

Parasitic diseases and urban development*

K.E. Mott,¹ P. Desjeux,¹ A. Moncayo,² P. Ranque,¹ & P. de Raadt¹

The distribution and epidemiology of parasitic diseases in both urban and periurban areas of endemic countries have been changing as development progresses. The following different scenarios involving Chagas disease, lymphatic filariasis, leishmaniasis and schistosomiasis are discussed: (1) infected persons entering nonendemic urban areas without vectors; (2) infected persons entering nonendemic urban areas with vectors; (3) infected persons entering endemic urban areas; (4) non-infected persons entering endemic urban areas; (5) urbanization or domestication of natural zoonotic foci; and (6) vectors entering nonendemic urban areas. Cultural and social habits from the rural areas, such as type of house construction and domestic water usage, are adopted by migrants to urban areas and increase the risk of disease transmission which adversely affects employment in urban populations.

As the urban health services must deal with the rise in parasitic diseases, appropriate control strategies for the urban setting must be developed and implemented.

Introduction

Urban development, a process related to economic and political factors, has a direct bearing on the health of urban populations.^a Social phenomena such as rural-to-urban migration and job opportunities, urban infrastructure, and economic factors such as per capita domestic product and per capita private expenditure are among the determinants shaping the epidemiological pattern of parasitic diseases in urban and periurban settings.

The trend towards urbanization and higher urban growth rates due to the migration of rural inhabitants to cities contrasts with the lower demo-

graphic growth rates in the last decade (1). The urbanization of rural parasitic diseases is thus a relatively new phenomenon; high population densities in areas with inadequate housing, poor or absent sanitation and water supply, and difficult routes of access have created conditions favouring disease transmission to a greater extent than in the rural areas of origin of these migrants.

This article deals with parasitic diseases other than malaria,^b namely, Chagas disease, filariasis, leishmaniasis, and schistosomiasis, which are current public health problems in both urban and periurban settlements in the large cities of the developing world. Intestinal parasites, particularly *Ascaris*, *Trichuris*, *Giardia* and the amoebas, are not included, although there is extensive literature on them and their public health importance in terms of diseases and secondary effects on nutritional status in urban areas is recognized.^c

Epidemiological determinants

The epidemiological determinants of urban parasitic diseases can be analysed in the following six scen-

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¹ Division of Control of Tropical Diseases, World Health Organization, 1211 Geneva 27, Switzerland. Requests for reprints should be sent to Dr K.E. Mott at this address.

² UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases, World Health Organization, Geneva, Switzerland.

^a *Report of the Joint UNICEF/WHO Meeting on Primary Health Care in Urban Areas, Geneva, 25–29 July 1983*. Unpublished WHO document SHS/HSR/83.1, 1983.

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^b The problems of urban malaria are well documented and require a separate article.

^c **Ken, S.P.** *Effects of urbanization on intestinal parasitism*. Unpublished WHO document PDP/EC/WP/86.20, 1986.

arios, each being appropriate for one or more parasitic diseases. Some situations are unclear and cannot be classified because, for example, it may not be possible to determine whether transmission was already established in an urban area or if vectors were already present before migration occurred.

1. Infected persons entering nonendemic urban areas without vectors

When infected persons enter a nonendemic urban area, (a) they will require diagnosis and treatment in the urban health care facilities, (b) in the case of Chagas disease, urban blood banks should be aware of the risk of transmission through transfusions (the distribution of parasitic diseases in the urban areas will initially depend on their prevalence among the migrants), and (c) surveillance of vectors will be required, since the changing ecology of the periurban situation may eventually create suitable habitats.

Probably the most important consequence in this scenario is transmission of infected blood by transfusion in the main cities of Latin American endemic countries, involving migrants from endemic areas as well as individuals infected in periurban foci, thus reinforcing the "urbanization" of Chagas disease (2). The rates of infected blood used for transfusion in blood banks are alarming in cities in Argentina (6% in Buenos Aires, 20% in Santiago del Estero, and 12% in Mendoza), Brazil (15% in Brasilia and 25% in Goiania), and Bolivia (63% in Santa Cruz) (3).

Epidemiological surveillance in urban health services will require information on:

- distribution of the parasitic infection in the rural areas of origin of the migrants;
- the type of parasite causing the infection; and
- the overall prevalence in the population (4).

The urban health services will have to serve these migrants seeking medical care. Since the vectors are usually absent, transmission can only be initiated if they are introduced in the urban area.

2. Infected persons entering nonendemic urban areas with vectors

In this situation, the vector's existence is already known and surveillance of the migrants is needed to avoid initiating transmission. Schistosomiasis is generally considered a rural disease but, owing to migration, both urban and periurban areas of endemic countries in Africa and South America are now foci of transmission. African cities like Dar es Salaam (5), Harare (6), and Kinshasa (7), as well as industrialized cities like São Paulo (8) and Belo Horizonte (9) in Brazil, are endemic.

In general, the snail intermediate hosts of schistosomiasis are more widely distributed than the area of actual transmission. The arrival of infected migrants from the rural areas therefore changes the transmission patterns. The ecological niches of the freshwater pulmonate snails are diverse. These aquatic snails are particularly adapted to stagnant water bodies with a high level of organic pollution, i.e., like those frequently observed in the periurban areas with poor run-off, poor drainage, and poor sanitation (10).

Vectorial transmission of Chagas disease has been documented in the periurban shanty towns in many cities in Latin America. In metropolitan Santiago, Chile, 23% of the periurban substandard houses and 60% of the slums ("ranchos") were infested with *Triatoma infestans* and 15% of the captured insects were infected by *Trypanosoma cruzi*, the causative agent of Chagas disease. In addition, it was demonstrated in the present study that the poorer the construction material of the walls, the higher the infestation of the houses and ranchos: 40% for walls made of mud and wattle but only 9% for walls made of cement (11). In Tegucigalpa, Honduras, 45% of *T. infestans* and 35% of *Rhodnius prolixus* were found infected with *T. cruzi* (12). In ten Bolivian cities including Cochabamba and Sucre (altitude, 800–2500 m above sea level), 42% of triatomid bugs examined were positive for *T. cruzi* (13).

3. Infected persons entering endemic urban areas

After transmission has been established, infected migrants contribute directly to spread, aggravation and even an increase in transmission. It is possible that new species of parasites may be introduced into urban areas where suitable vectors, which are transmitting other species, may be present. The question of the existence of a previous endemic focus of a parasitic disease in the past may be suggested by the appearance of a new species of *Schistosoma*, a difference in strain or species of *Leishmania*, a new zymodeme of *T. cruzi*, or even a new *Filaria* species. Infected persons entering an endemic area may further extend its geographical limits, initiate new foci of transmission, or aggravate the transmission.

The spatial distribution of schistosomiasis is not uniform in either rural or urban areas. Kloetzel & Vergetti (14) have shown that prevalence and intensity of infection are highly focal in endemic urban areas. This focality is due to intense transmission and water contact patterns. It is usually not believed that the settlement into the city of people infected with anthroponotic cutaneous leishmaniasis, although being reservoirs, could create a new focus.

Two species of *Filaria* transmitted from man to

man by mosquitos cause lymphatic disease in man that produces serious deformities such as elephantiasis and hydrocele: these are *Wuchereria bancrofti*, which is transmitted in urban areas of Asia, East Africa and Latin America, and *Brugia malayi*, which is almost entirely rural. Urban filariasis and rural filariasis are a major problem in Bangladesh, Pakistan, India and Indonesia (15, 16).

4. Non-infected persons entering endemic urban areas

The presence of transmission in the periurban area can have severe clinical and epidemiological consequences. Individuals who have never been exposed to infection may develop more severe forms of acute schistosomiasis or acute Chagas disease than those living in endemic areas. Risk factors such as concomitant malnutrition or other infectious diseases appear to alter the natural history and prognosis of the infection (e.g., visceral leishmaniasis).

Urban foci of transmission of schistosomiasis are usually intensive sites of transmission owing to the frequency of water contact, high level of faecal contamination, and population density. Acute schistosomiasis among children in urban areas is now being reported from Cairo (Egypt) and Belo Horizonte (Brazil). Acute schistosomiasis is a severe infection which may require hospitalization (17); individuals from non-endemic areas are particularly prone to this form of the disease.

The epidemiological situation may be very complex. According to laboratory records in Yaoundé, Cameroon, transmission of three types of schistosomiasis due to *S. mansoni*, *S. haematobium* and *S. intercalatum* probably occur within its urban limits.^d Thus a previously uninfected person or a person infected with one of these parasites would be at risk to acquire one or both of the other two parasites, since there is no cross immunity. On the other hand an "urbanization" phenomenon of *S. mansoni* transmission has been observed in Surinam. The residents of the periurban area are owners or are employed in the surrounding irrigated rice fields. These periurban areas flood periodically and the houses are completely surrounded by water. As the population of the snail intermediate hosts increase and fecal contamination continues, peridomestic transmission in these periurban areas is intense.

Urban cutaneous leishmaniasis in the Old World is anthroponotic, which means that transmission occurs from man to man through the bite of the

peridomestic sandfly, *Phlebotomus sergenti*. When the disease is endemic and the sandfly population sufficient, most of the human population becomes infected and immune early in life. In the case of rapid rural/urban migration, the risk of transmission of urban cutaneous leishmaniasis is increased, and even reaches epidemic proportions, among the dense non-immune populations from rural areas. In Afghanistan, anthroponotic cutaneous leishmaniasis is endemic in most cities and towns. In recent years, about 4000 cases have been reported annually in Kabul and 5000 cases annually from the cities in provinces by passive case detection. In the cities, low-income groups concentrate in the periurban compounds, close to the leishmaniasis zoonotic cycle (18).

Urban filariasis was first described by Wucherer in 1866 among the people living in "stilt houses" over the fresh-water back bays of Salvador, Bahia, Brazil. This urban focus was still active one hundred years later, but with urban improvement this has disappeared. Further north the focus of filariasis in Recife has expanded and it is now estimated that up to 30 000 persons are infected.

5. Urbanization or domestication of natural zoonotic foci

In the tropics and subtropics, uncontrolled rapidly expanding urbanization may bring the urban population into contact with the previously established silvatic cycle in adjacent rural areas. The evolution of a zoonotic focus of transmission to include man may have significant clinical consequences of epidemic proportions. The parasite of the zoonotic cycle may have a different pathogenicity than that usually infecting man.

Schistosomiasis due to *S. haematobium* and *S. mansoni* does not have zoonotic cycles, but both *S. japonicum* and *S. mekongi* involve a wide range of domestic and wild mammals. In central China, particularly Hubei and Hunan provinces, all urban centres are surrounded by vast irrigation systems and canals where domestic animals are raised. Since 70% or higher prevalences of infection are not uncommon among these animals, the conditions for maintaining transmission to labourers in these areas are ideal. The prevalence of *S. mekongi* in Khong City on Khong Island (Laos) is very high; the houses here are built over the water, snail intermediate hosts are present, and the numbers of the main mammalian reservoir (the dog) are high.

In the New World, the rapid growth of some cities surrounded by primary forest (e.g., Manaus in Brazil) has led to large new suburbs built at the edge of the city in areas of cleared primary forest. The extremely close contact with the surrounding forest,

^d Mott, K.E. et al. A proposed national plan of action for schistosomiasis control in the United Republic of Cameroon. Unpublished document WHO/SCHISTO/86.88, 1986, p. 7.

where cutaneous leishmaniasis is enzootic, has led to an annual incidence of thousands of cases.* In many villages and cities of various countries, it was reported that the infection rate is higher among people living at the edge of the forest, close to the silvatic cycle (19). The transmission rate falls rapidly as the distance from the forest increases owing to the limited flight range of sandflies (20). The interface between the forest and the new houses is a high-risk area because of the proximity of highly infected reservoirs, including rodent pests, and the vector.

In Santarém city, Pará State (Brazil), poor quality house construction during rapid urbanization has been associated with the onset of a new zoonotic visceral leishmaniasis focus, probably due to the availability of new habitats for the vector *Lutzomyia longipalpis* combined with the presence of infected dogs.

In the Old World, in some countries, the unplanned urbanization has brought urban population into the cutaneous leishmaniasis zoonotic cycles, and led to epidemics. The population in Khartoum (Sudan) has increased dramatically during the last 10 years because of immigration from the drought areas. Most of the immigrants have settled in shanty towns on the fringes of the main city. Between 1985 and 1987, about 100 000 cases of cutaneous leishmaniasis were reported by the Ministry of Health (21).

In eastern and central Saudi Arabia (Hofuf, Riyadh and Al-Kharj), a sharp increase of cases has been reported and 4000 cases were observed in 1985 (22, 23). The rates of infection among non-immune immigrants have been particularly high, probably due to living in the periurban areas in proximity to the natural foci of the disease.

In Kuwait city, the recent increase in cutaneous leishmaniasis is believed to be related to similar circumstances since most of the patients live in the new periurban suburbs (24). In Jordan, between 1982 and 1987, 300 cases were reported from new residential areas near Amman which were previously uninhabited, suggesting that a zoonotic cycle had been previously established in these areas.†

6. Vectors entering nonendemic urban areas

It is not often appreciated that the rural persons arriving in urban areas bring both the parasites and

their appropriate vectors. Snails travel well in fishermen's nets and buckets and reach urban areas in ornamental plants (25). Poor or no sanitation promotes contamination of the environment. In the recent past, the snail has been blamed as being the cause of schistosomiasis; however, in the urban environment the role of man in creating conditions for initiation and maintenance of transmission are implicit. Since man is the only reservoir of this important human disease, in the urban setting he is solely responsible for maintenance of the life-cycle.

Over the past 25 years, *Triatoma infestans* has spread to small towns along the main migratory route in the central northeast of Brazil. In some of these towns, epidemics of acute Chagas disease have been described (26). Transmission in metropolitan areas such as Rio de Janeiro by direct invasion of the vectors or via sacks of rice from rural endemic areas has been documented (27).

The main vector of filariasis due to *W. bancrofti* is *Culex quinquefasciatus* which breeds in liquid-waste drainages and disposals in periurban settings. The rapid and chaotic urbanization in developing tropical countries results in a spread of the geographical distribution of this vector species (28). In Léogane (Haiti) the prevalence of *W. bancrofti* infection and the microfilarial densities were highest in the periurban areas, compared to the central parts of the city (29).

Consequences and control

Transfer of rural culture/ecology to the urban environment

As in the rural areas, women and children are at highest risk of infection in periurban areas where natural water bodies are the immediate sources of water for domestic and recreational purposes since protected sources are either not available or are unreliable. It is almost axiomatic that the level of protected water sources is inversely proportional to the stability of the residential population. Thus a high prevalence of schistosomiasis in a population of rural migrants into the periurban area creates a high risk of transmission owing to the tendency to use natural water bodies in the same ways as they were used in the rural areas.

Transfer of rural habits to the city is usual and to be respected. However, primitive housing and low sanitary standards in personal hygiene and sewage/refuse disposal increase the risk of disease transmission. Piles of organic refuse and rain water in discarded containers constitute potential breeding sites for mosquitos, rodents and sandflies.

* Barrett, T.V. et al. *Leishmaniasis in Manaus*. Paper presented at a Meeting on American Leishmaniasis, Cayenne, French Guyana, 10-11 December 1987 (unpublished document).

† Oumeish, O. & Saliba, E. *Epidemiology of cutaneous leishmaniasis in Jordan*. Paper presented at Second Pan-Arab Seminar on Leishmaniasis and other Zoonoses, Amman, 1987.

Impact on employment patterns in urban areas

Schistosomiasis is paradoxically related to the employment patterns in periurban areas. The small irrigated vegetable gardens, which provide food for city dwellers, offer ready employment to the rural migrant who may have been a farmer. If infected, these workers can introduce transmission; if not previously exposed or infected and the irrigated areas are endemic, they are at risk of acute schistosomiasis and associated complications (due to invasion of the central nervous system) and will require specific diagnosis and treatment.

The interaction between *Salmonella*, hepatitis B virus and the adult schistosome may contribute to significant public health problems among food handlers, a favourite employment of immigrants from rural areas. These organisms persist in the individual with schistosomiasis and cause greater morbidity than in persons who are not infected. Besides possible spread of salmonellosis and hepatitis by food handlers with schistosomiasis, the increased morbidity due to salmonellosis and hepatitis means that the cost of medical care of these individuals will be greater than that for the general population.

Seroprevalence of antibodies against *T. cruzi*, the causative agent of Chagas disease, in a recent study in Goiânia (Brazil) was found to vary from 8% to 15% in a representative sample of the urban, economically active population of the city. More stable jobs were associated with lower seroprevalence. Migrants from São Paulo and Minas Gerais presented higher prevalence and higher relative risks (2.2 and 1.9, respectively) compared with workers from the city of Goiânia (30).

The risk of sudden death due to Chagas cardiomyopathy among bus drivers in the interior of Brazil and among construction workers in the metropolitan areas of Rio de Janeiro and São Paulo has been well documented. Some employers demand pre-employment serological screening and reject all seropositive applicants.

Consequences on urban health services

It was observed in Recife in northeast Brazil that the majority of persons with schistosomiasis due to *S. mansoni* in major hospitals had been admitted to undergo some form of surgery related to advanced disease (4). While usually not the main reason for migration from rural endemic areas where medical services are limited, severe hepatosplenic schistosomiasis with ascites and haematemesia or squamous cell carcinoma of the bladder secondary to *S. haematobium* infection may influence families in their decision to move nearer to tertiary medical care

facilities. This increases both the unemployable proportion of the population and the demand on medical services. The average hospital stay of an individual with hepatosplenic schistosomiasis and gastrointestinal bleeding can be expected to be over 30 days. Owing to recurrence the individual may be readmitted several times a year.

Bladder cancer associated with urinary schistosomiasis may have an even more dramatic impact on health care delivery. In seven years (1977-83) at the National Cancer Institute in urban Cairo, 4163 cases of bladder cancer were observed and radical cystectomy with urinary diversion was performed on 1773 (31). Obviously all of these patients did not stay on in the urban area and no estimates are available as to the proportion that remained. On the other hand, in several other series the five-year-survival rate for this type of cancer has ranged from 27.3% to 38.9% (32). The cost of management of this end-stage form of schistosomiasis is enormous for the health care system.

The cost of medical management of chronic lymphatic filariasis is also very high because the surgical approaches that have been used require long periods of hospitalization. In Calcutta it was estimated that 30% of men and 5% of women have acute clinical symptoms attributable to filariasis (15). There are wide geographical differences in the frequency of acute and chronic manifestations as well as their localization in the body.

Chronic cardiomyopathy due to Chagas disease is a major cause of outpatient consultation in urban hospitals in Brazil, northern Argentina, and Bolivia. Medical management, whether based on antiarrhythmic drugs or cardiac pacemakers, is expensive and is a burden on these health care systems.

An urban epidemic of cutaneous leishmaniasis creates a very grave situation beyond the capacity of most health services. Confirmation of the diagnosis requires microscopic examination and treatment with antimonial injections must continue for several weeks. Each full course of treatment costs US\$ 120-240 for the drugs as well as syringes and needles for injection.

Specific control of urban parasitic diseases

Plans for parasitic disease control in urban areas should be included in long-term national strategies after identification of both general and specific control measures. Since intersectoral coordination is an integral part of the urban planning process there should be participation of parasitologists, epidemiologists and environmental health personnel. Achievement of control requires four fundamental interventions:

- adequate public services such as water supply, sanitation, and drainage;
- efficient health services including laboratories capable of diagnosis and drug supplies for correct treatment;
- surveillance and monitoring of data derived from inpatient and outpatient health services to determine the pattern and distribution of parasitic diseases; and
- appropriate and sustained vector control measures.

Although interventions directed against the vectors of parasitic diseases can be highly efficient and cost-effective in urban areas, the health sector alone cannot be responsible for vector control. For example, the maintenance of an adequate public service infrastructure will reduce the propagation of snail intermediate hosts and prevent initiation of transmission in all endemic countries where the potential of urban transmission of schistosomiasis is high.

While schistosomiasis and filariasis are chronic infections with subclinical signs, cutaneous or visceral leishmaniasis may occur as epidemics. In the cities of the Old World, control will be focused on antivectorial measures—mainly residual spraying of insecticides inside and outside the dwellings; this will reduce the populations of the vector, but to be effective it has to be carried out over a long period. In the cities of the New World that are surrounded by primary forest, an integrated approach has been suggested to reduce the contact between man and the silvatic vector: environmental management by clearance of the forest (for at least 400 m from human habitation), followed by insecticide spraying in the cleared zones (20).

Control of the urban vector of bancroftian filariasis can be attempted by control of the larval or adult mosquito populations. As the vector feeds and rests both indoors and outdoors, indoor residual insecticide spraying has very little impact on the population. Space sprays, using thermal fogs and ultra-low-volume (ULV) insecticide concentrates, will produce a rapid reduction in adult populations but the biotic potential of the species is such that the population will very quickly recover and return to its former densities. Continual or routine use of space sprays would be too expensive for most vector control programmes to maintain.

Vector control of *C. quinquefasciatus* has therefore centred on larval control. This species breeds primarily in polluted water and its population densities are especially high in areas where sanitation is poor and open sewage is common, e.g., in the cities of developing countries where human population increases have far exceeded the ability of the urban

sanitation services to provide adequate disposal of sewage. Larval control can be achieved either through environmental measures that eliminate the polluted water sources in which *C. quinquefasciatus* breeds or by the use of chemical or biological larvicides. Trials in various parts of the world have shown that it is possible to reach a very high level of vector control by well-organized larval control programmes based on one of several chemical or biological larvicides. This has been demonstrated in Burkina Faso, Cameroon, Myanmar (Burma), and the United Republic of Tanzania. However, in most urban areas with control programmes, vector densities are hardly affected by the level of routine controls carried out.

In large cities, environmental measures involve underground sewage disposal and treatment systems; the cost of installing these in urban centres where they do not already exist would be extremely high. In small towns and villages, environmental control through the use of individual sanitary disposal systems is feasible and also desirable as it will control other water-related diseases as well. In the past it is noteworthy that public drainage and sewage systems have played a significant role in elimination of filariasis from urban areas. Chernin, for example, has argued that the disappearance of lymphatic filariasis from Charleston in South Carolina (USA) by 1930 was due to reduction of polluted breeding sites of *C. quinquefasciatus* by public works initiated in the 1890s (33).

Laboratories capable of microscopic diagnosis of schistosomiasis and filariasis are essential to detect these chronic infections. Microscopists must be trained to identify these parasites through regular training courses and quality control must be maintained. Since parasitic infections are among the important health indicators within urban areas of developing countries, identification of any of the above scenarios presents a challenge for prevention and control.

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