Chapter

Leishmaniasis Epidemiology and Psychosocial Aspect

Ghulam Rahim Awab

Abstract

Leishmaniasis is a neglected tropical and the most important vector-borne disease caused by protozoan parasites of the genus *Leishmania*, transmitted by female sand-fly vector to the vertebrate host including human, highly correlated with poverty, malnutrition, climate and environmental factors such as crowded living conditions and poor sanitation that affect health, wellbeing, and livelihoods of millions of people around the world. Transmission is complex due to relationships between reservoir hosts, parasites, sand fly vectors, and socio-environmental risk factors. There are various clinical manifestations, ranging from spontaneously healing cutaneous lesions to potentially fatal visceral leishmaniasis caused by different *Leishmania* species. The psychological long-term manifestations leading to stigmatization, social exclusion, discrimination, and psychosocial impacts, advocating the importance of the One Health approach to combat these diseases effectively.

Keywords: leishmaniasis, neglected tropical diseases, vector-borne disease, epidemiology, sand fly, parasite

1. Introduction

Epidemiology of Leishmaniasis is the study of the characteristics of the parasite and sand-fly species, ecological characteristics of the transmission sites, current and past exposure of the human population to the parasite, human behavior, geographical distribution, and impacts on human populations [1]. Leishmaniasis is a multifactorial anthropo-zoonotic protozoal disease, responsible for various syndromes in humans, by way of anthroponotic and/or zoonotic transmission. The interactions among all of the agent, vector, climatic, environmental, and socioeconomic factors influence the risk of leishmaniasis [2]. Infection and transmission are initiated by inoculating of the causative agent (free promastigotes of *Leishmania*) by vector (female sand flies of the genus *Phlebotomus* and *Lutzomyia*) bite in vertebrate hosts [1]. The vertebrate hosts are attacked by female sand flies for blood meals necessary for eggs development cycle.

It is a global public health threat, a neglected grave tropical disease that portends possible poor prognosis and fatal consequences due to broad range of clinical manifestations observed worldwide with numerous endemic zones in various continents and cases are raising due to urbanization, deforestation [1, 3].

Leishmaniasis epidemiology has a major role in clarifying the etiology of particular *Leishmania* various species and variants as the cause of specific diseases, in improving our understanding of the overall characteristics of specific vectors, in determining factors affecting host susceptibility and immunity, in unraveling modes of transmission, in clarifying the interaction of parasite with environmental determinants of disease, in determining the safety, efficacy, and utility of preventive and curative weapons (personal protection, vaccines, drugs) especially in alerting and directing disease prevention and control actions [4]. Information on morbidity burden and biopsychosocial properties rates contributes directly to the establishment of priorities for prevention and control programs, whether this involves insecticide, drug and vaccine development and delivery, environmental and hygienic improvements, enhancement of socio-economic and nutritional status, personal or community behavior, agricultural and constructional processing enhancements, reservoir host and vector control, and international cooperation and communication.

2. Problem statement

Leishmaniasis is among the top three vector-borne diseases of parasite origin along with malaria and filariasis that impacts significantly on the health, wellbeing, and livelihoods of affected communities. It is also the third most common infectious disease in terms of morbidity, after tuberculosis and malaria with great diversity of parasite species, reservoirs, and vectors that play role in transmission [5]. The disease is considered as an endemic tropical and subtropical zoonotic health threat with outbreak and mortality potential occurs primarily in countries with (sub) tropical climates, disproportionally affecting individuals living with poverty, poor sanitation, malnutrition, restricted healthcare access, displacement, poor housing, weak immunity, and lack of financial resources. Existence in non-endemic areas linked to globalization, urbanization and environmental changes, migration, tourism and other international types of population movements [1]. Different species might cause different clinical features, and the severity differs from spontaneously healing lesions to life-threatening visceral disease that might be ended with more than 90% deaths if not promptly treated particularly in people living with HIV/AIDS [6]. The cutaneous leishmaniasis (CL) is the predominant clinical manifestation with skin lesions or ulcers, on the face, head, arms and legs and other exposed to sand-fly biting parts of the body [7, 8], leaving life-long scars and serious disability, disfiguration and stigma "horrific social discrimination" and cause significant maternal morbidity, and even fetal mortality during pregnancy [3, 9]. Although the disease is not lethal, the disfigurement and social stigmatization may cause or precipitate psychological disorders, restriction of social participation, reduction of health-related quality of life of affected individuals. Thus CL not only affects the physical well-being of the individual but also significantly alters their psychological, social, and economic well-being [10]. The overall leishmaniasis outcomes are determined by the inter-relationship between the individualities of the parasite, the bio-environmental aspects of the vector, and the immune response of host [1].

3. Problem magnitude

Globally, leishmaniasis is among the top ten neglected tropical health burden, endemically existing in people of every continent except Australia and Antarctica.

Currently, 98 countries are endemic for leishmaniasis in the tropics, subtropics, and Southern Europe. More than 350 million individuals are at risk, 12 to 15 million infected, and 1.5 to 2 million new cases occur annually with 20,000–30,000 deaths [11, 12]. The endemic regions include Mediterranean Basin, Africa, Central and South America and Asia. As per WHO 2012 report, predictably, 59 countries are endemic for visceral lieshmaniasis, although cases fall excessively on seven of these as 90% of these cases happened in INDIA, South Sudan, Brazil, Ethiopia, Kenya, Sudan, Somalia and among 95% of CL cases occurred in the Americas, Middle East and Central Asia, approximately 70% reported in Syria, Brazil, Algeria, Colombia, Afghanistan, Iran, Ethiopia, Sudan, and Costa Rica [13].

Presently, over 85% of new CL cases occurred in 10 countries, namely Afghanistan, Algeria, Brazil, Colombia, Iraq, Libya, Pakistan, Peru, the Syrian Arab Republic, and Tunisia. Likewise, 10 countries: Brazil, China, Ethiopia, Eritrea, India, Kenya, Somalia, South Sudan, Sudan, and Yemen were accountable for more than 90% of new VL cases reported to WHO [11].

4. Epidemiological determinants

It is known that different species of *Leishmania* can cause in many mammalian hosts various clinical manifestations, and the severity varies from spontaneously healing lesions to life-threatening visceral disease. The outcome is determined by the inter-relationship between the characteristics of the parasite, the biology and habitat of the vector, and the behavior and immune response of host (**Table 1**) [1].

4.1 Agent

Leishmaniasis human disease is caused by more than 20 pathogenic species of *Leishmania* parasites transmitted from host to host by a tiny insect. *Leishmania* parasites are categorized into either old world (The Eastern Hemisphere) or new world (The Western Hemisphere) species, most notably the old world species: *L. major, L. tropica, L. aethiopica*, and the new world species: *L. amazonesis, L. braziliensis, L. mexicana, L. panamensis, and L. guyanensis* [15]. Old world species can be found in Asia, the Middle East, the Mediterranean Basin, and Africa, whereas new world species are found in the Americas [16].

4.2 Vector

Approximately, in over all 600 known species of sand flies, 10% act as disease vectors. And only 30 are important from public health point. Particular species of *Leishmania* are transmitted by particular adult female sand fly of *phlebotomine* belonging to either *Phlebotomus* spp. (Old World) or *Lutzomyia* spp. (New World) to either incriminated or suspected reservoir hosts [17]. The sand flies generally are active at night and inoculate the parasite when they bite humans ("from dusk to dawn") [18] and are less active in the hottest day-time, but still bite if they are bothered. Sand flies do not make noise, they are small, and their bites might not be noticed the parasite are spread. Adult sand flies often inhabit rock cracks, hollows, and rodent holes, and rest in cool, dark, and humid corners of animal shelters or human dwellings and their ability to acquire, maintain, and

Agent	Vector	Reservoir/Host	Geographical location
Old World			
Labrus donovani	*P. Argentipes, P. orientalis, P. martini, P. alexandri*	Humans (anthroponosis)	North-East India, Bangladesh, Nepal, Sudan, Kenya, Horn of Africa, China
L. infantum	*P. perniciosus, P. perfiliewi, P. chinensis, etc.*	Dogs, cats, foxes, jackals	Mediterranean, Sudan, West Africa, Middle East, China, Central Asia
L. major	*P. papatasi, Polypauropus duboscqi*	Gerbils (e.g. Rhombomys, Meriones), Rodents, Human anthroponosis	Semideserts in North Africa and Middle East, North India, Pakistan, Central Asia, Sub-Saharan Savannah, Sudan
L. tropica	*Paralongicollum sergenti*,	Humans, dogs	Mediterranean Basin, Central Asia, North Africa, Middle East, Iran, Afghanistan
L. aethiopica	*P. longipes, P. pedifer*	Hyraxes (Procavia, Heterohyrax), Rodents	Highlands of Kenya, Ethiopia, Uganda
New World			
L. infantum	*Lu. longipalpis, Lu. evansi*	Dogs, foxes, opossums (Didelphis)	Most of Central and South America, especially Brazil
L. mexicana	*Lu. Olmeca*	Forest rodents (especially Ototylomys)	Central and Northern South America
L. amazonensis	*Lu. Flaviscutellata*	Forest rodents (especially Proechimys, Oryzomys)	Tropical forests of South America
L. brasiliensis	*Lu. wellcomei, Lu. whitmani, etc*	Rodents, opossums, dogs, and equines	Tropical forests & cultivated land throughout South & Central America
L. guyanensis	*Lu. Umbratilis*	Sloths (Choleopus), arboreal anteaters (Tamandua)	Northern South America
L. panamensis	*Lu. trapidoi, etc.*	Sloths (Choleopus)	Central America, Ecuador, Colombia
L. peruviana	*Lu. verrucarum, Lu. Peruensis*	Dogs, rodents, opossums	West Andes of Peru

Abbreviations P = Phlebotomus, Lu., Lutzomyia.

Table 1.
Disease types and transmission cycles of leishmaniasis worldwide [14].

transmit the parasites depends on maturity, density, biting habit parasite-vector-host interactions as well as on the ecological and epidemiological features of the infection [19]. Many sand fly species are opportunistic and feed on easy to access animals [20].

4.3 Reservoir hosts (host preference)

Humans, domestic animals, and wild animals are known to act as reservoir hosts such as up to 70 animal species, have been found as natural reservoir hosts of Leishmania parasites.

4.3.1 Human

Despite the human genetic susceptibility, hereditary factors, population ethnicity, genome-wide association, and immunological responses correlated to disease epidemiology [21, 22] the following demographic factors are of consideration.

Age: People of all ages are at risk for leishmaniasis if they live or travel to leishmaniasis endemic areas. Indigenous prevalence increases with age up to 15 years, after which the prevalence stabilizes or decreases, presumably reflecting the progressive buildup of immune protective status [23, 24]. Children under 10 years old displayed the highest proportion (>50%) of new infection [25] potentially due to lack of protective immunity or due to them collecting water or playing in gorges close to sand-fly habitat.

Gender: There is no real gender difference in leishmaniasis, but for decades, male patients have comprised the majority of reported cases, perhaps because of referral bias, more risk-taking behaviors by men or possibly, men are less likely to strictly adhere to recommended preventive measures and thus increase their risk of contracting the disease [26, 27]. The sex-related differences cannot be explained solely in terms of environmental exposure, socio-cultural determinant or healthcare access. Furthermore, transcriptomic evidence is revealing that biological sex is a variable impacting physiology, immune response, drug metabolism, and consequently, the progression of disease [28].

Poverty: Poverty increases the risk for leishmaniasis due to remote and rural inhabitance, low-income, malnutrition, poor waste management (such as open sewerage), poor housing and domestic sanitary conditions which increase sand-fly breeding and resting sites, as well as their access to humans. Sand flies are attracted to crowded housing as these provide a good source of blood-meals. Human behavior, such as sleeping outside or on the ground, may increase risk. Malnutrition and protein deficit, as well as a lack of iron, zinc, and vitamin A in the diet is also a risk factor for complications and for the disease progressing to kala-azar [29].

Population mobility: Migration, tourism, shipment to an area of endemic illness, and occupational exposure of non-immune people into areas with existing transmission cycles increase the risk of infection and epidemics leishmaniasis are often associated with massive migration, internal dislocation, and the population movement [30, 31].

4.3.2 Domestic animals

Dogs are the known reservoirs for the parasites of all types of leishmaniasis and natural host for *L. infantum, L. chagasi, L. tropica, and L. peruviana* as being infected by them, prevalently in Mediterranean, Asia, and Latin America [32]. Cats are considered secondary reservoirs of the infection in endemic areas as Leishmaniasis has been reported sporadically in several parts of the world [33, 34].

Cattle may possibly increase transmission burden by remaining as untreated reservoir for the parasite, their closeness to human owners, and because of increased availability of blood meals for the sand fly [35].

4.3.3 Wild animals

The detection of Leishmania infection in rodents, suggests that wild animals are also contributing to maintaining the life cycle and transmission of Leishmaniasis. Several rodents, namely, Mus musculus (domestic mouse), Microtus socialis, Rattusrattus (black rat), Cercomys cunicularius (wild rat), Mesocricetus auratus (Syrian hamsters), and marsupial e.g. Didelphis albiventris (opossum) in America, Africa, and Asia lead to spread of leishmaniasis [36, 37]. Other potential reservoirs are squirrels, wild canids, reptiles, and bats [38–40].

4.4 Ecology/environment

Leishmaniasis is climate-sensitive such as the pathogens, vectors, and hosts involved in the transmission cycle are environmentally sensitive [41] and impacted by climate change and human modification of ecosystems, therefore, changes in ecological settings (range from rain forests to deserts), rainfall, atmospheric temperature, and humidity resulting in fluctuations in sand fly numbers [42] due to variation in the developmental time and metabolism of sand flies and Leishmania development cycle within vector [43]. Humidity and moisture from rainfall or in the soil dealing with survival, development, and activity of sand flies. The matter of hygiene, (which is generally neglected in rural areas), presence of waste or stables in the vicinity of houses, use of traditional building materials for house construction, are all environmental factors that favor the development of the vector and reservoirs, therefore impact the incidence and distribution of leishmaniasis in different regions of the world. Environmental changes such as conversion of natural forest to other land uses, habitat destruction, altered landscape composition, urbanization, human incursion into forested areas, tourism into natural areas, the creation of roadways, energy networks, new farmlands, water management, and poorly planned urban development play an important role in Leishmaniasis epidemiology [44].

5. Transmission of pathogens

Understanding the transmission cycles is very important in effective prevention of leishmaniasis. There is no direct transmission from person to person and the indirect (vector-born) transmission of Leishmania species that cause VL or CL can be zoonotic or anthroponotic [45] depends on the characteristics of the parasite and sand-fly species, characteristics of the transmission sites, current and past exposure of people to the parasite, and human behavior. The zoonotic transmission from canine to humans, is found in the Mediterranean region and many other drier regions of Latin America. Leishmania species reported from dogs and occasionally from cats include *L. mexicana, Labrus donovani*, and *L. braziliensis*. Cats are at risk of infection especially in areas where these parasites are endemic [19]. In many endemic areas, infected people are not necessarily maintaining the transmission cycle, but infected animals along with sand flies, maintain the cycle. Only for anthroponotic transmission,

infected people are needed to maintain the cycle (human-sand fly-human), parasite transmission being mostly nocturnal and typically seasonal [46].

The incubation period in human is quite variable, generally 1 to 4 months; range is 10 days to 3 years. Visceral leishmaniasis is 3–8 months (range 10 days to 34 months) and of the Cutaneous leishmaniasis is 2 weeks to several months (rarely up to 3 years).

6. Psycho-social impact

Leishmaniasis due to disfigurement and social stigmatization causes or predisposes severe psychological disorders and negatively affects the quality of life varied from minor domestic restrictions to severe physical and emotional isolation that results in poor mental health [47]. The adolescents with lesions are often faced with difficulty in social relations such as finding job, friends, spouse or deemed unsuitable for marriage or social communal life. While the children disfigured by lesions or scars, due to painful treatment, because of exclusion from play with other children are also psychologically affected and emotionally damaged [48].

The social exclusion, discrimination, and psychosocial impacts negatively affect socioeconomic opportunities which showed that depression and anxiety symptoms were higher in patients. Body satisfaction was also impaired in the groups with active CL and healed scars. Culturally, older people were more accustomed to the CL scar, but younger generations had less acceptance of any lifelong stigma and disfigurement on the face [49].

Understanding the psychosocial consequences, economic cost, health importance and the interaction of pathogenic protozoan, sand flies vectors, environmental impact is encouraging prevention, control, and surveillance of Leishmaniasis under a holistic view and integrated approach of human and veterinary medicine, environmental science, and wildlife conservation under the "One Health" approach.

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