

# Urbanisation and infectious diseases in a globalised world

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The world is becoming urban. The UN predicts that the world's urban population will almost double from 3·3 billion in 2007 to 6·3 billion in 2050. Most of this increase will be in developing countries. Exponential urban growth is having a profound effect on global health. Because of international travel and migration, cities are becoming important hubs for the transmission of infectious diseases, as shown by recent pandemics. Physicians in urban environments in developing and developed countries need to be aware of the changes in infectious diseases associated with urbanisation. Furthermore, health should be a major consideration in town planning to ensure urbanisation works to reduce the burden of infectious diseases in the future.

## Introduction

In 2009, more than 50% of the world's population were living in cities.<sup>1</sup> Although most developed nations already show high rates of urbanisation (about 80%), tropical countries are experiencing a remarkable expansion of their urban agglomerations (figure 1). The population of Niamey, Niger, for example, increased from 250 000 people in the 1980s to almost 1 million today. By 2050, the world's urban population is expected to reach 6·3 billion. Almost all of this growth will be in low-income regions: in Africa the urban population is likely to triple, and in Asia it will more than double.<sup>1</sup> Although Latin America became mostly urban in the early 1960s, sub-Saharan Africa remains mainly rural and is not expected to pass the urban tipping point before 2030.<sup>3</sup> Although nearly half of the increase will be in small urban centres (less than 500 000 inhabitants), most mega-cities in Europe and northern America will grow by less than 0·5%. High-growth rates are expected in Lagos, Nigeria, Dhaka, Bangladesh, and Karachi, Pakistan. This worldwide increase in urban population results from a combination of factors including natural population growth, migration, government policies, infrastructure development, and other major political and economical forces, including globalisation.

There is no universally accepted definition of what urban is. Some countries use a basic administrative definition (eg, living in the capital city); others use population measures (eg, size or density), or functional characteristics (eg, economic activities). Data are therefore difficult to extrapolate from one country to another. Moreover, there are few high-quality studies assessing urban health in tropical regions and most studies are cross-sectional. Most studies address differences between urban and rural settings and data are rarely disaggregated according to disparities within urban settings, which are therefore masked. Finally, urban growth might be driven by different forces in different cities, and the epidemiology of individual diseases might differ according to specific urban dynamics and contexts.<sup>4</sup>

In industrialised nations, urbanisation has contributed to an overall improvement of health and to a major shift in disease patterns towards a rise in chronic diseases. However, in many low-income countries, economic

growth does not keep pace with the rise in urban populations. Many national and municipal governments do not have the resources to cope with the steady influx of migrants or with the explosive demographic growth of urban centres. The urban sector's share of the poor is therefore on the rise. In Sudan and Central African Republic, more than 94% of urban residents live in dismal conditions in shanty towns.<sup>5</sup> In 2001, 924 million urban residents lived in slums and informal settlements. This number is expected to double to almost 2 billion by 2030.<sup>6</sup> The health transition that has taken place in developed cities is still beyond reach for most low-income countries. Chronic illnesses have been increasing in importance, but infectious diseases remain a leading cause of mortality and morbidity.<sup>7-9</sup> Furthermore, important socioeconomic disparities have emerged in urban centres mirrored by profound health inequalities.<sup>9,10</sup> Urbanisation of low-income countries raises new health challenges for the international community.<sup>9</sup>

Several rural pathogens have adapted to urban environments and others have emerged or re-emerged in urban areas. The heterogeneity in health of urban dwellers, increased rates of contact, and mobility of people, results in a high risk of disease transmission in large urban populations. Cities become incubators where all the conditions are met for outbreaks to occur. Although poor urban areas are typically affected first,

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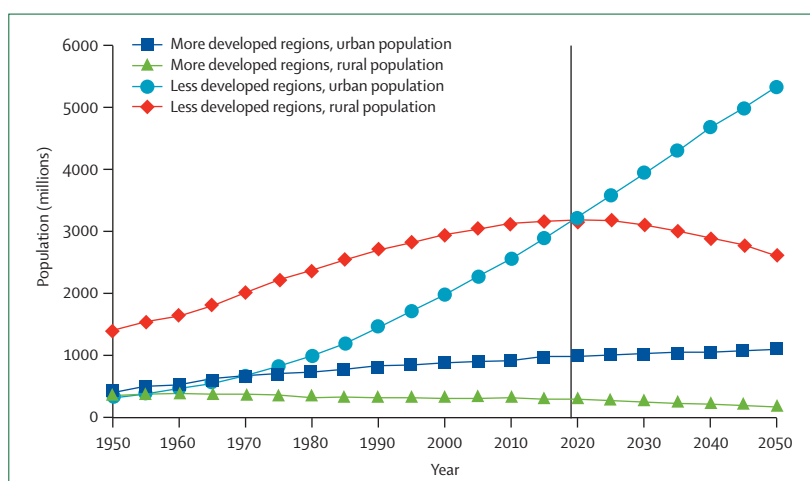


Figure 1: Evolution of urban and rural populations between 1950 and 2050<sup>2</sup>

infections have the potential to rapidly propagate to other parts of the city, including wealthy neighbourhoods and tourist areas. Additionally, in an interconnected world, cities become gateways for the worldwide spread of infections. These issues have substantial public-health implications, reshaping the epidemiology of both chronic and infectious diseases, with consequences worldwide. They also change the practice of physicians working in cities of tropical regions, and of travel doctors in developed nations. This Review will summarise how urbanisation influences the epidemiology of infectious diseases. We focus on low-income countries where most rapid urbanisation is taking place with important consequences because of the scarcity of resources.

### A web of interconnected determinants

#### Specificities of urban populations

The close proximity of people is a prominent urban factor. The world's densest cities are in Asia, and with almost 30 000 inhabitants per km<sup>2</sup>, Mumbai, India leads the way. Population density affects diseases, particularly those transmitted via respiratory and faecal–oral routes. Because of high-population density, an increased amount of shared airspace increases exposure to influenza, measles, and *Mycobacterium tuberculosis*. Urban centres usually have higher rates of tuberculosis infection than do rural areas.<sup>11</sup> In impoverished suburban areas of Karachi, Pakistan, the prevalence of pulmonary tuberculosis is 329 per 100 000 people, much higher than the prevalence of 171 per 100 000 that was reported by Pakistan national statistics.<sup>12</sup> Densely populated cities also provide favourable grounds for the spread of emerging diseases, as shown by the severe acute respiratory syndrome or the recent H1N1 influenza epidemics. Careful urban planning is crucial to restrict household overcrowding, and the provision of parks and open spaces relieves congestion.

In most low-income countries, urban expansion is due to natural population growth. However, migration of

people from other urban centres or from rural areas contributes substantially to the growth of cities.<sup>1</sup> Economic migration and forced displacement can contribute to population movements. In Amman, Jordan, at least 500 000 of the 2 million inhabitants have moved to the city seeking refuge from conflict or disaster.<sup>3</sup> For urban growth, migration is generally more important in nations with low rates of natural increase. In China for example, the floating population of rural migrants moving to coastal cities is about 120 million. Large population movements are also occurring between cities, notably in Latin America and the Caribbean. In São Paulo, Brazil, a third of all urban growth can be attributed to migration from other cities.<sup>9</sup> Migration affects the transmission of communicable diseases in several ways. First, cities might provide favourable conditions for the spread of germs that are imported by migrants. Schistosomiasis has established itself in urban areas most probably through infected migrants.<sup>13</sup> The snail intermediate host of *Schistosoma* spp is present in urban water bodies, and endemic foci occur in large cities such as in Bamako, Mali, Dar el Salam, Tanzania, and Kampala, Uganda.<sup>14–16</sup> Second, migrants who are infected might also increase the transmission of a disease that is already present in a city. In Kinshasa, Democratic Republic of Congo, the massive inflow of internally displaced persons from provinces where African trypanosomiasis is endemic, contributed to an increase of ten times in the number of cases reported.<sup>17</sup> Finally, rural migrants travelling from non-endemic areas might also change the epidemiology of infectious diseases already present in cities. Many newcomers do not have the specific immunity for these diseases and are more susceptible to infections and more likely to develop severe forms than are residents.<sup>18,19</sup> Naive migrants also contribute to the spread of latent forms of the disease. In Kabul, Afghanistan, where cutaneous leishmaniasis is endemic, most of the population become infected and immune in early life. Since 1987, rural-to-urban population movements have substantially increased the risk of transmission among newcomers, and the spread of this disease has reached epidemic proportions.<sup>20</sup>

#### The physical environment of cities

According to WHO, almost 137 million people in urban populations have no access to safe drinking water, and more than 600 million urban dwellers do not have adequate sanitation.<sup>21</sup> The situation is particularly alarming in congested cities of sub-Saharan Africa (figure 2). In Nigeria for example, only 3% of residents from Ibadan have access to piped water, and in Greater Lagos, only 9% of its 10 million residents have access.<sup>4</sup> Unsafe water sources and inadequate sanitation and hygiene are prime contributors to diarrhoeal infections and might lead to cholera endemicity.<sup>22</sup> The overall prevalence of diarrhoea can be very high in cities as shown by data from northern Jakarta, Indonesia, where



**Figure 2: A slum of Kibera**

Dwellers of slums live in dire, overcrowded environments, with no access to water or sanitation. In the slum of Kibera, Kenya the number of inhabitants is almost 1 million.

prevalence is 50 per 1000 people.<sup>23</sup> Inadequate sanitation also affects the transmission of soil-transmitted helminthiasis and intestinal parasites. Several surveys<sup>23–27</sup> show a high prevalence of intestinal parasites among children—for example, 52·8% in Karachi, Pakistan.<sup>27</sup> Finally, absence of sewerage systems can lead to the proliferation of rodents, as in El Salvador's slums, where rats carrying *Leptospira interrogans* proliferate.<sup>28</sup> During the rainy season, open-drainage gutters tend to overflow, flooding streets and adjacent homes, and triggering outbreaks of leptospirosis.<sup>29–30</sup> Solutions to the urban transmission of water-borne diseases include improved water access, quality, and sanitation, and the promotion of personal hygiene practice. If continued political and financial commitment is made, these interventions might result in a high return on investment.<sup>31</sup> In Beijing and Chongqing, China, alliances of several stakeholders were established to address long-term sustainability of urban water cycles. The doubling of Chongqing's population between 1995 and 2003 has resulted in water scarcity and serious environmental degradation. Recycling of waste water and initiatives for harvesting rainwater are under development.<sup>32</sup>

Urbanisation also creates an increasing problem for the management of solid waste. The Asian Development Bank estimates that the waste quantities generated by Indian cities will increase from 46 million tonnes in 2001, to 65 million tonnes in 2010. In rural areas, most waste is reused as compost, burnt, or recycled to meet daily needs. In cities, this is rarely possible, and when municipal services are deficient, waste piles up in empty lots and street sides, leading to soil, air, and water pollution. This pollution might increase the prevalence of diarrhoeal and intestinal parasitic infections.<sup>33,34</sup> Accumulated waste can also be a breeding site for vectors. Phlebotomine sandflies—the main vectors for leishmania parasites—breed in organic waste from human beings and domestic animals. In Teresina, Brazil, the risk of contracting visceral leishmaniasis is six times higher for people living in houses with no regular rubbish collection than for people with regular rubbish collection.<sup>35</sup> *Aedes* spp mosquitoes, which are vectors for dengue, yellow fever, and chikungunya, have adapted well to the urban environment and often breed in cans, plastic bottles, and tyres.<sup>36,37</sup> Accumulated waste also favours the swarming of rodents. The epicentre for plague outbreaks in Mahajanga, Madagascar, is a densely populated area including two large markets, which generate the town's largest amount of rubbish.<sup>38</sup>

Housing conditions are commonly better than in rural areas, with concrete floors and walls rather than houses built with leaves and mud. In many low-income countries, however, poor residents of slums generally build their own dwellings from flimsy, scrounged materials and with no concern for vector hygiene. In the suburbs of Arequipa, Peru, about half of the houses are infested with *Triatoma infestans*, which transmits *Trypanosoma cruzi*.<sup>39</sup> Infestans

were also found in peri-urban areas of Cochabamba, Bolivia.<sup>40</sup> However, several municipalities have deployed large-scale efforts to upgrade shantytowns and other impoverished areas. A government programme in Mexico to replace dirt floors with cement floors in Mexico City led to a 78% reduction in parasitic protozoa infestations and a 49% reduction in diarrhoea among children.<sup>41</sup>

### Social disparities drive health inequities in urban settings

Many social determinants interact to define individual exposure and vulnerability to disease.<sup>42</sup> In urban settings, the most substantial factors include socioeconomic status, place of residence, race, ethnicity, gender, and education.<sup>43</sup> Urbanisation contributes to economic growth and is generally a positive factor in overall poverty reduction. Cities provide opportunities for many rural migrants who are attracted by greater job prospects and higher salaries than those found in rural areas. Improved socioeconomic status results in improved health and health conditions are on average better in urban areas than in rural areas. However, in most cities in low-income countries, high inequities in economic, social, and living conditions are often noted, which are often mirrored by inequalities in health (figure 3).<sup>8,44</sup> In cities in Brazil, low income, unemployment, and material deprivation are associated with an increased risk of dengue, schistosomiasis, and leptospirosis.<sup>45–48</sup> In addition to individual-level factors, the socioeconomic characteristics of neighbourhoods also matter, and slum dwellers and informal settlers are the most vulnerable groups.<sup>42</sup> In El Salvador, Brazil, the risk of acquiring severe leptospirosis is four times higher for residents of favelas than for other residents.<sup>30,49</sup> Similarly, education levels are higher on average in urban centres than in rural areas. Furthermore, urban residents have better access to mass media and are more exposed to campaigns for disease prevention. Knowledge and skills attained through education make people more receptive to health education. For example, knowledge of HIV and AIDS is better in many cities than in rural areas, and urban dwellers generally use condoms more frequently.<sup>50</sup> In urban Bangladesh, access to education and mass media are among the strongest predictors of health outcomes in women.<sup>51</sup> Educated mothers are more aware of the importance of breast feeding, immunisation, and simple hygienic measures;<sup>52</sup> but huge intraurban disparities persist. A study comparing rural, urban, and slum residents in India, found that literacy rates were higher in rural areas (80·6% literacy) and other urban areas (94·3%) than in slums (65·3%). Immunisation coverage, contraceptive use, and antenatal care were poorer in slums than in other urban districts.<sup>53</sup>

Socioeconomic disparities also determine differential access to, and use of health care, with a substantial effect on prevention, treatment, and survival. In the city of Chandigarh, India, despite the presence of tertiary-care



**Figure 3: Socioeconomic disparities in Paraisópolis, São Paulo**

The urban environment is characterised by important socioeconomic disparities and geographical heterogeneity. In Paraisópolis, São Paulo, Brazil, high-income housing is just two steps away from the favela shacks.

hospitals, multispeciality hospitals, and a network of public dispensaries and private clinics, coverage indicators for reproductive and child health are inferior in impoverished neighbourhoods.<sup>53</sup> In the slums of Nairobi, Kenya, tumbledown, private-owned, and unlicensed clinics might be the only health facilities to which residents have access.<sup>54</sup> Access to vaccination is also an issue for poorer urban residents, and in sub-Saharan Africa, rapid rates of urbanisation are associated with negative outcomes in access to vaccination.<sup>55</sup> Differential access to medication might result in the emergence of resistance in the urban environment, (eg, malaria resistance to chloroquine<sup>56</sup>). The number of cases of multidrug-resistant (MDR) tuberculosis is also rapidly increasing in several cities.<sup>57</sup> For Baku, Azerbaijan, this increase is particularly daunting: among newly diagnosed cases of tuberculosis, the proportion of single-drug resistant and MDR tuberculosis are 56.3% and 22.3%, respectively. Surveys have also reported alarming rates of MDR tuberculosis in Tashkent, Uzbekistan, Mumbai, India, Dhaka, Bangladesh, and Cape Town, South Africa.<sup>57–59</sup>

Finally, the urban environment results in many changes in human behaviour that affect transmission risks, in particular, for sexually transmitted diseases. Decreased social cohesion, new family structures, and the relaxation of traditional cultural norms yield new patterns of behaviour, including changes in sexual activity and the use of drugs.<sup>60,61</sup> Young people are particularly at risk. In Kampala, Uganda, a survey done among adolescents showed that 20.6% of the girls and 13.2% of the boys had at least one sexually transmitted disease.<sup>62</sup> Migrants are also a particularly vulnerable group, because they are often young, single, and living away from their relatives.

The 120 million migrants of China have been identified as the tipping point for the country's AIDS epidemic and several reports have underlined the high prevalence of high-risk sexual behaviours among this floating population.<sup>63–67</sup> Risk perception about sexually transmitted diseases and HIV and AIDS is profoundly changed in rural-to-urban migrant populations;<sup>64,65</sup> however, the link between health behaviour and transmission of sexually transmitted diseases remains complex. A study comparing behaviours in Cotonou, Benin, Yaoundé, Cameroon, Kisumu, Kenya, and Ndola, Zambia, found that high-risk sexual behaviour was not more common in cities with the highest HIV prevalences than in others.<sup>68</sup> Furthermore, some studies show that the sexual behaviour of young adults might be more high-risk in rural areas than in cities.<sup>69,70</sup>

### Important infectious diseases in tropical urban environments

Several infectious diseases have emerged or re-emerged in urban areas.<sup>71</sup> Some that were traditionally thought of as rural, have adapted to the urban environment and are now common in cities. Others have acquired the potential to start sudden epidemics. However, urban development has also reduced the transmission of other diseases. Because tuberculosis<sup>10,58,59,72–74</sup> and HIV<sup>50,75</sup> transmission have already been documented elsewhere, these diseases, though of primary importance, are not discussed here.

### When rural diseases turn urban

Several of the neglected tropical diseases that were once most common in rural, remote areas, are now frequently found in cities. Leishmaniasis is a growing health problem, and rapid urbanisation contributes to this increase.<sup>76</sup> In several cities, the numbers have exploded: in Kabul, Afghanistan, cases of cutaneous leishmaniasis increased from 14 200 in 1994, to 65 000 in 2002, and in Ouagadougou, Burkina Faso, the incidence of cutaneous leishmaniasis increased from 28 cases in 1995, to 2375 in 2000.<sup>77</sup> Visceral leishmaniasis has become an important issue in several Latin American cities including Teresina, Belo Horizonte, São Luis, and Salvador de Bahia in Brazil.<sup>78,79</sup> Several processes contributed to the urbanisation of this disease. First, rapid urban expansion might bring populations into contact with zoonotic cycles established in adjacent rural areas. For example, cutaneous leishmaniasis has established itself in the periphery of Manaus, Brazil, Bella Vista, Argentina, Marrakech, Morocco, and Khartoum, Sudan.<sup>80–83</sup> Second, migrations have probably contributed to the urbanisation of visceral leishmaniasis. In northeast Brazil, prolonged droughts have triggered massive population movements towards the outskirts of large cities. Rural migrants settled in shantytowns and brought chickens, pigs, and dogs with them, creating ideal conditions for the proliferation of sandflies and for the establishment of an urban transmission cycle.<sup>76</sup> Similarly, the emergence of

visceral leishmaniasis in Khartoum in 1988 likely resulted from the influx of people from western Upper Nile province, southern Sudan, who had fled the civil war in the south.<sup>84</sup> Finally, poor sanitary conditions and changes in vector ecology also contributed substantially to the spread of visceral leishmaniasis, and high numbers of sandflies were recorded in several cities.<sup>35,85,90</sup>

Chagas disease, the American trypanosomiasis, caused by the protozoan parasite *cruzi*, affects 8 million to 10 million people every year.<sup>91</sup> This disease is transmitted by triatomine bugs that hide in wall cracks and thatched roofs of rural households. Chagas disease has long been thought of as a disease of rural areas, but several reports suggest the existence of transmission foci in urban and periurban areas. In 1996, a seroepidemiological survey in Cochabamba, Bolivia, found anti-*T-cruzi* antibodies in 12.5% of the inhabitants.<sup>40</sup> Another survey showed that 22% of children from Cochabamba aged 5–13 years were seropositive for *T-cruzi* infection.<sup>92</sup> In poor suburbs of Arequipa, Peru, of the 397 households surveyed, 194 (52%) were infested with triatomines, and 72 (19.3%) harboured insects that were infected with *T-cruzi*.<sup>39</sup> In urban settings, *T-cruzi* can also be transmitted via blood transfusion or organ transplants. In Latin American cities between 1980 and 1989, 1.3–51.0% of blood units intended for transfusion were infected with *T-cruzi*.<sup>93</sup> Rural-to-urban migrants have probably played an important part in the establishment of Chagas disease in cities by transporting vectors from endemic rural areas to the peripheries of towns where they usually settle. Triatomine bugs were detected in Buenos Aires and San Juan, Argentina, in Heredia, Costa Rica, and in Cuernavaca, Mexico.<sup>94–97</sup> Vector proliferation is associated with poor socioeconomic conditions, poor housing, and the presence of domestic animals in and around houses.<sup>39</sup> Other neglected tropical diseases have adapted to the urban environment. Among the 1.2 billion people at risk of lymphatic filariasis, about 29% live in urban settings.<sup>98</sup> In poor neighbourhoods in Nigeria, Brazil, and India, mismanagement of waste water, absence of sewer systems, and accumulation of waste promote the proliferation of *Wuchereria bancrofti* vectors and increase biting rates.<sup>99–102</sup>

### The looming threat of explosive urban epidemics

The urban environment offers favourable grounds for the spread of epidemics, mainly because of high-population densities. Some diseases, such as dengue, have become permanently established in urban areas and cause regular epidemics, while others, like Ebola in Kikwit, Democratic Republic of Congo, in 1995, or Marburg haemorrhagic fever in Angola in 2005, might produce occasional, patchy outbreaks. Epidemic forms of certain diseases, such as chikungunya, might become restricted to the urban environment.<sup>103</sup> In Africa, despite several decades of relative inactivity, outbreaks of yellow fever have occurred since the mid 1980s, sometimes involving tens of thousands of cases.<sup>104</sup> Interruption of

immunisation programmes, population movements, and urbanisation all partly account for the spread of this virus. In several endemic countries, rapid urban growth has resulted in non-immune populations being concentrated in overcrowded slums that are swarming with *Aedes* spp mosquitoes. Several densely-populated cities are near areas of enzootic activity, and the risk of large and uncontrollable outbreaks is looming.<sup>105</sup> Since 2000, west Africa has had several urban epidemics: Abidjan, Côte d'Ivoire, in 2001 and 2008, Dakar and Touba, Senegal, in 2002, and Bobo-Dioulasso, Burkina Faso, in 2004.<sup>106–108</sup> In South America, re-emergence of urban yellow fever might also occur in the near future, particularly in densely populated coastal regions where most of the population is not vaccinated.<sup>109</sup> The 2008 re-emergence of yellow fever in Paraguay was almost an urban outbreak.

Dengue fever is mainly an urban disease that has been associated with sudden epidemics in tropical and subtropical regions. The geographical distribution of dengue has increased substantially in the past 30 years, and it is now endemic in more than 100 countries.<sup>110</sup> About 50 million infections occur every year, including 400 000 cases of dengue haemorrhagic fever. The incidence of dengue has increased greatly in south Asian cities. In 2007, Indonesia reported 127 687 cases of dengue fever, 25 000 of which were in Jakarta.<sup>111</sup> Epidemics of dengue fever and dengue haemorrhagic fever start in major cities and spread geographically outwards to rural areas.<sup>112</sup> Low-herd immunity, high-population density, increased mobility, air travel, and ineffective control programmes are thought to have contributed to the re-emergence of the virus in south Asia. Unplanned urbanisation has also been central to the re-emergence of dengue fever in the Americas.<sup>113</sup> The epicentre of the epidemic that affected Brazil between January, and April, 2008, was in Rio de Janeiro and resulted in more than 120 000 reported cases, including 647 cases of dengue haemorrhagic fever and 48 deaths.

### When urbanisation curtails transmission

There are several examples of urban growth triggering the decline of infectious diseases. Air and water pollution, which exist in many cities, can hinder vector proliferation. A study examining phlebotomine proliferation in Marrakech, showed that urbanisation generally decreased sandfly populations.<sup>114</sup> Although most anopheline species do not tolerate polluted waters, some have adapted to contaminated waste water.<sup>115–119</sup> Evidence for transmission of malaria has been found in most cities in sub-Saharan Africa, but levels of transmission are generally lower in urban areas than in rural areas.<sup>120,121</sup> Estimates predict that among the 0.6 billion people from Africa who are at risk of malaria, about 200 million are urban dwellers.<sup>122</sup> In urban environments, anopheline vectors are less abundant and less likely to be infected with *Plasmodium* spp. Furthermore, urban dwellers experience reduced

biting rates. Destruction of vector habitats, improved housing conditions, and improved access to preventive and curative measures all partly account for this decreased transmission. However, substantial variations in malaria transmission exist in different areas of the same city, thus reflecting disparities in environmental conditions and population dynamics.<sup>123</sup> A survey done in Ouagadougou, Burkina Faso, showed that the prevalence of parasitaemia among school children varied between 24.1% in the centre, and 68.7% in peripheral areas.<sup>124</sup> Urban transmission is usually remarkably focal and occurs in the vicinity of *Anopheles* spp breeding sites.<sup>125</sup> In particular, urban farming might promote high densities of mosquitoes and increase transmission of malaria in specific areas.<sup>126,127</sup>

Hepatitis A is another example of the positive effect that cities can have on transmission of infectious diseases. Hepatitis A is typically a disease of the poor, its prevalence being closely related to socioeconomic status, hygiene, and living conditions. In most low-income countries, exposure to hepatitis A virus is thought to be universal before age 10 years.<sup>128–130</sup> However, in several countries, improvements in sanitation and public-health programmes have shifted the epidemiological pattern of hepatitis A viral infection, with exposure to the virus occurring at a later age.<sup>131,132</sup> This shift is particularly evident in urban areas, where

improved socioeconomic status is generally accompanied by a decline in the prevalence of hepatitis A. For example, over the past 30 years, there has been a substantial decrease in hepatitis A infections in Singapore, and a 50% drop in the seroprevalence of hepatitis A antibodies since 1975.<sup>131</sup> About 10 years ago, hepatitis A was viewed as an important health issue in Hong Kong, causing 67–83% of all notified cases of viral hepatitis.<sup>133</sup> However, the number of notified cases showed a decrease of ten times since the 1990s, with 63 cases reported in 2005.<sup>134</sup>

### Highly interconnected urban hubs: a catalyst to the spread of diseases

Global travel has changed substantially in the past 30 years, with ever-escalating speed, distance, and volume. According to the World Tourism Organization, international tourist arrivals increased from 25.3 million in 1950, to 924 million in 2008; an astounding increase of 36 times. Increased mobility has provided new opportunities for emerging diseases, such as for severe acute respiratory syndrome or chikungunya, particularly in cities, which constitute entry points for most travellers.<sup>135</sup> Air travel and increased mobility have been central to the large and rapid outbreaks of chikungunya that occurred in cities of the Indian Ocean between 2005 and 2006. These epidemics involved genetically similar

	Preventive measures for the community	Preventive measures for urban travellers
<b>Water-borne diseases</b>		
Bacterial dysentery, hepatitis A, cholera	Improvement of water supply, sanitation, and sewage systems	Food and water precautions Vaccination (hepatitis A and cholera)
<b>Vector-borne diseases</b>		
Dengue; chikungunya	Promotion of actions to remove larval habitats of mosquito vectors	Protection against mosquito bites
Malaria	Elimination of mosquito breeding sites, use of mosquito nets, and indoor residual spraying with insecticides	Protection against mosquito bites Prophylactic drug
Leishmaniasis	According to the species: vector control, ±control of mammalian hosts	Protection against sandfly bites
Lymphatic filariasis	Elimination of mosquito breeding sites	Protection against mosquito bites
African trypanosomiasis	Reduction of the tsetse fly population Diagnosis and treatment of people who are infected	Avoidance of affected regions Protection against tsetse fly bites
Chagas disease	Vector control (insecticide spraying) and housing improvement	Not sleeping in precarious dwellings Bednets
Yellow fever	Vector control Vaccination	Vaccination Protection against mosquito bites
Plague	Improvement of waste management	Protection against flea bites
Leptospirosis	Improvement of sewerage systems and waste management	Avoidance of direct and indirect contact with animal urine
<b>Air-borne diseases</b>		
Tuberculosis	Early diagnosis and treatment of patients who are infectious Reduction of social situations that increase the risk of infection	Avoidance of exposure to patients with known tuberculosis in crowded environments
Pneumonia	Reduction of atmospheric pollution	
<b>Sexually transmitted diseases</b>		
HIV	Health education in the public and in schools Access to condoms and treatment	Condoms Avoidance of use of unsterilised material (eg, for medical and dental procedures, or tattooing) and blood products

Table: Examples of preventive measures for diseases that have a modified epidemiology because of urban determinants

viruses, suggesting unique viral spreading, probably originating from southeast Africa.<sup>136</sup> Urban epidemics can reach unprecedented scales and quickly become uncontrollable. The 2009 influenza A H1N1 pandemic shows how fast infections can spread worldwide. In African cities, where disease surveillance of human beings and animals is weak, movement is not effectively managed, and health-care systems are overtaxed by AIDS, tuberculosis, and malaria, the control of influenza viruses will be especially problematic.<sup>137</sup>

The changing epidemiology of diseases in the urban environment, combined with the increased global mobility of travellers and migrants, can also change the practice of physicians. Patients with unfamiliar diseases may consult physicians who are unaware of the existence of some imported diseases. With the arrival of migrants from Latin America, Chagas disease should be recognised and patients coming from endemic areas should be screened. Because cities are becoming major travel destinations, physicians should be informed about ongoing epidemics of yellow fever, the geographical expansion of dengue or chikungunya, and the existence of leishmaniasis or rabies in the cities visited by travellers. Additionally, the risks to visiting friends and relatives might change because of urbanisation, as shown by the reduction in malaria incidence in the UK.<sup>138</sup> Prevention measures are summarised in the table. Furthermore, the rapid modernisation and advertising of large cities in emerging economies change how travellers perceive risks. Because most travellers are urban dwellers themselves, they tend to underestimate the risks related to the heterogeneity of cities. Large gatherings like the Olympic Games and the football World Cup now take place in countries such as China, South Africa, or Brazil. There are risks inherent to these events, such as the spread of diseases like measles or influenza; additionally, endemic diseases still persist, posing risks to travellers. This risk is particularly so if they combine a visit to rural areas in which conditions are very different from the better standards of the cities where events take place. The epidemiological transition in cities and the changes in the perception of risk by travellers visiting them oblige specialists in travel medicine to adjust their recommendations frequently.

### Conclusion: opportunities for action

Urbanisation increasingly affects the epidemiological characteristics of infectious diseases. Depending on the pace, dynamics, and environment, urbanisation can either promote or hinder the spread of pathogens. In most developed cities, better living conditions, improvement of domestic hygiene, and targeted public-health interventions started the decline of infectious illnesses. In parallel, chronic diseases have progressed because of changes in lifestyle, population ageing, and improvement in the diagnostic capacities of health services. Several agglomerations in developing countries seem to be on

track for this epidemiological transition.<sup>6,7</sup> However, uncontrolled urban growth has also resulted in large health inequities and in increases in the transmission of infectious diseases. In cities, numerous resources are present, and political power, money, and knowledge are concentrated. Urban centres offer incredible opportunities for disease surveillance, control, and prevention that are absent in rural areas. Well-planned strategies for vector control have enabled cities to eliminate malaria and dengue, and city-wide housing and sanitation programmes have shown spectacular effects.<sup>124,139,140</sup> Additionally, higher levels of social cohesion, the presence of community-based organisations that mobilise populations and advocate for resources, and access to media and modern communication allow urban residents to have increased visibility and a stronger political voice than their rural counterparts.<sup>141</sup>

The improvement of local capacities to identify, control, and prevent communicable diseases that have the potential to spread widely is of international interest. Surveillance is of primary importance, and changes in public health strategies can have substantial consequences. In Singapore, the re-emergence of dengue is partly a result of decreased vector surveillance and a shift towards case detection in the late 1980s.<sup>140</sup> Through use of the International Health Regulations, WHO has the mandate to help nations improve their surveillance and response capacities, with a substantial local, national, and international effect. Clearly a comprehensive global approach to disease surveillance, control, and prevention is increasingly needed.<sup>135</sup> Conventional health strategies should be adapted according to the dynamics of urbanisation and to the distinctive epidemiological pattern of transmittable diseases in cities. Increased public spending on health and provision of technical assistance will certainly not suffice to curtail the urban expansion of communicable diseases. Rather, the solution is in sensible planning of the expansion of cities, and depends on policy interventions at the community, municipal, national, and worldwide level.<sup>142,143</sup>

Whenever possible, local governments should incorporate health concerns into urban policies, such as economic promotion and community development. The Healthy Cities programme is a trans-sectoral approach that showed excellent results. In Marikina, Philippines, the combination of riverside clean-up campaigns, improvements in waste-management services, health education, and resettlement programmes resulted in a sharp decrease of dengue infections.<sup>141</sup> In South Africa, the Cape Town Equity Gauge was established in 2002 in response to health inequities throughout the city. This collaborative initiative involved reallocation of health staff, health-promotion programmes in schools, and a pilot implementation of dry-sanitation toilets in informal settlements.<sup>144</sup> Controlled and thoughtful urbanisation can produce substantive economic and health returns, both at the individual city level, and worldwide.<sup>142</sup> Benefits include increased life expectancy, improved health during

### Search strategy and selection criteria

We identified references through searches of PubMed between January 1975 and November 2009. We used MeSH terms “Urban Health” or “urbanization” with disease-specific terms (ie, “diarrhoea”, “intestinal diseases, parasitic”, “respiratory tract infections”, “trypanosomiasis”, “schistosomiasis”, “leishmaniasis”, “HIV”, “sexually transmitted diseases”). Additional searches of PubMed and the Cochrane Library were done with the terms “urban”, “health”, “slums”, and “infectious diseases”, and references from pertinent reviews and articles were also used. Online searches were restricted to articles in English, French, and Spanish. Duplicates were removed and only studies of tropical countries were selected. Of about 350 relevant papers, about 150 were retained. Articles were selected on the basis of relevance and quality of the methodology. Finally, websites from international organisations and from UN agencies (eg, World Bank, UN-Habitat, WHO) were searched for relevant information and reports addressing issues related to urbanisation were analysed.

childhood and during peak earning years, safer travel, preparedness for worldwide outbreaks, and containment of epidemics. Urban health should therefore be viewed as an international and worldwide issue, and appropriate resources should be allocated to reduce inequities.

#### Contributors

EA and LG did the reference search. EA wrote the article and chose the pictures. LG drew the table. FC, BS, and LL proofread and edited the Review.

#### Conflicts of interest

We declare that we have no conflicts of interest.

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