insecurity specifically in slums found rates of 85%
509 of households in Nairobi,⁹³ 77% in Northern India,⁹⁴ and 74% in Addis Ababa, Ethiopia.⁹⁵
510 Three reviews examining diet and nutrition in slums^{67, 96, 97} all showed that people who live in
511 slums were at a nutritional disadvantage compared with other urban residents. People who
512 live in slums rely on street vendors of pre-cooked foods for about a fifth of their calorie
513 intake.⁹⁸

514 Under-nutrition interacts with recurrent diarrhoea⁹⁹⁻¹⁰¹ in children leading to stunted
515 growth.¹⁰² A systematic review reports that across multiple regions (including the Democratic
516 Republic of Congo, Bolivia, India, Bangladesh, and Kenya) the rate of stunting in children
517 residing in slums is higher than in non-slum urban or rural areas.^{23, 77} Early childhood
518 diarrhoea also impacts child cognitive development,¹⁰³⁻¹⁰⁶ the economic consequences of
519 which¹⁰⁷ are overlooked in cost-effectiveness studies of slum improvement (paper two).

520 Exclusive breastfeeding to age six months and partial breastfeeding from 6-23 months
521 reduce incidence of, and mortality from, diarrhoea and pneumonia, and also reduces all-
522 cause mortality in LMICs.¹⁰¹ Breastfeeding rates are low in slums,¹⁰⁸ partly due to labour
523 market conditions that make it difficult for mothers to either stay at home or take their babies
524 to work with them.

525

526 **Injury, accidents and violence**

527 Trauma accounts for 10% of deaths worldwide and this proportion is increasing.⁴⁵ According
528 to a recent study in Nairobi in slums, injury accounted for 22% of all deaths among adults,
529 over a half of all deaths among men under 35 years, and 69% of deaths in young men aged
530 15-19. Over half of all injury related deaths resulted from assault.¹⁰⁹ Although data are not
531 available for control areas, we have noted that the social environment differs greatly across
532 slums and this is likely to influence crime and hence injury rates as discussed earlier.

533 A review on child health reported that paediatric burns are more frequent in slums than in
534 non-slum urban, or rural areas,⁷⁷ largely due to cooking methods. A cohort study of children
535 in the Kibera slum, Kenya found an incidence of burns that was ten times higher than across
536 LMICs as a whole.¹¹⁰

537

538 **Mental health**

539 Neuropsychiatric conditions are, according to one estimate, the single leading cause of
540 years of life lost to ill-health, disability, or early death (DALYs) worldwide.¹¹¹ The living and
541 working conditions in slums predisposes to stress (as described above) and stress leads to
542 psychological disorders¹¹² such as those seen among workers in garment factories in
543 Bangladesh.¹¹³ We found one systematic review which reported that children living in slums
544 experience more behavioural and emotional problems than children living in rural or non-
545 slum urban areas.⁷⁷ Our principle finding is that there is very little direct literature on slum
546 mental health or how it may be affected by the social milieu in slum neighbourhoods.

547

548 **Non-communicable diseases**

549 Non-communicable diseases now outweigh communicable diseases as a cause of loss of
550 life years even in LMICs.⁴⁵ Just two reviews examined non-communicable diseases in

551 slums, both focussed on the high prevalence of childhood asthma.^{114, 115} Indoor cooking with
552 solid fuels is a cause of respiratory disease in poor households generally,¹¹⁶ and the
553 unsanitary conditions in slums are associated with up-regulation of inflammatory responses
554 leading to a high prevalence of non-atopic asthma, in contrast to high-income countries
555 where, according to the hygiene hypothesis, allergy results from excessive cleanliness.¹¹⁴
556 Rates for hypertension were slightly lower in slums than in other populations both in a
557 Kenyan ¹¹⁷ and Brazilian study ¹¹⁸. The former study also examined treatment and control of
558 hypertension, which was less comprehensive in the slum setting – a finding consistent with
559 the above mentioned problem of accessing healthcare in slums. With respect to other major
560 non-communicable diseases, cardiovascular disease, cancer and diabetes, the risk among
561 people who live in slums is poorly documented. Cigarettes are unaffordable to many and
562 there is evidence that the number of cigarettes consumed by smokers in slums is very much
563 lower than smokers in general.⁹³ Women and men in slums are heavier and exercise less
564 rural dwellers but have more exercise and are less obese than non-slum urban controls.¹¹⁹

565

566 **Conclusion**

567 Nearly a billion people live in slums and this is projected to double by 2030. This is not
568 reflected in the literature, which is rudimentary when compared to the heft of the literature on
569 urban health generally, rural health, and the relationship between poverty and health. Yet
570 there are good reasons to study slum health specifically, since slums are spaces where
571 neighbourhood effects are likely to exist, mediated through factors such as faecal
572 contamination of the environment, garbage mountains, stagnant ground water,
573 overcrowding, poorly constructed homes, physical hazards (such as burns, scalds, and
574 accidental fires), and indoor and outdoor pollution. More generic determinants of health
575 include job insecurity, lack of tenure/title, poor transport networks, stigmatisation, and the
576 social structures within slums that vary from supportive to highly toxic.

577 Given these determinants it comes as no surprise that people in slums have much worse
578 health than those in non-slum urban areas. More controversial is the effect of slum versus
579 rural habitation. Here we find that the so-called 'urban bias' in favour of urban areas, does
580 not necessarily extend to slums, and that, at least in some slums and on some dimensions
581 of health, people who live in slums have worse health than the rural poor. This, of course,
582 does not mean that people have made a miscalculation in moving to slums because those
583 with short sojourn times are under-represented in cross-sectional samples. However, those
584 who remain in slums can enter a downward spiral of ill health and financial distress leading
585 to 'poverty traps' from which escape is difficult, as Jeffrey Sachs has shown.^{23, 120}

586 Another important finding relates to the particular vulnerability of children in slums. They are
587 more susceptible to infections, such as diarrhoea, and suffer long-term consequences in
588 terms of health and life chances – the topic of a recent systematic review.¹⁰⁷ It is for this
589 reason that we will stress the plight of children in paper two. Another particularly stark finding
590 is the high rate of violent death among young adult males – a topic worthy of further enquiry.
591 The literature on mental health and chronic disease in slum populations is disproportionately
592 small. Such evidence as we have been able to glean suggests that hypertension, an
593 enormous emerging problem in sub-Saharan Africa is, in fact, less prevalent in slums than in
594 other urban areas. Likewise, smokers tend to smoke a considerably smaller number of
595 cigarettes in slums than elsewhere. We have not examined evidence on obesity and
596 diabetes in slum populations, although we have received anecdotal reports that this is a
597 rising problem.

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

603 **Key messages**

- 604 1. The population of slums has increased massively in size over the last 60 years and
605 slums now dominate many cities in LMICs, and are increasing in total population
606 size, particularly in Africa.
- 607 2. Slum health issues are widely subsumed in urban health and the relationship
608 between poverty and health. Failure to recognise slums as spatial entities obscures
609 neighbourhood effects that are likely to have potential influence on health in slums.
- 610 3. There is a long and unfortunate history in which people in slums have been
611 marginalised and even stigmatised with the result that they experience expropriation
612 of property, displacement, and denial of access to basic services.
- 613 4. People in slums frequently live hand to mouth so that when illness occurs the victim
614 is likely to fall into extreme poverty, which in turn leads to worse health leading to
615 extreme inequality and poverty traps.
- 616 5. Inadequate water supply, sanitation, drainage, and garbage collection in a crowded
617 environment predisposes to recurrent diarrhoea and diseases such as typhoid, hook
618 worm, and cholera.
- 619 6. Children are especially vulnerable in slums because of low breastfeeding rates,
620 under-nutrition, and poor sanitation, predisposing to chronic diarrhoea, stunting, and
621 impaired cognitive development. Child health was found to be even worse in slums
622 than among the rural poor in numerous studies.
- 623 7. Reservoirs and vectors for infectious diseases such as dengue, leishmaniasis, and
624 leptospirosis flourish in slum environments.
- 625 8. The shared physical and social environment of slums exposes residents to health
626 risks of injury from fire, extreme weather, and crime.
- 627 9. Insufficient attention has been paid to mental health and non-communicable diseases
628 in stressful slum environments, or of how slum characteristics might influence health
629 outcomes.

630 10. Slum health should be distinguished from urban health and mainstreamed in the
631 implementation of the Sustainable Development Goals and the New Urban Agenda.

632

633

634

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644

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646 The authors declare no competing interests

647

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662

663

664 **Figure Legends**

665 **Figure 1.1: Basic model depicting population flows between countryside and the city**
666 **and between formal versus slum precincts of the city***

667 * *Use of yearly transition rates enable dynamic flow to be modelled net of seasonal*
668 *fluctuations.*

669 A key transition in the *generation* of slums is movement between countryside and city – t_1
670 and t_3 . According to a famous model from Harris and Todaro ¹⁴ migration from the
671 countryside is propelled by surplus labour on the land in the run up to the demographic
672 transition and a growing demand for labour in the cities, which generates a gap in expected
673 wealth.¹⁴

674 Transitions from city to countryside are represented by t_2 and t_4 . A sustained period (five
675 years or more) where migration from city to countryside exceeded migration from
676 countryside to city (t_2 and t_4) > (t_1 and t_3) happened in only five LMICs in a 35 year period
677 (1960-1995) and these include the massive upheavals in China and Cambodia.

678 People move from formal city precincts to slums because of their financial circumstances,
679 but this transition (t_5) also occurs when previously better off areas fall into decay through
680 economic recession and middle-class flight, as happened in previously fashionable precincts
681 of Lima, Peru.¹⁵ The reverse transition (t_6) can also come about because people move from
682 slum to formal precincts or because a slum is upgraded to a non-slum area. The balance
683 between t_5 and t_6 is, of course, critical to the question of whether slums expand or contract,
684 as discussed in the text.

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