

Improving the Health and Welfare of People who Live in Slums

Authors:

Richard J Lilford, DSc (hon), PhD, FRCOG, FRCP, FFPH¹

Oyinlola Oyebode, PhD, FFPH¹

GJ Melendez-Torres, DPhil, RN, MFPH¹

Yen-Fu Chen, PhD¹

Samuel I Watson, PhD¹

Jo Sartori, BA (Hons) ¹

David Satterthwaite, PhD⁴

Blessing Mberu, PhD²

Tilahun Haregu, PhD²

Robert Ndugwa, PhD³

Ruhi Saith, PhD⁵

Waleska Caiaffa, PhD⁶

Tony Capon, PhD⁷

Alex Ezeh, PhD²

1. Warwick Centre for Applied Health Research and Delivery, University of Warwick, Coventry, CV4 7AL.
2. African Population and Health Research Centre, Manga CI, Nairobi, Kenya
3. Global Urban Observatory | Research and Capacity Development Branch ,United Nations Human Settlements Programme , UN Avenue Gigiri, UN Complex, Block 4, South Wing, 2nd level P.O.Box 30030, GPO Nairobi 00100, Kenya.
4. International Institute for Environment and Development, London, UK.
5. Oxford Policy Management, New Delhi
6. School of Medicine, Federal University of Minas Gerais, Brazil.
7. United Nations University, Kuala Lumpur

Corresponding Author:

Richard J. Lilford

Warwick Centre for Applied Health Research and Delivery. Warwick Medical School.

University of Warwick

Coventry. CV4 7AL United Kingdom

Email: R.J.Lilford@warwick.ac.uk Tel: +44 (0)24765 75884

Word count: ~4,556

Summary (150 words)

The first paper in this series discussed slums as a phenomenon defined in space, where a shared physical and social environment results in neighbourhood effects on health and wellbeing. As a result, slums offer high returns on investment because beneficial effects are also shared across many people in densely packed neighbourhoods as John Snow showed in 1854 where he disabled the Broad Street water pump in the Soho slum of London. But many interventions that seem sensible, even self-evident, have produced disappointing results in practice. Here, we try to understand why interventions often fail and how this may be avoided. We also examine slum health as a subject and find that it is under-developed. Based on this finding we make recommendations for the conduct of national censuses across the world and for the creation of infra-structure for studies aimed to improve health and welfare in slums specifically.

(147 words)

Introduction

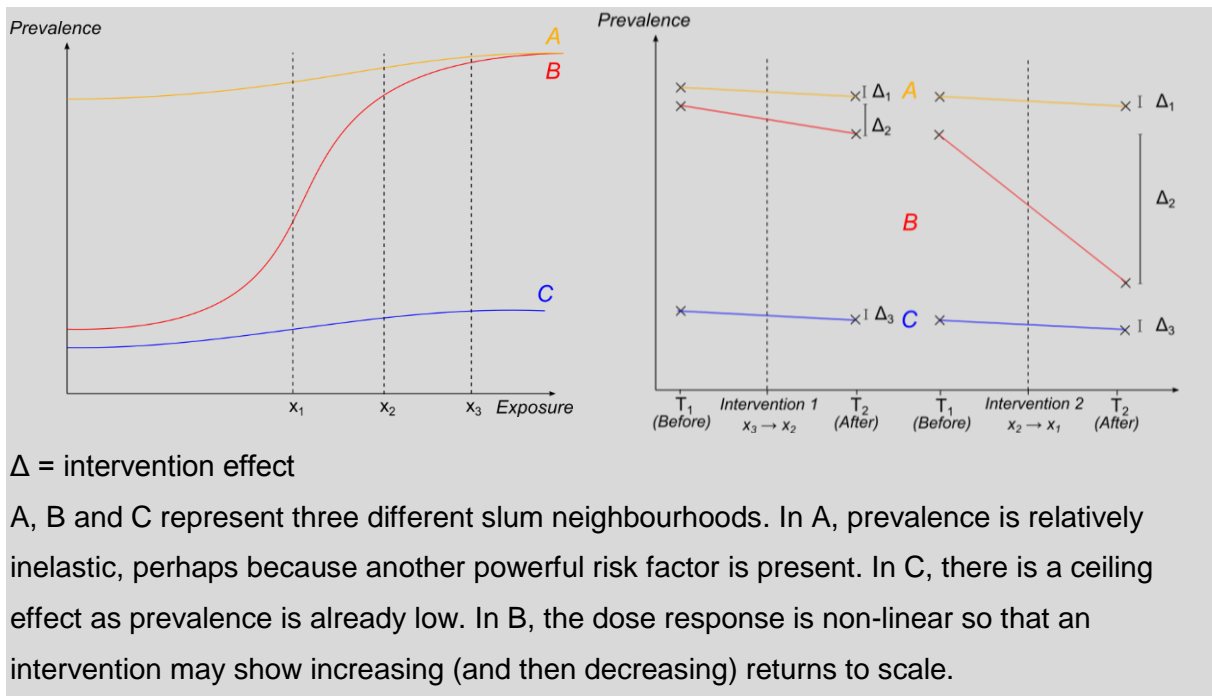
The lives of people who reside in slums are influenced by decision makers at different levels from the WHO headquarters in Geneva to a clinic in Kinshasa. This causal pathway is represented in Figure 2.1 which we have consolidated from other examples ^(1, 2) and which conforms broadly to the framework presented in paper one. The pathway starts at the left of the diagram with upstream (macro-level) policies that affect all citizens irrespective of whether or not they live in slums – fiscal or monetary policies, trade policies, freedom of the press, independent judiciary and so on. These are crucially important policies but they are *not* necessary conditions for improved health ^(3, 4). Massive gains in health have been recorded even in countries with poor national governance ⁽⁵⁾ and it is worth reflecting that infant mortality in slums is currently about 46 per thousand ⁽⁶⁾, whereas in Victorian England the *upper* class infant mortality rate in 1899 was three times higher (136 per thousand) ⁽⁷⁾. We shall not consider these macro-level policies but turn our attention first to meso-level interventions, often at local authority level, that are directed at the people who live in slums in particular rather than the country at large. These concern issues such as security of tenure and zoning land for development. These interventions often have consequences for health even if this is not their primary purpose. We will then consider downstream interventions, at the micro-level, addressing specific threats to health; for example, sanitation, housing and health services recognising that interventions targeted at one outcome may have spill over effects on others. The literature reviews that informed our analysis was described in paper one.

We demonstrated in paper one that the intimately shared physical and social environment in slums is likely to generate strong neighbourhood effects. Here we evaluate policies in terms of their ability to improve health and welfare of those who live in slums and discuss the upside of neighbourhood effects when we come to act. The densely packed slum neighbourhoods not only provide economies of scale but may also provide *increasing* economies to scale when interventions are promulgated. This idea is further explicated in Box A.

Box A. Neighbourhood effects and the effectiveness of interventions: non-linear returns to scale

As stated in paper one, the risk of disease in a locality is affected by both personal factors, such as diet and genetic constitution, and factors in the local environment such as faecal contamination, vectors of disease and pollution. The latter are causes of neighbourhood effects. There are two major influences that determine how a neighbourhood level intervention will play out in a community. First, there are differences within neighbourhoods and between neighbourhoods in the extent to which the prevalence of a disease is affected by exposure to a risk factor. Second, the dose response may vary and is often non-linear. The latter is particularly likely in dynamic scenarios where one person's risk affects another person's risk, either because the disease is infectious or because one person's behaviour influences another person's risk. We have modelled the way that these two influences interact in the left hand panel of the Figure below. A consequence of this is that interventions designed to reduce the prevalence of a target disease will demonstrate differing levels of effectiveness in different areas and within the same area over time, depending on the conditions prevailing when the intervention is adopted or whether there is a sufficient 'dose' of the intervention. The shape of the response curve may yield scenarios of increasing returns to investment, up to a tipping point, demonstrated in the right hand panel of the Figure. Providing sanitation is likely to exhibit increasing returns as faecal contamination is progressively reduced. Failure to realise the steep part of the curve by supplying sanitation at insufficient scale or intensity may explain why many sanitation improvement projects have yielded disappointing results as described later.

Figure. (Left) Relationship between exposure to a risk factor for a disease and prevalence of the disease in three different neighbourhoods. (Right) Observed effectiveness of an intervention aimed at reducing exposure.



Δ = intervention effect

A, B and C represent three different slum neighbourhoods. In A, prevalence is relatively inelastic, perhaps because another powerful risk factor is present. In C, there is a ceiling effect as prevalence is already low. In B, the dose response is non-linear so that an intervention may show increasing (and then decreasing) returns to scale.

(361 words)

Meso-level policies directed at slums

Restricting migration or benign neglect

Restricting free movement of citizens within a country is an illiberal policy redolent of the Cultural Revolution and apartheid South Africa – the days of ‘pass laws’ have been properly consigned to history.

The converse of authoritarian restrictions on movement is a “*laissez faire*’ policy of benign neglect. Proponents of this hands-off policy adhere to ‘modernisation’ principles arguing that slums are a temporary phenomenon, and that intervening to improve the lives of people in slums is self-defeating because it will encourage more inward migration – the ‘Todaro effect’⁽⁸⁾. This argument can be rejected because we have seen (paper one) that:

1. Modernisation is ‘distorted’ under the political and macro-economic conditions prevailing in countries with large slums.
2. Migration is no longer the main factor associated with perpetration or growth in many countries – 86% of people in South America already live in cities, for example⁽⁹⁾.

Resettlement / Relocation Programmes

During the reign of Napoleon III, Baron Haussman rebuilt central Paris, destroying the medieval city to create the landscape we see today. Haussman’s intervention was not evaluated scientifically but the results of resettlement programs in LMICs are often

disappointing⁽¹⁰⁾. Sometimes this is because they amount to a covert form of expropriation when rents on new buildings are too high for displaced residents to afford. Even when residents are resettled in alternative accommodation, they are liable to find themselves on the periphery of sprawling cities, where land is affordable. Many instances have been described where settlers return to their original, 'inferior', dwelling to avoid debilitating commutes to work. Absent development of infrastructure (transport, water, electricity and sewerage) the cheaper policy of *in situ* slum upgrading is generally preferable to relocation⁽¹¹⁾. Interestingly, a lottery system enabling people to move to better-off neighbourhoods that worked well in USA⁽¹²⁾ (Box A, paper one) was not successful when tried in India largely because many residents returned to their original location⁽¹³⁾.

Security of tenure

It is in the nature of most slums that they tend to be informal settlements where residents do not have titles or secure tenure. According to economic theory, people are unlikely to invest in their properties unless they feel secure against summary eviction⁽¹⁴⁾; a theory confirmed empirically with respect to farm land⁽¹⁵⁾. In slums specifically, two studies^(16, 17) exploited natural experiments in which title was assigned to households in intervention but not control slums without regard to any particular feature of the slums in question. The first study in Peru provided further support for economic theory, confirming a sharp increase in investment in home infrastructure, including sanitation, in the intervention slums. The second study in Uruguay, focused on health, again finding statistically significant improvements (an 18 percentage point reduction in reported illness)⁽¹⁷⁾. Title is maximally effective when financial systems that allow residents to release collateral value are in place⁽¹⁸⁾. On the other hand, awarding title may be a longwinded and expensive legal process. In such cases systems of tenure or registration that instil confidence that homes will not be bulldozed may be enough to encourage residents to invest in developments that will improve the determinants of health⁽¹⁹⁾.

City Governance

In many cities, slums are a manifestation of failures in planning, governance and legislation, so good local authority policies as promulgated by the 'Health Cities movement' are conducive to slum health as discussed in a Lancet Commission on urban health⁽²⁰⁾. Local government can help ensure that land markets work efficiently, and that the playing field is not tilted in favour of powerful elites wishing to build expensive houses for the middle-class and that building restrictions do not price the poorest people out of the market⁽²¹⁾. Pro-active zoning of land for low-cost housing provided with basic utilities can help reduce the size of slums. While such planning processes may be corrupt or incompetent, leading to ghost cities

(22, 23), they can also be successful as is seen in Porto Alegre and Belo Horizonte in Brazil (24-26).

Part and parcel of good local governance is formalising slum areas so as to provide rights and entitlements for those who live in slums. (27). For instance a recent study comparing contiguous slum areas in India, one 'notified' and one not, showed markedly better outcomes in education and health in the notified area, for example an infant mortality rate 58 versus 25 per 1000 live births (28). Yet only half of Indian slums are notified and in China, migrants to cities are frequently denied access to basic services due to their rural registration numbers (Hukou)

Community Engagement

There is an expanding literature confirming the effectiveness of interventions to promote local engagement, action and innovation (29, 30) and the more the community drives the intervention the greater the effect (31). A systematic review of women's groups to improve perinatal outcomes included seven randomised controlled trials (RCTs). While the results were positive overall, the effect was highly dependent on participation rates which were low in the three studies with null results, one of which was conducted in a Mumbai slum (32). In the other four studies, in which at least 30% of pregnant women participated, a 49% reduction in maternal mortality and 33% reduction in neonatal mortality was shown. There are a number of examples of successful grass-roots networks in slums (31, 33-36). The programme in Porto Alegre mentioned above incorporated participatory budgeting where communities were involved in setting priorities (24, 37). Such groups have provided successful escort for pregnant women when they go into labour in Nairobi slums (38), enhanced protection and rights for sex workers in Zimbabwe (39) and improved self-organisation of waste pickers in slums who have gone on to bid successfully for municipal contracts (40). City and national slum dwellers federations have been active in conducting slum surveys using these to provoke and plan action with local authorities (41).

(983 words)

Specific (micro-level) interventions in slums

Here we consider specific interventions of two types; physical / engineering approaches to slum upgrading and health interventions. We do not include cash transfers / microfinance. Three of the reviews (one a Cochrane review (42)) located in our search (search two, Box C, paper one) evaluated this topic (Table 2.1) but none provided results for slums specifically.

Physical and engineering approaches in slum upgrading

The evidence we have adduced for physical interventions draws on two Cochrane Reviews. One deals with housing conditions but most of the included studies are from high income countries, with only three rather poor quality studies from slums (all involving re-housing) ⁽⁴³⁾. The other covers water and sanitation, solid waste management, housing, road paving and drainage ⁽²⁾. Three other reviews also covered physical interventions but contributed little for reasons given in Table 2.1.

A description of studies that we have ascertained is provided in Web Appendix 2.1; here we summarise them briefly. Given the results in paper one it would be surprising if physical / infrastructure interventions did not improve health. The great majority of evidence on improved water supply and sanitation suggests that it is indeed effective, but the effect sizes are smaller than one might have expected. For instance, four studies from a systematic review of interventions to improve water quality at source reported rate ratios of 0.87 (95% CI, 0.74, 1.02) ⁽⁴⁴⁾. Effectiveness was somewhat greater when eight point-of-use water quality improvement interventions were evaluated in the meta-analysis with a rate ratio of 0.52 (0.47, 0.82). A separate literature suggests that these modest average effects might be due to poor maintenance of facilities and inadequate installations. For instance it has been demonstrated that piped water distribution systems are often contaminated and that pit latrines, classified by the UN as 'improved sanitation', do little to reduce environmental contamination in congested slum neighbourhoods ⁽⁴⁵⁾.

An interesting RCT over three countries in South America showed that raised floors reduce the incidence of diarrhoea when the ground is heavily contaminated from 15% to 12.4% ($p \leq 0.05$) and the improved homes also generated an improved sense of wellbeing ⁽⁴⁶⁾. Improved street lighting and paving have been strongly recommended by UN-Habitat on the basis of observational studies but the single RCT in the Cochrane Review did not confirm improved security or health, perhaps because the effect was too small to be detected ⁽⁴⁷⁾. Removing solid waste is doubtless a good idea given its effects on quality of life but the scant literature on health effects documented in paper one is mirrored by little evidence on how best to dispose of garbage or on the expected health benefits of doing so.

Health service provision

The problems that people in slums, especially informal workers, have in accessing services described in paper one are compounded by severe limitations at the supply side, which

includes reluctance of clinicians to work in slums. The service is typically fragmented between private services, non-governmental organisations, pharmacists and traditional healers. A recent survey in a slum in Dhaka found that just 14% of people sought care from modern public health services ⁽⁴⁸⁾.

Two systematic reviews examined methods to improve access to preventive, diagnostic and curative services. One of these reviewed the prevention and control of HIV/AIDS, TB and vector-borne diseases in slums and reported that similar infectious disease control interventions work in these settings as elsewhere ⁽⁴⁹⁾ [Lola – I can't see where this is – table what?]. Likewise, a systematic review of Anti-Retroviral-Therapy (ART) programme evaluations conducted in slums of Kenya, South Africa and Haiti found that adherence rates of 91% at one year could be achieved by various combinations of home visits, peer support groups, education sessions and a buddy system ⁽⁵⁰⁾.

The literature captured in these systematic reviews [Lola check please] is limited in scope to infectious disease, does not consider cost-effectiveness and does not consider generic service design issues, such as deployment of Community Health Workers, satellite clinics or use of technology across communities. A recent paper contributing to the Lancet Commission Universal Healthcare: Markets, Profit and the Public Good showed that providing a network of accessible free clinics crowded out low quality, under-qualified providers ⁽⁵¹⁾ now work on optimising service configurations in slums is urgently required. It is also important to ensure interventions are aligned with population healthcare needs; spending by NGOs is often misaligned with local population preferences ⁽⁵²⁾. However, there is again a paucity of evidence in this regard.

Health protection

Childhood immunisation is one of the most effective health interventions and may be the single most cost-effective intervention for health in Sub-Saharan Africa at an estimated 1.10-5.52 US dollars per disability adjusted life year ⁽⁵³⁾. A review of child health in the slums reported that immunisation rate, knowledge of oral rehydration therapy and access to sanitation had a stronger influence on child mortality than gross national income per capita ⁽⁵⁴⁾. However, children residing in slums are less likely to be vaccinated than other urban infants ⁽⁵⁵⁾ and we found no studies of interventions to improve uptake. New vaccines are often trialled in slum populations ⁽⁵⁶⁻⁵⁹⁾ and an injustice is perpetrated if slum communities are then unable to reap the benefits of such research.

People in low and middle income countries tend to have poor access to screening programmes. A study of World Health Survey data in 15 low-income countries found that just 4.1% of women ages 18–69 years had received cervical cancer screening in the past three years, and only 2.2% of women ages 40–69 years had received breast cancer screening in the past 5 years. Screening rates were inversely correlated with poverty ⁽⁶⁰⁾ but we did not find literature on improving access to screening for people who live in slums. We did find literature examining prevention and treatment of parasitic disease in slum children, including head lice and worms; five RCTs showed reduced colonisation by the parasites and/or better growth parameters in intervention children ⁽⁶¹⁻⁶⁵⁾. We also identified an RCT investigating the effect of regular antibiotic prophylaxis in female sex workers in a slum in Nairobi showing a decline in the incidence of STIs [Bill likes us to say from what to what Lola?] but not HIV-1 ⁽⁶⁶⁾.

Health Improvement

The majority of RCTs in slums have addressed vaccination (as mentioned above) and nutritional interventions (Web Appendix 1.1.4, paper one). RCTs have examined supplementation with zinc, probiotics, prebiotics, glutamine, oral calcium, iron, vitamin A and combinations of these elements in children and in pregnant women. A variety of outcomes have been assessed including anaemia, acute diarrhoea, persistent diarrhoea, fetal femur length, weight gain, cognitive outcomes and respiratory tract infections with mostly positive results but occasional harms due to one element (e.g. zinc) interfering with the function of another (such as iron). One would not expect different results in slums compared to other deprived populations provided that compliance was the same. Recently two slum-based RCTs, one in India and one in Bangladesh, showed that snacks providing key nutrients improved nutrient profiles in local populations ^(67, 68).

A systematic review (Table 2.1) examining behaviour change interventions to reduce the health effects that arise from pollution caused by burning solid fuel inside the house identified 55 interventions from 20 countries including slum-specific programmes in Bangladesh and Uganda. When averaged across all studies, an 88% fall in indoor particulate levels was observed (from 13.2 to 1.6 parts per million) with a 21% reduction in acute respiratory disease (absolute risk not given) along with overall saving in fuel costs ⁽⁶⁹⁾.

A systematic review (Table 2.1) examining paediatric burn prevention programmes identified 30 studies from developed and developing nations ⁽⁷⁰⁾. Strategies of most relevance to a slum setting involve adaptation to dwellings to reduce hazards. This idea is supported by a further RCT (not included in the review) demonstrating that provision of safety devices

(backed up by education) reduced the number of household hazards associated with electrical and paraffin appliance injuries and poisonings in a South African slum ⁽⁷¹⁾.

We found a large number of further individual RCTs of health promotion interventions conducted in slums (Table 2.2). The majority of trials yielded positive results concerning promotion of hand-washing in Pakistan ^(54, 72), weight management interventions for women and for children in Brazil ^(73, 74), health education to reduce stunting in Peru ⁽⁷⁵⁾ and peer training plus home-based counselling to improve exclusive breast-feeding in Kenya ⁽⁵⁴⁾. An RCT examining vocational training for youth in the slums of Kampala, Uganda found that those who received training were more likely to be in employment, had better quality of life, and reduced risk of delinquent behaviour four months later ⁽⁷⁶⁾. Unsuccessful interventions included using community health workers to support postnatal women ⁽⁷⁷⁾ and an intervention for the wives of heavy drinkers in a slum in Bangalore ⁽⁷⁸⁾.

The essence of the above findings is that health improvement interventions that work elsewhere will work in slums if they are taken up and therefore the priority is to find cost-effective ways to overcome the barriers to access and uptake documented in paper one and hence improve access to preventative services.

(1,505 words)

Recommendations for Policy and Research

Identifying and studying slums as spatial entities

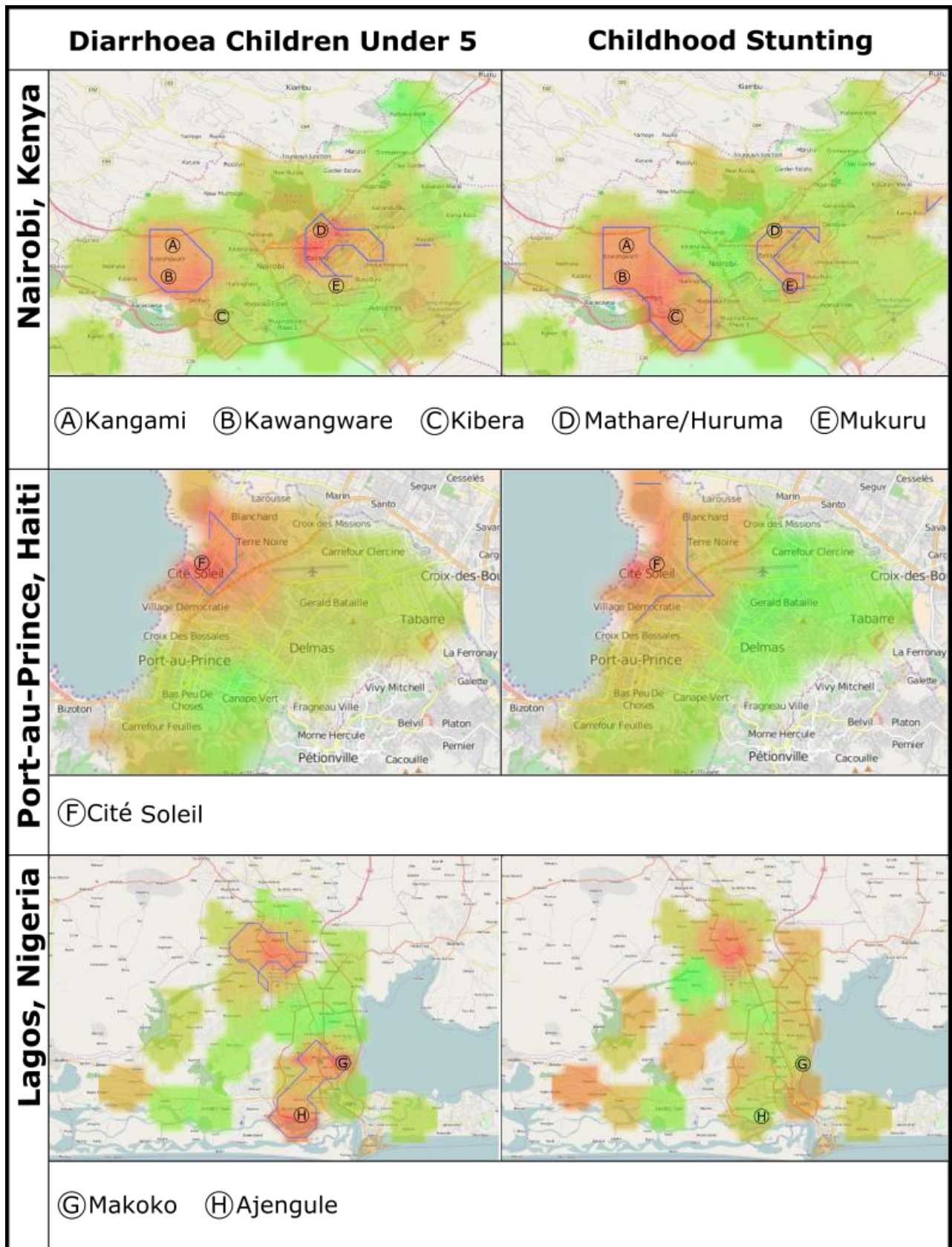
Slum enumeration areas should be identified in all census listings and sampling frames, and made available for use in national surveys and relevant epidemiological studies and evaluations of policy interventions. The justification is that urban averages are meaningless. If slums have worse outcomes than non-slum urban areas and the slum population, as a proportion of urban population, has been changing, then urban trend indicators may represent nothing more than differences in the respective growth rates of slum vs. non-slum urban populations. All measures of place of residence should move from a binary urban-rural construct to one that splits urban into slum and non-slum. We spell out how this could be achieved in Box B. Pending the measures recommended it is up to individual researchers to identify slums and relate these spaces to disease prevalence. As an illustration we have estimated the risk of diarrhoea and stunting in children using data from the Demographic Health Survey across three urban areas in Nairobi, Port-au-Prince and Lagos and related that to well-known slums in Figure 2.2. There is clear variation across urban areas with high-risk in slums.

Box B. Suggested process to identify slums and include them in censuses so that studies/surveys based on a census can distinguish between slum and non-slum locations.

In order to achieve this :1) enumeration areas should be designated (tagged) to one of three categories (slum, non-slum and rural) in such a way that no single urban enumeration area straddles slum and non-slum areas; 2) while nations classify slums according to their own context, their methods should be transparent and consider the five household level criteria in the UN Habitat definition; 3) census takers should link households to enumeration area and; 4) Quality assurance should check that all clusters are enumerated and then that all dwellings are recorded within each cluster. This will ensure all national surveys and data systems can effectively sample and report indicators using three residential domains; rural, urban slum and urban non-slum. Some countries, notably Kenya and Bangladesh, already follow a process to identify slum areas and identify / sample households within slums. This is why these countries were selected for the study in Table 1.2, paper one.

It would be impossible to negotiate a common definition across all countries, and in any case this is not necessary in order to determine the spatial /neighbourhood effects in slums just as different countries define urban differently.

Figure 2.2: Maps showing risk of diarrhoea in children aged under five and childhood stunting in across Nairobi, Port-au-Prince, Haiti, and Lagos with major slum areas indicated by circled letters



Legend to figure: Red indicates higher risk and green lower risk. Blue lines outline areas with a greater than 80% probability of increased risk of the disease relative to other areas in the city. Disease risk is estimated by applying a spatial filter across a regular lattice grid over each urban area using data from the Demographic and Health Surveys (DHS) and then estimating a binomial model to predict disease risk at each grid point. Contact the authors for further information.

Deeper understanding of disease and neighbourhood effects in slums

While there are excellent reasons to predict neighbourhood effects in slums for reasons spelled out in paper one, the nature of these effects and the form of dynamic transmission between people remains unknown. Without this knowledge interventions may be poorly designed. For example, sanitation interventions might yield disappointing results simply because the dynamic nature of disease transmission has not been understood. Likewise, better understanding of the origin and transmission of a violent culture that leads to so many young adult deaths and that varies considerably from slum to slum (as we saw in paper one) is an essential precursor to design of effective preventative interventions.

Priority actions in slums

Policy priorities should drive priorities for evaluative research. Children are the most vulnerable group living in slums as pointed out in paper one. They also offer great potential returns in investment, through numbers of lives saved, life years to be gained and health and wealth in later life. These gains can be realized by tackling the ‘big four’ determinants of child health in slums:

- Vaccination
- Breast feeding
- Malnutrition
- Clean water and sanitation

The first three items lie in the purview of health services and the evidence shows that slum populations are denied these relatively straightforward measures which should be a priority for implementation along with evaluation to identify the most effective and efficient methods of delivery. Improving water and sanitation, on the other hand, requires engineering solutions and presents a paradox – improvements in water supply and sanitation have yielded modest health benefits in modern slums by comparison with the massive effects credited to the major works carried out in European and North American cities during the ‘sanitary awakening’ in the 19th century ⁽⁷⁹⁾. We speculate that there is a very straightforward reason for this which turns on the issue of increasing returns to scale described in the introduction; most interventions have simply not been up to the job. Piped water installations have been prone to contamination and sanitation has removed insufficient waste to reduce faecal contamination of the environment to the ‘tipping point’ where rapidly increasing returns to scale might be achieved (Box A). Agencies of the UN may even have exacerbated the problem by setting standards for water and sanitation that are unsuitable for densely crowded slum conditions ⁽⁴⁵⁾. We therefore recommend that the UN should withdraw this

effete standard for slum contexts and that further more comprehensive installations should be installed as a matter of urgency within the framework of robust large scale comparative studies to work out which types of installation are suitable for which type of slum environment. It goes without saying that interventions should be designed in partnership with local people, representatives of slum dwellers and organizations that have for long campaigned for better sanitation.

The art of the possible in slum improvement

Multi-component interventions tackling housing, loans and water and sewerage have proven successful⁽⁸⁰⁾. It has become fashionable for scholars to argue that the whole ‘slum nexus’ should be tackled in a co-ordinated way^(81, 82). At the limit such an approach amounts to a programme to convert slum to non-slum. While this is an entirely laudable aim, we are concerned that the ideal should not become the enemy of the good. Cost-effective strategies, such as vaccination and installing sanitation systems should not mark time if the moment is not propitious for a holistic strategy. We side with Robert Buckley who powerfully resists the argument that NGOs and local authorities should sort out land rights / tenure before improving sanitation in slums⁽⁸³⁾. We also caution that reliance on ‘community assets’ should not be taken too far – the greatest potential health and wellbeing gains are among people who are most deeply trapped in poverty and hence most in need of a helping hand – an idea that has been confirmed empirically with respect to rural poverty^(84, 85).

A call for multicentre studies with contemporaneous controls

The literature on policy interventions and on physical upgrading of slums is based largely on case studies. We do not wish to disparage such studies, but we advocate balancing the literature with a greater proportion of studies with contemporaneous controls^(86, 87). We have seen, for example, that there were only fourteen such intervention studies in the large field of physical environment and infrastructure of slums, and that only five of these were of ‘high quality’ and only two were experimental studies. The literature in paper one identified a great shortage of slum based studies of health interventions compared to studies in broad urban or rural settings. Given that approaching one billion people live in slums, it is only possible to conclude that this constituency is as under-served by controlled research studies as it is in other ways. While not reifying experimental methods, Field and Kramer cite empirical evidence that supports theoretical arguments for use of experimental methods in a slum context^{(88) (89, 90)}.

Consider multiple outcomes and populations

The effects of policy and service are often broad – they ‘spill over’ to affect outcomes different to the original target. For instance, improving water and sanitation has beneficial effects on education, wellbeing and productivity in addition to those on health (Web Appendix 2.1). A corollary is the importance of capturing both dimensions of health (for example in Disability Adjusted Life Years) but also dimensions of subjective wellbeing (happiness and life satisfaction). Generic interventions can have different effects in the short and long-term, so follow-up is important. Special attention should be paid to groups who are marginalised or especially vulnerable ⁽⁹¹⁾ and cost-effectiveness analyses should seek to examine dimensions of equity, particularly catastrophic out of pocket expenses and proportions of people pushed below the poverty line (two dollars per day at purchasing power parity ⁽⁹²⁾). Gender issues are important - interventions to improve access play out differently for men and women.

Slum health as an academic discipline

This series has been predicated on the idea that there is merit in abstracting the idea of slum health and welfare from that of poverty in general or urban health in particular. Given the salience of space, and given the massive scale of modern slums, we think there is a need for a subject dedicated to improving conditions in slums. The corollary of our conclusion that research into slum health and welfare is at an early stage, compared to public health and development economics, is that steps should be put into place to develop the academic discipline. We identify four groups of people who can promote this cause – those who control the purse strings, those who control the intervention, those whose lives are at stake and those who have experience and expertise in the design, conduct and reporting of academic studies. Organisations that promulgate interventions across jurisdictions, such as the World Bank, agencies of the United Nations and major donors, are in a good position to both exert the necessary leadership and provide practical support. Our final recommendation therefore, is for an international conference, perhaps as part of an urban development conference, to kick-start a community of practice across the above four groups.

(1,386 words)

Conclusion

While it is no longer true to say that people who live in slums are invisible, they are insufficiently visible and as a result continue to be marginalised. Many slums are not gazetted, it is difficult to locate people in national surveys based on censuses, research effort in slums is incommensurate with the size of the issue (particularly with respect to multicentre controlled studies), people who live in slums remain politically weak and subject

to expropriation, and conditions in slums are improving only slowly. The profile of slum health and welfare needs to be raised and the time to do so is propitious given the forthcoming United Nations Habitat III conference, the third of its type in 40 years, and the first United Nations global summit after the adoption of the 2030 Agenda for Sustainable Development and the Sustainable Development Goals. The time is ripe to revisit the Urban Agenda with an emphasis on slums. This will help in securing commitments to ensure that policies are backed up with adequate finance. Above all, we advocate the academic development of slum health in the form of a partnership between policy makers, academics and representatives of those who live in slums, so that knowledge can grow in tandem with efforts to improve health and wellbeing.

The putative neighbourhood effect in slums is a problem and an opportunity. It is a problem because it is likely to amplify health hazards and an opportunity because a single intervention can simultaneously improve many lives in densely packed communities. It is time for a concerted effort to generate political momentum and bear down heavily on the known threats to health and wellbeing in slums. Since young children are especially vulnerable and since the effects of chronic illnesses are indelible affecting their life chances, maternal and child health seems a good place to start and we have identified water/sanitation and nutrition as suitable focuses for worldwide concerted action.

(321 words)

Key messages

1. The neighbourhood effects in slums are likely to offer economies of scale and increasing returns for social and physical investments.
2. While relocation and resettlement can be necessary for reasons of safety, slum upgrading in situ is usually preferable.
3. Sanitation, which started the public health revolution in Europe and America during the 19th century, remains a cardinal neighbourhood challenge in slums.
4. Health services should be designed specifically to overcome barriers to utilisation, such as distance and cost, for people who live in slums.
5. Proactive elements of health services should aim to ensure health protection, e.g. by immunisation and surveillance of childhood malnutrition.
6. People who live in slums and their organisations should be involved in the prioritisation, design, implementation and evaluation of interventions in slums.

7. Slum enumeration areas should be identified in all census listings and sampling frames to enable clearer understanding of the neighbourhood effects of slums.
8. Enabled by this spatial construct, much more research is needed on slum health and how to improve it and a greater proportion of this research should be based on multicentre studies with contemporaneous controls.
9. Further to this, we advocate the development of capacity for research into slum health and the emergence of this as an academic discipline.

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, Federal University of Minas Gerais and Oxford Policy Management Institute. RJL and AE jointly conceptualised the framework and initial draft of this paper. GJMT, JS, SW and YFC conducted 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 manuscript.

Declaration of interests

The authors declare no competing interests

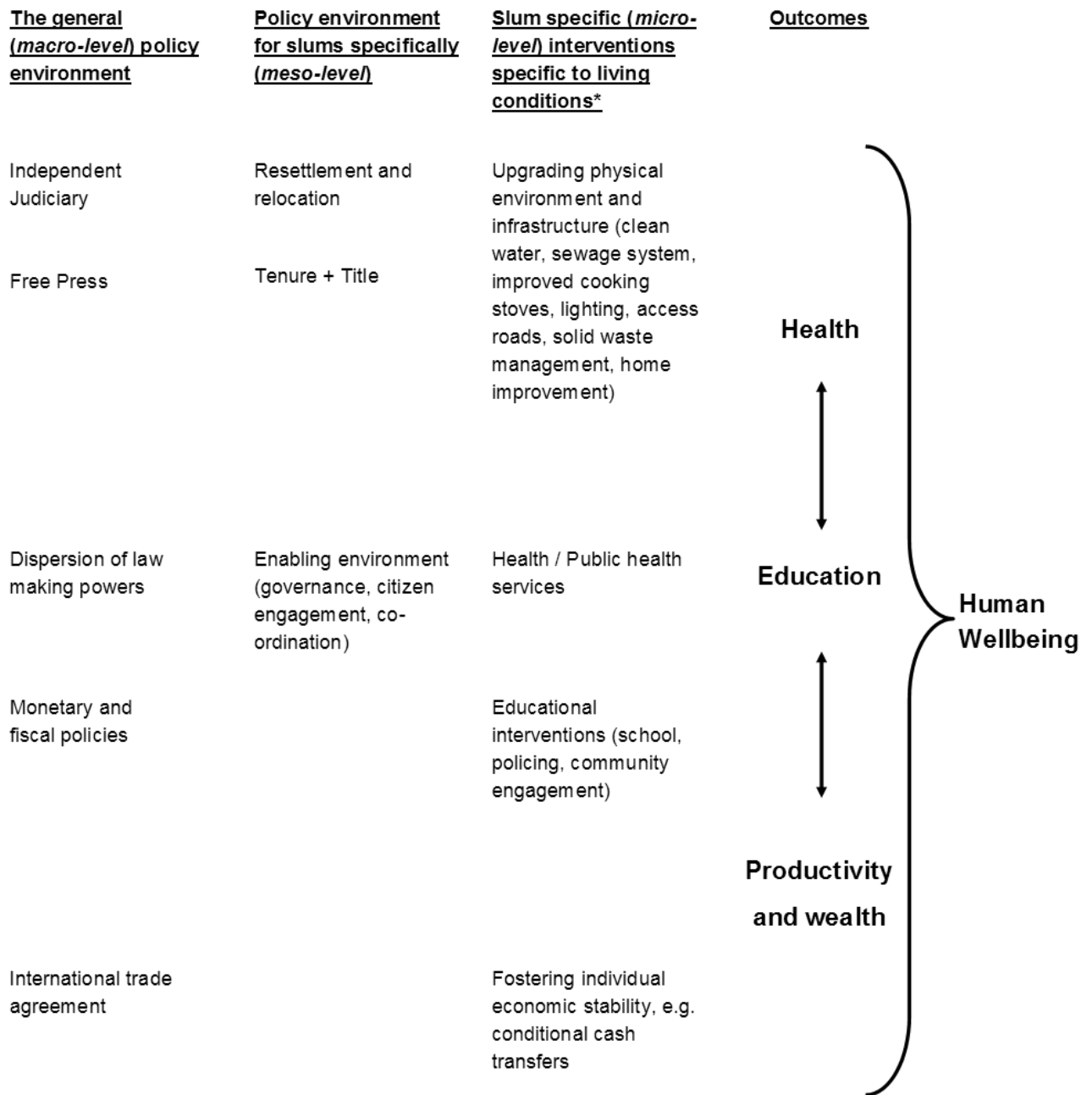
[Please add text if you have a declaration of interest]

Acknowledgements

Prof Richard Lilford and Dr Oyinlola Oyebode are supported by the NIHR Collaborations for Leadership in Applied Health Research and Care West Midlands initiative. This paper presents independent research and the views expressed are those of the author(s) and not necessarily those of the NHS, the NIHR or the Department of Health. Prof. Waleska T. Caiaffa is supported by the Brazilian National Council for Scientific and Technological Development (CNPq).

Figure 2.1.

Representation of causal pathways impacting on lives of slum dwellers.



* Headings taken from the Social Determinants of Health—Office of Disease Prevention and Health Promotion. V5 Dept of Health [REF]

Table 2.1 Systematic Reviews of interventions in slums targeted at health (among other things)

Study ID	Population and Geography	Intervention	Outcomes examined	Search Strategy	Slum Relevance
Adato 2009 ⁽⁹³⁾	Poor families, global.	Cash transfers (conditional and unconditional)	Education, health and nutrition	Search strategy not published. Review of 300+ documents and 20 deemed high quality were examined in depth.	Slums not explicitly mentioned. At least two of the studies reviewed in depth were specifically urban and therefore likely to include slum populations (as the interventions are restricted to families in poverty) and a further two included both urban and rural populations. Others may also have included slum populations. Some results were presented broken down by urban/rural (which often found positive effects were smaller in urban than rural populations).
Ali 2010 ⁽⁹⁴⁾	People living in slums, global.	Physical: Safe water provision	Cholera and diarrhoea	Search strategy not published.	All
David 2007 ⁽⁴⁹⁾	People living in slums, global.	Health: Public health interventions	Control of HIV, TB and vector-borne diseases	Search strategy not published. Academic and popular search engines used. "An exhaustive review was not possible due to time constraints"	All
Ernst 2013 ⁽⁵⁴⁾	Children living in slums, global.	Physical: Tenure, slum upgrading, access to services	Child health	Search strategy not published. Review one part of multi-method study.	All
Goodwin 2015 ⁽⁶⁹⁾	People living in "resource-poor settings", global.	Health: Behaviour change techniques	Cleaner cooking	Search strategy not published. 24 databases searched. 55 studies identified, 7 examined in depth and quality assessed.	Slums not explicitly mentioned. At least two of the 55 studies identified were explicitly in slum populations. At least two further studies in national populations and highly likely to include slum

					households.
Kulabako 2010 ⁽⁹⁵⁾	People living in slums, Kampala, Uganda.	Physical: Water supply, sanitation, solid waste management, stormwater management	General health and wellbeing outcomes	Search strategy not published. Review one part of a multi-method study.	All
Kumar 2009 ⁽⁹⁶⁾	Neonates living in “low resource settings”, global.	Health: Care of neonates to reduce heat loss	Prevention of hypothermia	Search strategy not published. Five databases searched.	One study was explicitly stated to have been located in an Indian slum. Other populations may have included slum residents.
Lagarde 2009 ⁽⁴²⁾	People living in LMICs.	Conditional cash transfers	Health outcomes and use of health services	Search strategy published. 25 databases searched. Quality assessment of included studies. 10 papers identified reporting on 6 studies.	Slums not explicitly mentioned. Five included studies were exclusively rural. One national programme evaluated in rural and urban households. Eligible households earned less than half the minimum wage therefore likely to include slum households however no urban/rural breakdown given.
Okurut 2015 ⁽⁹⁷⁾	People living in slums, global.	Health: Community mobilisation, behaviour change	Sustainable sanitation upgrading	Search strategy published. One database searched. 12 studies identified and quality assessed.	All
Parbhoo 2010 ⁽⁷⁰⁾	Children, global.	Health: Burn prevention programmes	Prevention of burns	Search strategy published. Eight databases searched. 30 papers identified and included in the review. No quality assessment.	Slums explicitly mentioned. Although no included study was set in a slum, many studies examined slum-related characteristics for example overcrowding, low socio-economic status, and found these were correlated with prevalence of burns and appropriate points of intervention were also particularly prevalent in slums

					(eg: stoves on the floor).
Pettifor 2012 ⁽⁹⁸⁾	Global.	Conditional cash transfers	HIV prevention and school attendance	Search strategy published. Two databases searched and other methods used to identify literature. 16 studies identified. 15 RCTs, 1 observational with appropriate methodology.	Slums not explicitly mentioned. Five studies were highly likely to have included slum populations although they are not explicitly mentioned eg: one which evaluated the Government of Kenya's Cash Transfer for Orphans and Vulnerable Children in 7 districts including Nairobi and Kisumu. To satisfy the poverty criteria households must display 8/13 characteristics related to welfare such as main material of walls and floor, access to potable water, type of lighting fuel, and ownership of small assets.
Ramin 2013 ⁽⁵⁰⁾	People with HIV/AIDS living in slums, global.	Health: Programme retention	Treatment outcomes	Search strategy not published. Three databases searched. 7 cohort studies identified.	All
Thomson 2013 ⁽⁴³⁾	Global.	Physical: Housing upgrading (focus on warmth, rehousing, provision of basic housing)	Health and social/economic outcomes	A Cochrane review with quality assessment of included studies.	Identified 3 studies reporting on LMICs post 1990 and a further three examining rehousing from slums pre 1970 in HICs. These 6 studies were generally of poor quality.
Turley 2013 ⁽²⁾	People living in slums, global.	Physical: Slum upgrading by means of physical and engineering interventions	Health and social/economic outcomes	A Cochrane review of literature with quality assessment of included studies. 14 interventions, most multi-component. 5 high quality studies of which 2 RCTs.	All

Table 2.2 Randomised Controlled Trials of Health Promotion Interventions in Slum Settings: Details of the interventions and their results [Lola, do you think we could cross reference between this table and the text – it is a bit disembodied and does not tell a story]

Reference	Setting	Intervention	Outcome
Langford et al, 2011 in Ernst 2013 ⁽⁵⁴⁾	Kathmandu, Nepal	Community health workers delivered hand hygiene messages on a daily basis for 2 weeks in the homes of mothers of 3-12 month-old infants, followed by a 6 month maintenance period during which messages were reinforced	41% fewer days of diarrhoea in the intervention children relative to the control (9.7 vs. 16.3 days on average during the 6 month study period for intervention and control groups, respectively; $p = 0.023$). No significant effect on markers of immune stimulation or growth variables.
Bowen et al, 2012 ⁽⁷²⁾	Karachi, Pakistan	Handwashing promotion during the first 30 months of life.	Intervention children attained greater global development quotients than control children at age 5-7 years. No significant effect on growth.
Alves et al 2009 ⁽⁷⁴⁾	Caranguejo, Brazil	Weight management intervention for obese, previously sedentary women. Supervised group aerobic exercise for 3 x 50 minutes per week for 6 months.	Intention-to-treat analysis found significant reduction in weight (-1.7kg) and BMI (-0.6 kg/m ²) in intervention women compared with controls.
Alves et al 2008 ⁽⁷³⁾	Recife, Brazil	Weight management intervention for overweight children. Supervised group aerobic exercise for 3 x 50 minutes per week for 6 months.	Intention-to-treat analysis found significantly smaller increase in weight (-1.4kg) and a significant difference in BMI (-0.5 kg/m ²) in intervention compared with control children.
Penny et al 2005 ⁽⁷⁵⁾	Trujillo, Peru	Three key messages on nutrition were disseminated among all staff in intervention health care facilities that had contact with caregivers of young children. Demonstrations for caregivers on how to prepare nutritious food and group sessions for caregivers of children of similar ages were provided by the health facilities.	Stunting was reduced by more than two thirds in the intervention group compared to control (8/171 in intervention group; 26/165 in the control group). (stats Lola?)
Ochola et al, 2013, In Ernst 2013 ⁽⁵⁴⁾	Nairobi, Kenya	Seven counselling sessions at home (one prenatally, six postnatally) by trained peers compared with one counselling session prenatally at a facility, or a control group who received no counselling.	Exclusive breast-feeding at 6 months was 23.6% in intervention group compared to 9.2% in the facility-based control and 5.6% in the control. (stats Lola?)
Rotheram-	Kampala,	Vocational training for youth aged 13-24 years	Individuals in the intervention group were more likely to

Borus et al, 2012 (76)	Uganda	participating in an HIV prevention programme. Training consisted of apprenticeships with local businesses, whose staff had also received training.	be in employment, had better quality of life, and reduced risk of delinquent behaviour than the control group four months later. There was no significant difference in risky sexual behaviour at 4 months.
Odendaal et al, 2009	Johannesburg and Cape Town, South Africa	Four home visits by a trained community health workers who offered education on the prevention of burns, poisonings and injuries, alongside the provision of safety devices	Reduced the number of household hazards associated with electrical and paraffin appliance injuries and poisonings in an informal settlement in South Africa. No significant effect on burn safety household practices and fall injury hazards.
Cottler et al, 2010 (78)	Bangalore, India	HIV prevention intervention for the wives of heavy drinkers.	None of the major intervention outcomes were significant.
In Coast et al 2012 (77)	South Africa	Community Health Workers	No reduction in postnatal depression

[\[Lola – need to state why stats given for some papers but not for others. If we don't, Bill will ask for it\]](#)

Web Appendix 2.1: Overview of slum upgrading (by means of physical infrastructure investments and health service / health improvement literature)

Physical Interventions

Provision of Safe Water and Sanitation

Improved water and sanitation is arguably the most pressing priority for slum upgrading (see recommendations).

Size of the problem: In paper one we discussed the following:

- 1) Water supply and sanitation remain woefully inadequate in slums, including those that have met low United Nations targets for improvement.
- 2) Poor water and sanitation leads to recurrent diarrhoea, one of the two great killers of children worldwide and arguably the greatest cause of loss of life in slums.
- 3) Diarrhoea and malnutrition create a vicious cycle leading to stunting which, in turn, has detrimental effects on a person's intellectual development and hence life chances.
- 4) Improving water and sanitation is the first priority of slum dwellers and productivity losses in time to access facilities are enormous ⁽⁹⁹⁾.

Implementation: The engineering details of water supply are matters for experts, but here we note that an adequate system of sanitation requires toilet facilities linked to a drainage system that empties into some sort of treatment plant. A recent systematic review has documented the sub-optimal performance of pit latrines generally ⁽⁴⁵⁾ but they are particularly unsuited for slums where space is limited and the risk of contaminating ground water and soil is considerable. Composting toilets do not seem to have reached the stage of development where they should be the default option and there are problems with the space they take up when whole families live in one room and in the ease with which the composted wastes can be collected. Sanitation is not only a technical problem; communities should be engaged at every level in the design and implementation of this intervention which need to be tailored to local circumstances ⁽¹⁰⁰⁾. We acknowledge the importance of hand hygiene education but such a measure can only gain purchase if clean water is plentiful. In summary there are many ways of financing interventions (public provision, household savings, donors and cost recovery) and while these and other implementation variables must be tailored to local circumstances, there is still plenty of room for experimentation and evaluation across intervention methods and contexts ⁽⁹⁴⁾.

Effectiveness: Improvements in water supply and sanitation formed the basis for the massive improvements in public health in high income countries – see for example Cutler and Miller ⁽¹⁰¹⁾. A study based on 172 Demographic Health Survey studies across 70 countries showed that improvements in water supply and sanitation respectively reduced the odds of childhood diarrhoea by 7% and 13% ⁽¹⁰²⁾ respectively. Case studies have shown improvements in health following sanitation interventions. In Brazil a citywide programme was associated with a 21% reduction in diarrhoeal episodes and the social class gradient in diarrhoea was also reduced ⁽¹⁰³⁾. Similar results followed a World Bank funded toilet block programme in Mumbai ⁽¹⁰⁴⁾. Water and sanitation improvements were evaluated in a number of studies in the systematic reviews identified in our search (Table 2.1). The review by Turley and colleagues included eleven studies where water and sanitation improvement was carried out ⁽²⁾. In all but one of these studies the improvement in water and sanitation was part of a package of measures but the results overall were positive. The remaining study involved improvement in water supply only, and a positive trend was noted (not quite reaching the 5% significance level).

Return on investment: Estimates of cost effectiveness are wide turning on in part which of the outcomes cited above are included in the model and are likely to be very sensitive to discount rates (given long-term effects and death at an early age). A list of cost effectiveness / return on investment studies is given in Table A4. None of the studies deals specifically with slums where returns on investment are likely to be better than average because diarrhoea is such a terrible scourge in these settings and because a single investment can reach so many people – a positive neighbourhood effect. According to WHO thresholds the estimates are in the range of cost effective to highly cost effective. The World Bank states that “sanitation is the single most cost effective major public health intervention to reduce child mortality” ⁽¹⁰⁵⁾. This is arguable (vaccination may be even more cost effective) but the cost benefit ratio is likely to be more favourable in slums than elsewhere because faecal contamination and contaminated water affect densely inhabited neighbourhoods.

Table A4: Economic assessment of water and sanitation interventions in LMICs

Author	Factors considered	Discount rate	Finding (sensitivity analysis)	Comment
Varley et al 1998 ⁽¹⁰⁶⁾	Short term morbidity (STM) Death	3% + differential weightings by age	Cost per DALY 20(140,2)	Covers ‘hardware’ (engineering installation and software e.g. health education) Impoverished set of factors
Hutton et al 2007 ⁽⁹⁹⁾	STM, Death, Education and	Not stated	Return \$5 to \$46 on \$1	Long term morbidity not considered. Main benefit

	productivity loss, Time saving		investment	was time saving to access facilities – this particular gain will be <u>lower</u> in slums
World Bank report 2006 ⁽¹⁰⁵⁾			Return \$9 on \$1 investment	
Clasen et al 2007 ⁽¹⁰⁷⁾	STM, Death	3%	Cost per DALY 1) Improving water at source \$123(14-322) 2) Point of use \$53(41-447)	Only water, not sanitation. Results for two WHO sub-regions assumes 50% intervention coverage. Point of use interventions most cost effective when resources limited. Time saving to access water not considered nor long term morbidity nor losses to education

Point of use water. We also noted in paper one that water is often contaminated during distribution. This is particularly so if the water supply is intermittent⁽¹⁰⁸⁾. Point of use water safety interventions to overcome this problem include chlorination, ceramic or biosand filters, or solar disinfection. One of the systematic reviews we identified examined point of use water safety interventions in urban, peri-urban and refugee camp settings. This review found that these have a significant effect- reducing the incidence of cholera and diarrhoeal diseases with a pooled relative risk of diarrhoeal disease of 0.74 (0.65-0.85)⁽⁹⁴⁾. Similar, albeit rather heterogenic, results were obtained in an updated Cochrane Review across all LMIC settings, not specifically slums⁽⁴⁴⁾ where the effect size was larger (rate ratio 0.62: 0.47-0.82) for point of use interventions than for at source interventions (0.87: 0.74-1.02). In poor settings point of use water treatment may be more cost effective than improving supply (Table 2.3).

Solid Waste Management

Accumulation of garbage is not just offensive, but provides a habitat in which the vectors of disease can flourish, and is also a source of toxic chemicals, such as lead.?? Waste that is disposed of improperly can block storm water and grey water drains, leading to further unsanitary conditions. One identified systematic review examined studies of infrastructure development and interventions to improve solid waste management in the slums of Kampala, Uganda. This review was supplemented with primary research carried out with slum residents, the local authority, and national agencies responsible for water, sewerage and environmental management. The review concluded that the necessary actions required to improve this situation were: 1.To increase education so that people who live in slums

practice safe disposal of their waste; 2. To increase training and technical capacity of the local government agency responsible for waste disposal and finally 3. To increase community based solid waste management to provide opportunities for income generation through recovering reusable or repurposable resources ⁽⁹⁵⁾.

Home improvements

There are theoretical reasons to think that health may improve if houses are improved. Infants have a habit of consuming dirt when they encounter it. The excessively decontaminated environment in the typical high income home predisposes to atopic conditions, such as hay fever and asthma, but faecal contamination in slums predisposes to diarrhoea and chronic enteropathy as described in paper one. Since the floors of dwelling are typically just an extension of the surrounding surface in slums, it is plausible that a raised easily cleanable floor will reduce gastroenteritis. Likewise, improvement in ventilation may reduce particle induced asthma associated with indoor cooking as described in paper one. As it turns out the health effects of upgrading dwellings themselves (without providing lavatories, cooking facilities, connections to a water system or gas/electricity) have been evaluated in three types of studies –cross-sectional observational studies, a ‘natural experiment’ and a randomised controlled trial of households in three South American countries. A systematic review of cross-sectional studies showed strong associations between poor housing and indicators of poor health ⁽¹⁰⁹⁾. The natural experiment ⁽¹¹⁰⁾ was picked up in the Cochrane review of slum interventions ⁽²⁾. After adjustment for confounders the incidence of diarrhoea was reduced in children under six years old (RR 0.87 [0.76-1.00]) by the intervention that consisted of a cement floor. Quality of life was also significantly higher in the intervention group. The randomised controlled trial is of considerable interest. It was opportunistic in the sense that the agency responsible for the intervention, a NGO offering inexpensive ‘flat-pack’ homes to people who live in slums, selected intervention houses in predefined areas by means of a lottery. **The houses cost less than \$1000 and included a raised floor. The intervention resulted in an improved sense of wellbeing and improved infant health (diarrhoea and respiratory disease), especially where health was poor at baseline ⁽⁴⁶⁾. This seems like a point that would be better made in the main text**

Transportation and roads

Generally, opening up routes of transport is socially and economically helpful, and streets can be seen as “the natural conduits that connect slums with the city” ⁽¹¹¹⁾. The UN-HABITAT have produced a strategy based on opening or upgrading streets to define spatial structures, improve slums and integrate them into the cities. Streets attract commercial properties ⁽¹¹²⁾, promote orderly development ⁽¹¹¹⁾, improve the sense of public safety ⁽¹¹³⁾, improve

sanitation, and can provide residents with a sense of identification ⁽¹¹¹⁾, improve their quality of life ⁽¹¹²⁾ and bring them closer to securing more rights ⁽¹¹¹⁾. Their improvements can set the basis for continuous transformation of the slum and local economy. International work has shown that such a street-led approach can be successful ⁽¹¹⁴⁻¹¹⁶⁾. In contrast, however, an RCT by Gonzalez-Navarro & Quintana-Domeque (2010) found that road paving had no significant effects on health, quality of life, income, employment, education, or crime ⁽⁴⁷⁾.

References

1. Hardoy JE, Cairncross S, Satterthwaite D. *The Poor Die Young: Housing and Health in Third World Cities*. London: Earthscan Publications; 1990.
2. Turley R, Saith R, Bhan N, Rehfuess E, Carter B. Slum upgrading strategies involving physical environment and infrastructure interventions and their effects on health and socio-economic outcomes. *The Cochrane database of systematic reviews*. 2013;1:Cd010067.
3. Baker J. *Urban Poverty: A Global View* Washington, D.C.: The World Bank, 2008.
4. Abuya B, Kassahun A, Ngware M, Onsomu E, Oketch M. *Free Primary Education and Implementation in Kenya: The Role of Primary School Teachers in Addressing the Policy Gap*. SAGE Open. 2015;1-10.
5. Organisation WH. *World Health Statistics* Geneva: World Health Organisation, 2015.
6. Kyu HH, Shannon HS, Georgiades K, Boyle MH. Association of Urban Slum Residency with Infant Mortality and Child Stunting in Low and Middle Income Countries. *BioMed Research International*. 2013;1-12.
7. Mitchell S. *Victorian Britain* Encyclopedia New York: Garland Publishing 1988.
8. Harris JR, Todaro MP. Migration, Unemployment and Development: A Two-Sector Analysis. *The American Economic Review*. 1970;60(1):126-42.
9. UN-Habitat. *World Cities Report 2016: Urbanization and Development Emerging Futures* Nairobi, Kenya: 2016.
10. Xavier HN, Magalhães F. *Urban slums report: The case of Rio de Janeiro 2003*.
11. Collins W, Shester KL. Slum Clearance and Urban Renewal in the United States. *American Economic Journal: Applied Economics*. 2013;5(1):239-73.
12. Chetty R, Hendren N, Katz L. The Effects of Exposure to Better Neighbourhoods on Children: New Evidence from the Moving to Opportunity Experiment. *American Economic Review*. 2016;106(4):855-902.
13. Barnhardt S, Field E, Pande R. *Moving to Opportunity or Isolation? Network Effects of a Randomised Housing Lottery in Urban India*. NBER Working Paper 21419. Massachusetts: 2015.
14. Patel SB. Dharavi: Makeover or takeover? . *Economic and Political Weekly*. 2010;45(24):47-54.
15. Banerjee A, Gertler P, Ghatak M. Empowerment and Efficiency: Tenancy Reform in West Bengal. *Journal of Political Economy*. 2002;110(2):239-80.
16. Field E. Property Rights and Investment in Urban Slums. *Journal of the European Economic Association Papers and Proceedings*. 2005;3(2-3):279-90.
17. Gandelman N. Property rights and chronic diseases: evidence from a natural experiment in Montevideo, Uruguay 1990-2006. *Economics and human biology*. 2010;8(2):159-67.
18. Buckley RM, Kalarickal J. *Housing Policy in Developing Countries: Conjectures and Refutations*. 2005.

19. Handzic K. Is legalized land tenure necessary in slum upgrading? Learning from Rio's land tenure policies in the Favela Bairro Program. *Habitat International*. 2010;(34):11-7.
20. Rydin Y, Bleahu A, Davies M, Davila JD, Friel S, De Grandis G, et al. Shaping cities for health: complexity and the planning of urban environments in the 21st century. *Lancet* (London, England). 2012;379(9831):2079-108.
21. Muller A, Mitlin D. Securing inclusion: strategies for community empowerment and state redistribution *Environment & Urbanization*. 2007;19(2):425-39.
22. Njoku J. Why Festac, Shagari housing schemes failed 2014 4th March 2016.
23. Etim EE, Atser J, Akpabio F. The new social housing scheme in Nigeria: How beneficial for the less privileged? . *Global Journal of Social Sciences* 2007;6(1):1-6.
24. Vlahov D, Caiaffa WT. Healthy urban governance and population health. Participatory budgeting in Belo Horizonte, Brazil. In: Sclar ED, Volavka-Close N, Brown P, editors. *The urban transformation: health, shelter and climate change*. London: Taylor & Francis; 2013. p. 63-81.
25. Viero OM, Cordeiro AP. New Rules, New Roles: Does PSP Benefit the Poor? The Case for Public Provisioning in Pôrto Alegre. 2003.
26. Goldsmith WW, Vainer CB. Participatory Budgeting and Power Politics in Porto Alegre. *Land Lines*. 2001;3(1).
27. Wang F, Xuejin Z. Inside China's Cities: Institutional Barriers and Opportunities for Urban Migrants. *The American Economic Review*. 1999;89(2):276-80.
28. Subbaraman R, O'Brien J, Shitole T, Shitole S, Sawant K, Bloom DE, et al. Off the map: the health and social implications of being a non-notified slum in India. *Environment and urbanization*. 2012;24(2):643-63.
29. Brunton G, Caird J, Stokes G, Stanisfield C, Kneale D, Richardson M, et al. Review 1: Community engagement for health via coalitions, collaborations and partnerships - a systematic review. London: 2015.
30. Cyril S, Smith BJ, Possamai-Inesedy A, Renzaho AM. Exploring the role of community engagement in improving the health of disadvantaged populations: a systematic review. *Global health action*. 2015;8:29842.
31. Rosato M. A framework and methodology for differentiating community intervention forms in global health. *Community Development Journal*. 2015;50(2):244-63.
32. Prost A, Colbourn T, Seward N, Azad K, Coomarasamy A, Copas A, et al. Women's groups practising participatory learning and action to improve maternal and newborn health in low-resource settings: a systematic review and meta-analysis. *Lancet* (London, England). 2013;381(9879):1736-46.
33. Dias S. Overview of Legal Framework for Social Inclusion in Solid Waste Management in Brazil. Cambridge, USA: WIEGO, 2010.
34. Chen M, Jhabvala R, Kanbur R, Richards C. Membership based organisations of the poor. London: Routledge; 2007.
35. Chen M, Vanek J, Lund F, Heintz J, Jhabvala R, Bonner C. Progress of the World's Women 2005: Women, Work and Poverty: United Nations Deveelopment Fund for Women (UNIFEM). New York: United Nations, 2005.
36. Chen M, Snodgrass D. Managing resources, activities, and risk in urban India: The impact of SEWA Bank. Washington D.C.: AIMS, 2001.
37. Cabannes Y. The impact of participatory budgeting on basic services; municipal practices and evidence from the field. *Environment & Urbanization*. 2015;27(1):257-84.
38. Bakibinga P, Ettarh R, Ziraba AK, Kyobutungi C, Kamande E, Ngomi N, et al. The effect of enhanced public-private partnerships on Maternal, Newborn and child Health Services and outcomes in Nairobi-Kenya: the PAMANECH quasi-experimental research protocol. *BMJ open*. 2014;4(10):e006608.
39. Kerrigan D, Kennedy CE, Morgan-Thomas R, Reza-Paul S, Mwangi P, Win KT, et al. A community empowerment approach to the HIV response among sex workers: effectiveness, challenges, and considerations for implementation and scale-up. *Lancet* (London, England). 2015;385(9963):172-85.

40. Fergutz O, Dias S, Mitlin D. Developing urban waste management in Brazil with waste picker organizations. *Environment & Urbanization*. 2011;23(2):597-608.
41. Patel S, Baptist C. Documenting by the undocumented. *Environment & Urbanization*. 2012;24(1):3-12.
42. Lagarde M, Haines A, Palmer N. The impact of conditional cash transfers on health outcomes and use of health services in low and middle income countries. *The Cochrane database of systematic reviews*. 2009(4):Cd008137.
43. Thomson H, Thomas S, Sellstrom E, Petticrew M. Housing improvements for health and associated socio-economic outcomes. 2013;2((Thomson) Social and Public Health Sciences Unit, Medical Research Council, Glasgow, UK.):CD008657.
44. Clasen T, Schmidt WP, Rabie T, Roberts I, Cairncross S. Interventions to improve water quality for preventing diarrhoea: systematic review and meta-analysis. *BMJ (Clinical research ed)*. 2007;334(7597):782.
45. Nakagiri A, Niwagaba CB, Nyenje PM, Kulabako RN, Tumuhairwe JB, Kansiiime F. Are pit latrines in urban areas of Sub-Saharan Africa performing? A review of usage, filling, insects and odour nuisances. *BMC public health*. 2016;16(1):120.
46. Galiani S, Gertler P, Cooper R, Martinez S, Ross A, Undurraga R. Shelter from the storm: upgrading housing infrastructure in Latin American slums. Working Paper 19322. Cambridge, MA: 2013.
47. Gonzalez-Navarro M, Quintana-Domeque C. Urban Infrastructure and Economic Development: Experimental Evidence from Street Pavement. IZA Discussion Paper No. 5346. Germany: 2010.
48. Jahan N, Howlader S, Sultana N, Ishaq F, Sikder M, Rahman T. Health Care Seeking Behavior of Slum-Dwellers in Dhaka City. Dhaka.: 2015.
49. David AM, Mercado SP, Becker D, Edmundo K, Mugisha F. The prevention and control of HIV/AIDS, TB and Vector-borne diseases in informal settlements: challenges, opportunities and insights. *Journal of urban health : bulletin of the New York Academy of Medicine*. 2007;84(3 Suppl):i65-74.
50. Ramin B, Pottie K. Antiretroviral therapy and program retention in urban slums. 2013;90((Ramin) University of Ottawa, Ottawa, ON, Canada.):167-74.
51. McPake B, Hanson K. Managing the public-private mix to achieve universal health coverage. *Lancet (London, England)*. 2016.
52. Samb B, Evans T, Dybul M, Atun R, Moatti JP, Nishtar S, et al. An assessment of interactions between global health initiatives and country health systems. *Lancet (London, England)*. 2009;373(9681):2137-69.
53. Shillcutt SD, Walker DG, Goodman CA, Mills AJ. Cost effectiveness in low- and middle-income countries: a review of the debates surrounding decision rules. *Pharmacoeconomics*. 2009;27(11):903-17.
54. Ernst KC, Phillips BS, Duncan BD. Slums are not places for children to live: Vulnerabilities, health outcomes, and possible interventions. *Advances in Pediatrics*. 2013;60((Ernst) Epidemiology, College of Public Health, University of Arizona, Tucson, AZ 85724, United States):53-87.
55. Mathew JL. Inequity in childhood immunization in India: A systematic review. 2012;49((Mathew) Advanced Pediatrics Centre, PGIMER, Chandigarh, 160012, India):203-23.
56. Bhattacharya SK, Sur D, Ali M, Kanungo S, You YA, Manna B, et al. 5 year efficacy of a bivalent killed whole-cell oral cholera vaccine in Kolkata, India: a cluster-randomised, double-blind, placebo-controlled trial.[Erratum appears in *Lancet Infect Dis*. 2013 Dec;13(12):1011]. *Lancet Infect Dis*. 2013;13(12):1050-6.
57. Ali M, Sur D, You YA, Kanungo S, Sah B, Manna B, et al. Herd protection by a bivalent killed whole-cell oral cholera vaccine in the slums of Kolkata, India. *Clinical Infectious Diseases*. 2013;56(8):1123-31.
58. Ali M, Sur D, Kim DR, Kanungo S, Bhattacharya SK, Manna B, et al. Impact of Vi vaccination on spatial patterns of typhoid fever in the slums of Kolkata, India. *Vaccine*. 2011;29(48):9051-6.

59. Sur D, Ochiai RL, Bhattacharya SK, Ganguly NK, Ali M, Manna B, et al. A cluster-randomized effectiveness trial of Vi typhoid vaccine in India. *N Engl J Med*. 2009;361(4):335-44.
60. Akinyemiju TF. Socio-economic and health access determinants of breast and cervical cancer screening in low-income countries: analysis of the World Health Survey. *PLoS one*. 2012;7(11):e48834.
61. Pilger D, Heukelbach J, Khakban A, Oliveira FA, Fengler G, Feldmeier H. Household-wide ivermectin treatment for head lice in an impoverished community: randomized observer-blinded controlled trial. *Bulletin of the World Health Organization*. 2010;88(2):90-6.
62. Awasthi S, Peto R, Pande VK, Fletcher RH, Read S, Bundy DA. Effects of deworming on malnourished preschool children in India: an open-labelled, cluster-randomized trial. *PLoS Negl Trop Dis*. 2008;2(4):e223.
63. Sur D, Saha DR, Manna B, Rajendran K, Bhattacharya SK. Periodic deworming with albendazole and its impact on growth status and diarrhoeal incidence among children in an urban slum of India. *Trans R Soc Trop Med Hyg*. 2005;99(4):261-7.
64. Sarkar NR, Anwar KS, Biswas KB, Mannan MA. Effect of deworming on nutritional status of ascaris infested slum children of Dhaka, Bangladesh. *Indian Pediatr*. 2002;39(11):1021-6.
65. Awasthi S, Pande VK. Six-monthly de-worming in infants to study effects on growth. *Indian J Pediatr*. 2001;68(9):823-7.
66. Kaul R, Kimani J, Nagelkerke NJ, Fonck K, Ngugi EN, Keli F, et al. Monthly antibiotic chemoprophylaxis and incidence of sexually transmitted infections and HIV-1 infection in Kenyan sex workers: a randomized controlled trial. *Jama*. 2004;291(21):2555-62.
67. Kehoe SH, Chopra H, Sahariah SA, Bhat D, Munshi RP, Panchal F, et al. Effects of a food-based intervention on markers of micronutrient status among Indian women of low socio-economic status. *Br J Nutr*. 2015;113(5):813-21.
68. Ahmed T, Choudhury N, Hossain MI, Tangsuphoom N, Islam MM, de Pee S, et al. Development and acceptability testing of ready-to-use supplementary food made from locally available food ingredients in Bangladesh. *BMC Pediatr*. 2014;14:164.
69. Goodwin NJ, O'Farrell SE, Jagoe K, Rouse J, Roma E, Biran A, et al. Use of behavior change techniques in clean cooking interventions: a review of the evidence and scorecard of effectiveness. *Journal of health communication*. 2015;20 Suppl 1:43-54.
70. Parbhoo A, Louw QA, Grimmer-Somers K. Burn prevention programs for children in developing countries require urgent attention: A targeted literature review. 2010;36((Parbhoo) Red Cross Hospital, Physiotherapy, Klipfontein Road, Cape Town, South Africa):164-75.
71. Odendaal W, van Niekerk A, Jordaan E, Seedat M. The impact of a home visitation programme on household hazards associated with unintentional childhood injuries: a randomised controlled trial. *Accid Anal Prev*. 2009;41(1):183-90.
72. Bowen A, Agboatwalla M, Luby S, Tobery T, Ayers T, Hoekstra RM. Association between intensive handwashing promotion and child development in Karachi, Pakistan: a cluster randomized controlled trial. *Arch Pediatr Adolesc Med*. 2012;166(11):1037-44.
73. Alves JG, Gale CR, Souza E, Batty GD. [Effect of physical exercise on bodyweight in overweight children: a randomized controlled trial in a Brazilian slum]. *Cad Saude Publica*. 2008;24 Suppl 2:S353-9.
74. Alves JG, Gale CR, Mutrie N, Correia JB, Batty GD. A 6-month exercise intervention among inactive and overweight favela-residing women in Brazil: the Caranguejo Exercise Trial. *Am J Public Health*. 2009;99(1):76-80.
75. Penny ME, Creed-Kanashiro HM, Robert RC, Narro MR, Caulfield LE, Black RE. Effectiveness of an educational intervention delivered through the health services to improve nutrition in young children: a cluster-randomised controlled trial. *Lancet (London, England)*. 2005;365(9474):1863-72.
76. Rotheram-Borus MJ, Lightfoot M, Kasirye R, Desmond K. Vocational training with HIV prevention for Ugandan youth. *AIDS & Behavior*. 2012;16(5):1133-7.

77. Coast E, Leone T, Hirose A, Jones E. Poverty and postnatal depression: a systematic mapping of the evidence from low and lower middle income countries. *Health Place*. 2012;18(5):1188-97.
78. Cottler LB, Satyanarayana VA, O'Leary CC, Vaddiparti K, Benegal V, Chandra PS. Feasibility and effectiveness of HIV prevention among wives of heavy drinkers in Bangalore, India. *AIDS & Behavior*. 2010;14 Suppl 1:S168-76.
79. Chaplin SE. Cities, sewers and poverty: India's politics of sanitation. *Environment & Urbanization*. 1999;11(1):145-58.
80. Keare D, Parris S, Urb. Evaluation of shelter programs for the urban poor : principal findings. Washington, D.C.: The World Bank, 1982.
81. Thieme T, Kovacs E. Services and Slums: Rethinking Infrastructures and Provisioning across the Nexus. The Nexus Network Think Piece Series, Paper 004: 2015.
82. Lobo J. The science and practice of urban planning in slums 2016 [cited 2016 29th June 2016]. Available from: <https://ugecv viewpoints.wordpress.com/2016/05/31/the-science-and-practice-of-urban-planning-in-slums/>.
83. Buckley R. Social inclusion in Mumbai: economics matters too. *Environment & Urbanization*. 2011;23(1):277-84.
84. Banerjee A, Duflo E, Chattopadhyay R, Shapiro J. Targeting the Hard-Core Poor: An Impact Assessment. New York: PublicAffairs 2011.
85. Banerjee AV, Duflo E. Mandated empowerment: Handing antipoverty policy back to the poor? Reducing the Impact of Poverty on Health and Human Development: Scientific Approaches. 2008;1136((Banerjee, Duflo) Department of Economics, Abdul Latif Jameel Poverty Action Lab., Massachusetts Institute of Technology, Cambridge, MA, United States):333-41.
86. Brown C, Hofer T, Johal A, Thomson R, Nicholl J, Franklin BD, et al. An epistemology of patient safety research: a framework for study design and interpretation. Part 2. Study design. *Quality & safety in health care*. 2008;17(3):163-9.
87. Chen YF, Hemming K, Stevens AJ, Lilford RJ. Secular trends and evaluation of complex interventions: the rising tide phenomenon. *BMJ quality & safety*. 2015.
88. Kremer M, Field E. Impact Evaluation for Slum Upgrading Interventions. Washington D.C.: The World Bank, 2006.
89. Hemming K, Haines TP, Chilton PJ, Girling AJ, Lilford RJ. The stepped wedge cluster randomised trial: rationale, design, analysis, and reporting. *BMJ (Clinical research ed)*. 2015;350:h391.
90. Girling AJ, Hemming K. Statistical efficiency and optimal design for stepped cluster studies under linear mixed effects models. *Statistics in medicine*. 2016.
91. Sweeney S, Vassall A, Foster N, Simms V, Ilboudo P, Kimaro G, et al. Methodological Issues to Consider When Collecting Data to Estimate Poverty Impact in Economic Evaluations in Low-income and Middle-income Countries. *Health economics*. 2016;25 Suppl 1:42-52.
92. Greco G, Lorgelly P, Yamabhai I. Outcomes in Economic Evaluations of Public Health Interventions in Low- and Middle-Income Countries: Health, Capabilities and Subjective Wellbeing. *Health economics*. 2016;25 Suppl 1:83-94.
93. Adato M, Bassett L. Social protection to support vulnerable children and families: the potential of cash transfers to protect education, health and nutrition. *AIDS care*. 2009;21 Suppl 1:60-75.
94. Ali SI. Alternatives for safe water provision in urban and peri-urban slums. 2010;8((Ali) School of Engineering, University of Guelph, 50 Stone Road East, Guelph, ON N1G 2W1, Canada):720-34.
95. Kulabako RN, Nalubega M, Wozzi E, Thunvik R. Environmental health practices, constraints and possible interventions in peri-urban settlements in developing countries - A review of Kampala, Uganda. 2010;20((Kulabako, Nalubega, Wozzi) Department of Civil Engineering, Makerere University, Kampala, Uganda):231-57.

96. Kumar V, Shearer JC, Kumar A, Darmstadt GL. Neonatal hypothermia in low resource settings: a review. *Journal of perinatology : official journal of the California Perinatal Association*. 2009;29(6):401-12.
97. Okurut K, Kulabako RN, Chenoweth J, Charles K. Assessing demand for improved sustainable sanitation in low-income informal settlements of urban areas: A critical review. 2015;25((Okurut, Chenoweth, Charles) Centre for Environmental Strategy, University of Surrey, Guildford, United Kingdom):81-95.
98. Pettifor A, MacPhail C, Nguyen N, Rosenberg M. Can money prevent the spread of HIV? A review of cash payments for HIV prevention. *AIDS and behavior*. 2012;16(7):1729-38.
99. Hutton G, Haller L, Bartram J. Economic and health effects of increasing coverage of low cost household drinking-water supply and sanitation interventions to countries off-track to meet MDG target 10. Geneva, Switzerland: World Health Organization, 2007.
100. Isunju JB, Schwartz K, Schouten MA, Johnson WP, van Dijk MP. Socio-economic aspects of improved sanitation in slums: a review. *Public health*. 2011;125(6):368-76.
101. Cutler D, Miller G. The role of public health improvements in health advances: the twentieth-century United States. *Demography*. 2005;42(1):1-22.
102. Gunther I, Gunther F. Water, sanitation and children's health : evidence from 172 DHS surveys. Policy Research working paper WPS 5275. Washington D.C.: 2010.
103. Genser B, Strina A, dos Santos LA, Teles CA, Prado MS, Cairncross S, et al. Impact of a city-wide sanitation intervention in a large urban centre on social, environmental and behavioural determinants of childhood diarrhoea: analysis of two cohort studies. *International journal of epidemiology*. 2008;37(4):831-40.
104. Shyamal S, Ghosh MS, Somnath S. The Mumbai Slum Sanitation Program : partnering with slum communities for sustainable sanitation in a megalopolis. Washington, DC: 2006.
105. Jamison DT, Breman JG, Measham AR, Alleyne G, Claeson M, Evans DB, et al. *Disease Control Priorities in Developing Countries*. 2nd Ed ed. Washington, D.C.: World Bank; 2006.
106. Varley RC, Tarvid J, Chao DN. A reassessment of the cost-effectiveness of water and sanitation interventions in programmes for controlling childhood diarrhoea. *Bulletin of the World Health Organization*. 1998;76(6):617-31.
107. Clasen T, Haller L, Walker D, Bartram J, Cairncross S. Cost-effectiveness of water quality interventions for preventing diarrhoeal disease in developing countries. *J Water Health*. 2007;5(4):599-608.
108. Jeandron A, Saidi JM, Kapama A, Burhole M, Birembano F, Vandeveld T, et al. Water supply interruptions and suspected cholera incidence: a time-series regression in the Democratic Republic of the Congo. *PLoS medicine*. 2015;12(10):e1001893.
109. Thomson H, Petticrew M, Morrison D. Health effects of housing improvement: systematic review of intervention studies. *BMJ (Clinical research ed)*. 2001;323(7306):187-90.
110. Cattaneo M, Galiani S, Gertler P, Martinez S, Titiunik R. Housing, Health and Happiness. *American Economic Journal: Economic Policy* 2009;1(1):75-105.
111. UN-Habitat. *Streets as Tools for Urban Transformation in Slums*. Nairobi: 2014.
112. Milone P. Kampung improvement in the small and medium sized cities of central Java. *Review of Urban and Regional Development Studies* 1993;5(1):74-94.
113. De Leon LT. Barrio Escopa. *Journal of Architectural and Planning Research* 1986;3(2):93-116.
114. Global, regional, and national incidence, prevalence, and years lived with disability for 301 acute and chronic diseases and injuries in 188 countries, 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet (London, England)*. 2015;386(9995):743-800.
115. Pasteur D. *The Management of Squatter Upgrading*. Farnborough, UK: Saxon House 1979.

116. Hasan A. Orangi Pilot Project: the expansion of work beyond Orangi and the mapping of informal settlements and infrastructure. *Environment & Urbanization*. 2006;18(2):451-80.

Rump file

There is a huge agenda for slum health – much too large to fully describe here and we do not have a monopoly of ideas. In Table 2.2 we list some urgent priorities that have stood out for us in our individual work programmes and in the writing of this series.

Table 2.2: Some research priorities for slum health

1.	Regularly updated systematic reviews. Only three Cochrane / Campbell reviews are based in slums – Table 2.1. We advocate a much more expansive set of ongoing reviews covering the topics in this paper.
2.	Generating league table of value of investment priorities for slums according to their condition at baseline.
3.	A study of the health of garbage miners. More formal studies of pollution levels in slums.
4.	Cash transfer interventions. Preferably compared with an alternative. For instance cash transfer versus nutritional supplements for families with children aged 6 to 24 months.
5.	Accommodation for breastfeeding at work

First best priority – a call to arms

There is one particular strategy that we think should be privileged above others – improvement in water supply and sanitation. There are a number of reasons for this. First, in paper one we showed that sanitation and water is woefully inadequate in slum areas, is perceived as a big problem, causes massive loss of productivity and is a cause of acute and chronic morbidity and loss of life years.

Second, in this paper, we showed that:

- 1) Interventions to provide water and sanitation are effective (albeit not as effective as they might be if more comprehensive and diligently implemented and maintained).
- 2) They are cost effective even at modest levels of effectiveness, yielding high returns on investment, perhaps second only to vaccination.

We would therefore designate water supply and sanitation as the prime candidate for attention internationally and locally – it should be development goal number one for slum improvement unless it has to be prioritised against vaccination. Organisations of the United Nations should spearhead the endeavour working with national and international agencies representing people who live in slums and with international organisations dedicated to water and sanitation in LMICs. The latter are the modern equivalent of the 19th century sanitary reformers such as Edwin Chadwick who created a broad political consensus and social movement that brought water and sanitation within reach of the poorest people in slums. This resulted in massive improvements in health and hence prosperity among growing urban populations of current high income countries ⁽⁷⁹⁾. This should now be replicated internationally. We refer those who disagree, or think we have gone beyond what can be proven in a formal sense, to our recommendation covering harmonised comparative health economic assessments below.