Environmental Factors Associated with the Distribution of Kala-azar in Nepal

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Abstract

Introduction Kala-azar is transmitted by the sandfly through a parasite-contaminated bite. Kala-azar has already established its grip in India and is also rapidly spreading in Nepal. Twelve districts in the eastern terai region of Nepal, viz. Jhapa, Morang, Saptari, Sunsari, Udaypur, Dhanusa, Mahottari, Sarlahi, Siraha, Bara, Parsa and Rautahat, have been identified as kala-azar endemic areas, whereas some cases have also been sporadically reported from Western terai region. However, little is known about the distribution of the disease in different geographical areas. During the present study, different environmental factors associated with the distribution of kala-azar were studied in southern part of Nepal.

Objectives Present study aims to identify the environment-related factors associated with the distribution of kala azar.

Methods Longitudinal studies in 21 VDCs of Siraha and cross-sectional study in 2 VDCs of Kanchanpur districts was carried out.

Results The present study showed strong correlation between the disease and the size of the settlement. There was more prevalence of kala-azar in clustered settlements. High to medium humidity was observed in most of the households of endemic, epidemic and epidemic potential areas where as medium to low in non-endemic areas. Medium to high congestion was observed in most households of the epidemic, endemic and epidemic potential areas where as low in that of non-endemic areas. The aspect of most of the households in all the strata was found facing towards the east followed by west, north and south direction. The source of drinking water in most of the households was tube well. The majority of the households were found to have nearby well. Animal sheds were found nearby the human dwelling in most of the households.

Conclusion The size of settlement and housing condition including humidity and congestion were found affecting significantly in the distribution and transmission of kala-azar.

Key Words Kala-azar, environment, ecology, Nepal

Introduction

Improving health requires understanding how environmental conditions foster disease. While causal connections are clear for some diseases and conditions for others, scientific evidence can only identify associations and likely contributors. Most infectious diseases are environmental in origin because most of them are intimately connected with the conditions in the physical environment. It is the fact that environmental conditions increase the biological organisms' ability to thrive or spread. Although some supporting conditions exists in the natural environment while many are created or enhanced by human activities.

Over the years Nepal has been known as one of the disease endemic countries, especially in vector borne diseases like visceral leishmaniasis (Kala-azar), malaria and Japanese encephalitis. These diseases are re/emerging rapidly and becoming great public health challenges. Being a root cause of disease transmission, environmental determinants are inevitable factors for successful intervention. To overcome this challenge, in addition to other, environmental factors associated with the distribution of vector and disease is the important part.

Kala-azar is transmitted by the sandfly through a parasite-contaminated bite. This disease is major problem in Africa, Latin America, Middle East

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and South Asia. WHO[8] estimated that some 350 million people are at risk of contracting the disease. Kala-azar has already established its grip in India and is also rapidly spreading in Nepal. In spite of the ongoing control program, the incidence of the disease has inclined in the recent past[1]. Reports suggest that VL, which may have killed thousands in the 1950 and through 1960s in the Terai, is now making come back[2]. Twelve districts in the eastern terai region of Nepal, viz. Jhapa, Morang, Saptari, Sunsari, Udaypur, Dhanusa, Mahottari, Sarlahi, Siraha, Bara, Parsa and Rautahat, have been identified as kala-azar endemic areas, whereas some cases have also been sporadically reported from Western terai region. However, little is known about the distribution of the disease in different geographical areas.

It is, therefore, important to understand the current status of the disease and their relations with several environmental variables. The present study aims to identify the factors associated with the distribution of disease and vector to some extent.

Materials and Method

Study Area: Present study was undertaken in Siraha and Kanchanpur districts of southern Nepal. Siraha is one of the kala-azar endemic districts of the country. Kanchanpur district, although, non- endemic for the disease possesses similar environmental and ecological characteristics like other disease endemic districts, was selected for the study. Altogether 23 VDCs, comprising 21 from Siraha and 2 from Kanchanpur district were randomly selected.

Methodology

In the present study the entire study VDCs were divided in to four different strata on the basis of the status of the disease. Four VDCs are epidemic (Incidence of the disease: >20/10,000 population at risk), five endemic (Incidence of the disease: 6-20/10,000 population at risk), eleven epidemic potential (Incidence of the disease: 0-5/10,000 population at risk) and three non-endemic VDCs (No disease)[9]. The non-endemic VDCs comprises two from Kanchanpur and one from Siraha district. Longitudinal study was carried in Siraha and cross-sectional in Kanchanpur district.

In order to assess the immunological status of the community, rK39 dipstick[3] test was used. This test is sensitive and reliable indicator of leishmaniasis and is suitable for use in field conditions because it requires only a drop of blood, needs no laboratory technology, and is simple to conduct and read. Anyone found positive with rK39 dipstick test was referred to district hospital for treatment. Majorities of cases were further diagnosed using bone-marrow aspirations. These individuals were followed-up for 2 to 24 months during the study period and new findings were recorded accordingly.

Observation: Regular periodic visit was made in both districts and the environmental and ecological factors were observed in household, settlement and VDC level.

Questionnaire: Semi-structured questionnaires were administrated to the elderly/ knowledgeable member of each household in order to get maximum information. For the purpose in addition to the study team members some local health personnel were also employed.

Results

The environmental information were collected in household and settlement level. Factors like humidity, congestion and aspect were studied with in the household level where as size of the settlement, source of drinking water, distance of pond, well and animal shed from the house were also studied.

The present study showed strong correlation between the kala azar and the size of the settlement. Only 4.8%, 4.9%, 2.8 % of the single (isolated in geographic space) households were found in kala azar epidemic, endemic and epidemic potential VDCs respectively where as 52.5% in non-endemic VDCs. Similarly 3-5 house cluster occupied 38.4% in epidemic, 50.08% in endemic 45.7% in epidemic potential and only 20.2% in non-endemic VDCs. Further more 48.8% of the households from epidemic, 27.9 % from endemic, 40% from epidemic potential and 24% of the households from non-endemic VDCs were part of large settlement. Most of the households of epidemic, endemic and epidemic potential areas were of 3-5 house clusters. This showed more prevalence of disease in clustered households.

Housing conditions play an important role in the transmission of disease. Humidity is the moisture in and around the house. It is the most essential component for sandfly growth and development. This was identified by visual inspection of the dampness of the surface of the yard, verandah and inside the house. High humidity was observed in 10.4% households of epidemic, 14.7% endemic and 11.4% of the households of epidemic potential areas. Higher numbers of households were found to be of medium humidity and a few with low. High humidity conditions coupled with optimum temperature offered most congenial conditions for the perennial occurrence of *P. argentipes*.[5]

Table 1: Environmental assessment with kala azar endemicity status

Characteristics	Epidemic 4 VDCs 178 cases and 125 HH	Endemic 5VDCs 67 cases and 61 HH	Epidemic potential 39 cases and 35 HH, 11 VDC and 1 Mun.	Non-endemic 2 VDC, 99 HH
Size of the settlement				
Single	6(4.8)	3(4.9)	1(2.8)	52(52.5)
3-5 house cluster	48(38.4)	31(50.8)	16(45.7)	20(20.2)
Less than 15 houses	10(8)	10(16.4)	4(11.4)	3(3.0)
Part of large settlements	61(48.8)	17(27.9)	14(40.0)	24(24.2)
Housing condition				
Humidity				
High	13(10.4)	9(14.7)	4(11.4)	00
Medium	78(62.4)	42(68.8)	24(68.6)	80(80.8)
Low	34(27.2)	10(16.4)	7(20.0)	19(19.2)
Congestion				
High	19(15.2)	10(16.4)	6(17.1)	1(1.0)
Medium	71(56.8)	35(57.4)	25(71.4)	6(6.1)
Low	35(28)	16(26.2)	4(11.4)	92(92.9)
Aspect				
East	52(41.6)	33(54.1)	18(51.4)	80(80.8)
West	24(19.2)	17(27.9)	9(25.7)	3(3.0)
North	32(25.6)	8(13.1)	7(20)	3(3.0)
South	17(13.6)	3(4.9)	1(2.8)	13(13.1)
Nearby well				
Yes	68(54.4)	33(54.1)	17(48.5)	5(5)
No	57(45.6)	28(45.9)	18(51.4)	94(94.9)
Type of well				
Dug well	68(100.0)	33(100.0)	17(100.0)	5(100.0)
Hand pump	00	00	00	00
Others	00	00	00	00
Distance of well (feet)	Mean:77.7, SD: 58.9	Mean; 137.1 SD: 98.6	Mean: 68.0; SD: 9.35	Mean: 36.8; SD: 36.6
Distance of pond (feet)	Mean: 208.6, SD: 183.4	Mean; 186.6 SD: 129.4	Mean:186.8; SD: 128.1	Mean: 77.0: SD: 54.9
Source of drinking water				
Open well	25(20)	12(19.7)	4(11.4)	1(1.0)
Tube well	100(80)	49(80.3)	31(88.6)	97(98.0)
Pond	00	00	00	1(1.0)
Tap	00	00	00	00
Animal shed nearby				
Yes	94(75.2)	39(63.9)	27(77.1)	97(98.0)
No	31(24.8)	22(36.1)	8(22.8)	2(2.0)
Animal shed distance (feet)	Mean: 14.0, SD: 31.3	Mean; 7.6 SD: 8.1	Mean: 12.2 SD:4.9	Mean: 17.6: SD: 14.8

Medium and low humidity was observed in households of all strata. It is reported that phlebotomine larvae have become adapted to live in moist soil. The larvae can not exist without water and due to this reason the female sandfly lays eggs in moist places. *P. argentipes*, a vector of kala- azar in Indian sub continent, breeds in soil with moisture and organic debris. Immature stages are often found in loose soil in cracks, near the human dwellings or cattle sheds. The larvae were also reported to be found in the moist floors[5].

Congestion is the configuration of the houses that create some openness or narrow and disorderliness. It is, basically caused by the geometry and arrangement of the houses. High congestion was observed in 15.2 % of the households of epidemic area, 16.4% of endemic and 11.4 % of endemic potential areas. Medium to high congestion was observed in most households of the epidemic, endemic and epidemic potential areas where as low congestion in that of non-endemic areas.

Sandfly activity was found associated with the air movement. In the present study the positive cases were mostly reported from the low lands in comparison to the elevated areas. This might be due to the strong wind in elevated areas that help to lessen the human sandfly contact. During our observation in the study area, we found comparatively higher wind velocity in elevated areas. However the wind velocity was not quantified. Adults of most species seldom bite when there is air movement[4]. During most nights, when wind velocity was below 1.5 m/sec, there was no noticeable effect on sandflies attracted to human lures. Between 1.5 to 2.5 m/sec, they had a strong influence on the biting activity. During the night, when wind reached that speed, biting fell of sharply but did not stop completely. When the winds were stronger than 4.0 m/sec, flies ceased biting entirely[7].

The source of drinking water in most of the households was tube well. However, some of the households were using open well also. The majority of the households were found to have nearby well. Water used for different household chores was drained openly in a small pond made nearby the house. The distance of well and pond from the household did not show any significant relation in the prevalence of disease. However some other factors might be associated with it.

People rely their livelihood on agriculture; and animal husbandry remained an integral part of their life. During the present study animal sheds were found nearby the human dwelling in most of the households. Nevertheless the animal sheds of non-endemic areas were found comparatively neat and drier. The mean distance was 14 Ft. in epidemic, 7.6 in endemic, 12.2 in epidemic potential and 17.6 Ft. was found in non-endemic settlements. Furthermore many of the households from epidemic and endemic areas were found to have common dwellings for both human and cattle.

Discussion

The distribution of vector and disease in a place is highly affected by its physiography and ecology. The ecological and environmental factors may contribute in the transmission of the disease by enhancing the physiological activity of vector and parasite.

Size of the settlement can contribute in the transmission of disease. If the settlement size is larger and compact there might be lower circulation of wind and consequently support the frequency of human sand fly contact. The present study showed higher prevalence of kala azar in the clustered households.

On the other hand climate plays a dominant role in determining the distribution and abundance of insects and tick species—directly, through its effects on vector and parasite development, and indirectly through its effects on host plants and animals and land-use changes[6]. Changes in climate and environment might have an effect on the geographical range and seasonal activity of vector species and, potentially, disease transmission. Therefore besides these, factors like soil type and texture, sandfly-plant relationships associated with the transmission of vector and disease should also be taken into consideration in order to explore more about the distribution of vector and disease.

It was found that the environmental factors like humidity, congestion and size of the settlements have much contributed in the distribution of sandfly vector and kala azar. However, being similarity in altitude, physiography and housing condition in both the districts the prevalence of kala azar in Siraha district only needs to be a subject of further investigation.

It is recommended that the plastering of houses with lime, dung and mud, improving existing ventilation system, making separate dwellings for human and animals and implementation of awareness program to the community people could be helpful in the reduction of the disease burden to some extent. Further more active case detection and treatment should be done simultaneously in order to control disease transmission.

Acknowledgement

The authors are grateful to WHO/TDR for financial support and Department of Community Medicine, Institute of Medicine for providing laboratory facilities.

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