

# An outbreak of cutaneous leishmaniasis among a displaced population in North Sudan: Review of cases

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## ABSTRACT

**Background:** Human cutaneous leishmaniasis (CL) is an endemic disease in many parts of Sudan. **Objective:** To document an outbreak of CL among internally displaced people (IDP) in north Sudan. **Methods:** A household survey was conducted in the rural region of New Manasir, at El Damer Locality in north Sudan during the year 2013. All villagers were screened for recent and old skin lesions in addition to other urgent medical problems. Written consent was obtained from each participant before data collection. A pretested, interviewer-administered questionnaire was used to collect the socio-demographic and clinical characteristics of participants. The diagnosis of CL was based on clinical findings and/or identification of the amastigotes on skin smears. **Results:** Out of the 1,236 individuals enrolled in this survey, 688 were diagnosed as cases of CL, giving an infection rate of 55.7%. Children constituted 244 (35.5%) of infected cases. Majority of skin lesions were found in the Extremities 524 (76.2%). The average duration of skin lesions was 3.6 months ( $\pm 1.6$ ). **Conclusion:** This outbreak among IDPs affected a large proportion of inhabitants of the newly established villages in north Sudan. Preventive measures might have help control such outbreaks.

**Keywords:** Cutaneous leishmaniasis, displaced population, North Sudan, outbreak, prevalence

## Highlights

- Cutaneous Leishmaniasis (CL) is one of the neglected tropical diseases, distributed in wide geographical areas worldwide
- Sudan was hit by CL outbreaks many times with the presence of sporadic cases from time to time mainly in the Eastern part of the country
- This outbreak of CL has a major significance due to it, s
- occurrence in a displaced population who were settled in anew green area (New Manasir Villages)
- The low immunity of displaced population in addition to the presence of vector resulting in a hight prevalent of CL (55.7%)
- An aggressive appearance of some cases of CL reported during this outbreak.

## Introduction

Leishmaniasis is a protozoan parasitic disease transmitted by sand fly species. The disease has four main clinical

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forms: cutaneous leishmaniasis (CL), mucocutaneous leishmaniasis (ML), visceral leishmaniasis (VL), and the post-kala-azar dermal leishmaniasis (PKDL).<sup>[1-3]</sup> Cutaneous leishmaniasis is estimated to cause the ninth largest disease burden in terms of morbidity and mortality among infectious diseases and is largely neglected in tropical and sub-tropical countries.<sup>[4,5]</sup> Cutaneous leishmaniasis is considered as a major public health problem worldwide and associated with an increase in both morbidity and mortality.<sup>[6]</sup> The disease also causes serious economic loss and impedes socio-economic development in many countries, especially in Africa, Indian Subcontinent, Eastern and Southern Mediterranean Regions and countries of the Middle East.<sup>[6-8]</sup>

Several contributing factors play an important role in increasing CL disease, which includes inadequate vector and reservoir control, urbanization, ecological changes, natural disasters, population movement, poor sanitation, and human behavioral risk factors.<sup>[9-11]</sup> All of these factors can lead to favor epidemic, emergence, and spread of CL.

In Sudan, CL is caused by *L. major*, zymodeme LON-1. The vector is *Phlebotomus papatasi* and the animal reservoir host is probably the Nile rat *Arvicantis niloticus*.<sup>[12]</sup> Leishmaniasis is an endemic disease spread over wide geographical areas in the country.<sup>[13]</sup> CL occurs in a fluctuating pattern in the country mainly in the west, central, and northern parts of Sudan.<sup>[14]</sup>

The first known outbreak of cutaneous leishmaniasis in Khartoum involved about 10,000 recorded cases.<sup>[12]</sup> The peak of the outbreak was in September 1986. The disease was widespread all over the province, mainly along the banks of the River Nile. People of both sexes, all age groups, different ethnic origins, and all socioeconomic classes were equally affected, suggesting that this epidemic was a new occurrence among a non-immune population.<sup>[12]</sup>

Possible contributory factors were mass population movement from known endemic areas of CL in Sudan, migration, displacement, high population densities of sand flies, and an increase in the rodent population.<sup>[12]</sup>

Cutaneous leishmaniasis outbreak usually occurred in the poorest regions and the poorest populations. It has adverse effects on the patients, skin ulcers causing serious disability, disfiguring, and permanent scarring after healing.<sup>[15]</sup>

This survey aimed to document the infection rate of CL, and to describe a new focus of CL in northern Sudan from epidemiological aspects of the CL disease including; age, gender, wound site, duration of lesions, seasonality of the disease. The findings of this survey, therefore, may update the available information about the disease in northern Sudan and may be considered a baseline for future control of CL especially in River Nile State (RNS).

## Methods

### Settings

This survey was conducted in Village Two in New Manasir area located in El Damer Locality, River Nile State, Sudan in a period from 8<sup>th</sup> May through to 23<sup>rd</sup> May 2013.

As a result of the construction of the Merowe hydroelectric dam in north Sudan, over 60,000 people were displaced from their origin homes in Old Manasir during the years 2006 through 2009.<sup>[16]</sup> Manasir tribe were the most affected population because their lands and houses were demolished due to Make Lake of the constructed dam. The Government of Sudan gave compensation and new resettlement places for the affected people. Alternative settlement places in RNS were arranged for them viz. Albuhaire and Alfigda in Abu Hamed locality and the New Manasir in El Damer Locality. A large proportion of the displaced people settled in the New Manasir area that included six villages in RNS. In these villages, big agricultural schemes were established and every household was given the land of (5 acres) to make their living. Infrastructure services were provided e.g., a well-equipped primary health care centers, local markets and community centers for each village. Each village is composed of 24 residence squares, every square contains 40 houses. Though the farm was adjacent to houses in these villages, most of the villagers have their animals including cattle, donkeys, and dogs living within houses or a temporary shelter immediately outside their homes, making frequent and close exposure to animals. The villages are located on a surface land, the water is held permanently throughout the year from River Nile through a big channel. The local climate is desert-like, cold in winter, dry, and hot in the summer.

### Study design and data collection

This survey was carried out in the most inhabited village (village 2) in New Manasir. Trained medical students from Faculty of Medicine, Nile Valley University collected the data from the household. Two physicians, in addition to a dermatologist and a microbiologist, were among the survey team. A pretested questionnaire was used that included 20 questions divided into 3 sections; section one composed of demographic and epidemiological data, section two were the duration, site, size, shape and other characteristics of skin lesion and section three inquired about the perception of patients about the methods of prevention.

The diagnosis of CL was made by clinical observations and identification of Leishman Donovan (LD) bodies on skin smears.

### Examination of skin smears

Microscopic examination: Lesions were cleaned with ethanol and punctured at the margins of the lesion with a sterile lancet. Smears were made from the exudating material, air dried and fixed in methanol. Then they were stained with Giemsa's stain for examination by light microscopy.<sup>[17]</sup>

## Statistical analysis

The data generated were coded, entered, validated and analyzed using SPSS, version 21, for Windows (SPSS Inc., Chicago, IL). Chi-squared test was used to compare the association between proportions. A *P* value of  $\leq 0.05$  was considered statistically significant.

## Ethical considerations

Permission was obtained from the local community leaders before commencing the field work and consent was obtained from every participant/guardian before starting data collection. The following information was given during data collection to ensure they had the information needed to make an informed choice: the participation was optional; there would be no penalty for refusal to participate; a complete description of the aims of the study; potential benefits and risks, assurance of confidentiality of any information given and test results. Any other requested additional information was provided by data collectors. During the outbreak, the main concern of health authorities was to manage cases and prevent transmission. Patients who had active lesion were transferred to the nearest PHCC for further management. This survey was augmented by a campaign to raise the awareness of the community. A senior dermatologist was available during the time of survey to provide consultation and management. A drug of Leshimanol provided free of charge for those who had active lesions during the survey.

Ethical approval was obtained from the Ethical Committee of Nile Valley University and the State Ministry of Health.

## Results

### Characteristics of the study population

A total of 1,236 population were randomly selected from the household survey in Village Two, New Manasir – RNS, 2013 year. There were 709 (57.4%) males and 527 (42.68%) females in the study group. Most study participants 938 (75.9%) were newly settled in new Manasir area in a period from 2007 to 2008 and the rest in the succeeding years. One-third of the study population 365 (29.5%) were illiterate. More than half of the study population 668 (54.0%) lived in a family with 4-7 family members. Participants had a different occupation; housewives were 322 (26.1%), students 309 (25.0%), and farmers were 307 (24.8%), more details about the socio-demographic characteristics were displayed in Table 1.

### Prevalence of cutaneous leishmaniasis

The prevalence rate of CL among the population in New Manasir area was 55.7% (688/1236), Table 2. The distribution of the infected cases by clusters in the village were shown on the Maps 1 and 2. Children under 15 years old were the most affected age group 383 (55.6%), while 305 cases (44.3%) reported in adults [Table 2]. The male to female ratio was approximately 1:1.

**Table 1: Characteristics of the surveyed population, NewManasir- RNS, 2013 (n=1,236)**

Characteristic	Variable	n	Percentage
Sex	Male	709	57.4
	Female	527	42.6
Age group (years)	Less than 2	20	1.6
	2-5	135	10.9
	6-15	290	23.5
	16-30	203	16.4
	31-59	498	40.3
	above 60	90	7.3
Educational Level	Illiterate	365	29.5
	Primary school	509	41.2
	Secondary school	121	9.8
	College	110	8.9
	Below school age	131	10.6
Occupation	Housewife	322	26.1
	Student	309	25.0
	Farmer	307	24.8
	Employer	107	8.6
	Free worker	72	5.8
	Idle	31	2.5
Original Residence	Old Manasir	1007	81.5
	Outside River Nile State	213	17.2
	El damer Locality	16	1.3
Resettlement duration	Before 2007	16	1.3
	2007-2008	938	75.9
	2009-2010	201	16.3
	2011-2012	81	6.6
Family Members	1-3 Member	168	13.6
	4-7 Member	668	54.0
	>7 Member	400	32.4

### Prevalence of CL infection according to the sex and age

It was observed that the highest outbreak of disease with 244 (35.5%) had occurred in children mainly the age group of 6–15 years [Table 2]. A significant statistical correlation was found between the age group and gender of the infected people (*P*, 0.00), males, were more affected than females, 128 (52.5%) vs. 116 (47.5%) in the same age group (6–15 years). But in the adult age group ranging from 16 to 60 + years old, we noticed the prevalence of the disease was slightly higher among female than male [Figure 1].

### Clinical findings

Data obtained from questionnaires and physical examination of study population showed a prevalence of Papuloplaque 52.2%, Nodule and ulcer 45.2%, and scar 2.6%. Most patients 539 (78.3%) had no history of traveling to endemic areas.

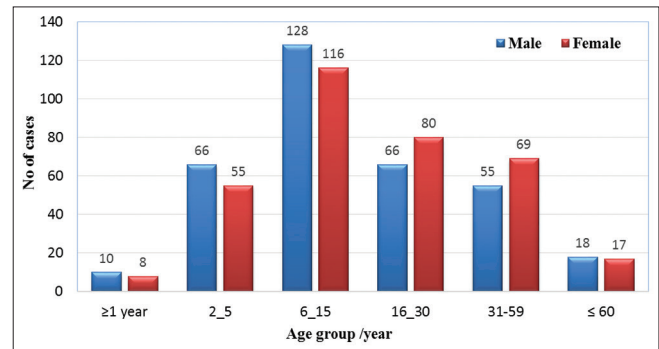
**Table 2: Clinical characteristics of Cutaneous Leishmaniasis patients, New Manasir- RNS, 2013 (n=688)**

Characteristic	Variable	n	Percentage
Infected Age group (year)	Less than 2	18	2.6
	2-5	121	17.6
	6-15	244	35.5
	16-30	146	21.2
	31-59	124	18.0
	<60	35	5.1
Infected sex	Male	347	50.9
	Female	338	49.1
Number of infected person per family	1 person/family	370	29.9
	2 persons/family	191	15.5
	<2 persons/family	127	10.3
Traveling history to an endemic area	No	539	78.3
	Yes	149	21.7
Type of lesions	Papuloplaque	359	52.2
	Nodule	286	41.6
	Ulcer	25	3.6
	Scar	18	2.6
Location of lesions	Extremities (Legs and Hands)	524	76.2
	Multiple sites	98	14.2
	Head and Neck	45	6.5
	Trunk	21	3.0
Symptoms and signs of disease	Multiple symptoms	347	50.4
	Itching	259	37.6
	Pain	29	4.3
	Discharge	19	2.8
	Scar	18	2.6
	Painless ulcer	16	2.3
Duration of lesions	>1 month	72	10.5
	1-6 months	457	66.4
	7-12 months	117	17
	<1 year	22	3.2
	I don't know	20	2.9
Healing of the lesion(s)	Cured	472	68.6
	Cured with a new secondary lesion(s)	102	14.8
	Self-healing	66	9.6
	Some cured others still not cured	48	5.4
Use of Local medication	No	279	40.6
	The mixture of stuff & Tar	217	31.5

Contd...

**Table 2: Contd...**

Characteristic	Variable	n	Percentage
Disease season	Herbs	144	20.9
	Cauterization	48	7
Mode of transmission	Winter	485	70.5
	Summer	200	29.1
	Autumn	3	0.4
Prevention methods	I don't know	369	53.6
	Sandfly	295	42.9
	Other types	17	2.5
	Contaminated Water	7	1.0
Prevention methods	I don't know	354	51.5
	Physical barriers	131	19.0
	Chemical barriers	194	28.2
	Others	9	1.3



**Figure 1: Distribution of the CL infected cases in relation to the age group and sex, New Manasir- RNS, 2013 (n = 688)**

Multiple symptoms were noticed in 50.4% of patients in addition to other symptoms like; Itching 37.6%, Pain 4.3%, and Discharge 2.8% [Table 2].

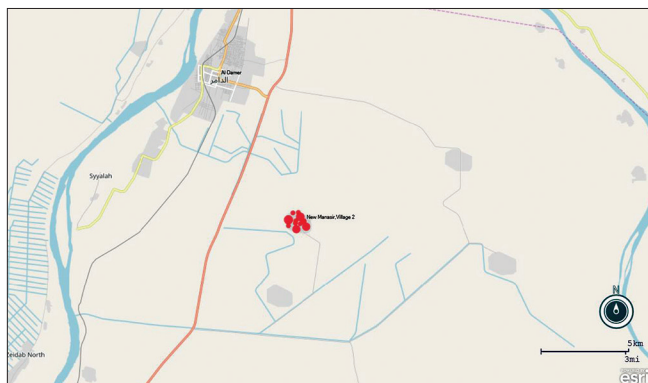
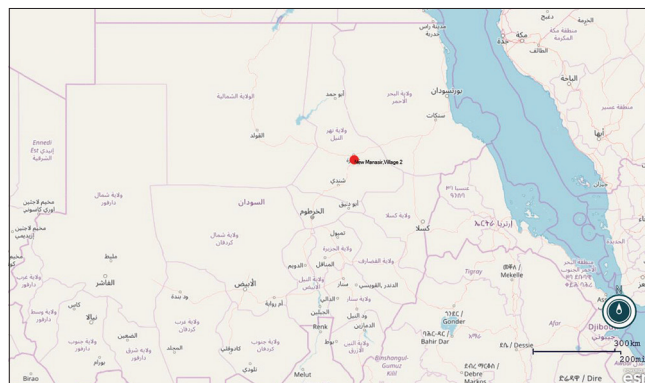
A positive reaction to the leishmanin skin test (LST) was observed in 12.2% (84 individuals, 21 females, and 63 males) of volunteers.

The distribution of lesions in the patients' body parts was varied as is shown in Table 2, the majority of the lesions 524 (76.2%) were found in the extremities (legs and hands). In relation to the distribution of lesions site and age groups, children group, shown the highest percentage in all sites of the lesions in comparison to the adult's group. However, site of lesions in extremities (hands and legs) remained high percent in both adults and children age groups. In children age groups, skin lesions in trunk represent the highest percent (95.2%), while in extremities the lowest percent (52.2%). This is opposite of the adult's age groups where the highest percent of the skin lesion in extremities (47.8%) and lowest in head and neck (25%) [Table 3].

Duration of skin lesions was ranged between 1 and 6 month in most of the cases (66.4%), an average was 3.6 (±1.6)

**Table 3: Distribution of the CL infected cases in relation to age group and site of the lesion(s), New Manasir- RNS, 2013 (n=688)**

Infected age group (year)	A site of lesion(s)								P
	Head & Neck		Extremities Legs & Hands		Trunk		Multiple sites		
	No	Percentage	No	Percentage	No	Percentage	No	Percentage	
Child (1-15)	33	75	274	52.2	20	95.2	40	67.8	0.000
Adult (16-60*)	11	25	251	47.8	1	4.8	19	32.2	
Total	44	100	525	100	21	100	59	100	

**Map 1:** Distribution of the CL infected cases, New Manasir Village 2- RNS, 2013 (n = 688). \*NB: The size of the circle roughly reflects the number of cases in each cluster**Map 2:** Edited Google map showing the location of infected cases of CL in, New Manasir Village 2- RNS, 2013 (n = 688)

months. Healing occurred in 78.2% of patients, while in a few cases (13.2%) the cured individuals experienced a new secondary lesion(s). More than half of the patients 409 (59.4%) were used different types of local medication; the mixture of stuff and Tar, Herbs and Cauterization, 31.5%, 20.9%, and 7%, respectively. [Table 2] A significant statistical correlation was found between the level of education and the use of local medication ( $P$ , 0.01).

The rate of CL infection in relation to certain social and environmental factors; the maximum cases 485 (70.5%) had been infected in the winter season. A significant statistical correlation was found between the patients' gender and occupation as risk ( $P$ , 0.00).

### Knowledge of the surveyed population

Only 295 (42.9%) out of 688 of the study population correctly recognized the vector to be sand fly, 369 (53.6%) did not know the mode of transmission, and 24 (3.5%) had misbeliefs about the mode of transmission [Table 2].

The perception of patients about the prevention of CL was varied, half of them 51.5% (354) did not know the prevention methods, and few of them knew the correct method for control of the diseases; those who knew the chemical barriers were 194 (28.2%) and physical barriers were 52 (7.5%). No statistical correlation had been approved between the educational level and patients' knowledge regarding the prevention methods of CL [Table 2].

## Discussion

Cutaneous leishmaniasis causes a public health problem in several countries. Its prevalence was under-estimated due to under-reporting, misdiagnosis, or non-diagnosis.<sup>[4,18]</sup>

In Sudan, it occurs sporadically throughout the years but for the last decade, it showed extension in its geographical distribution, due to some interlinking factors such as the state of immunity of infected humans and changes in the population of reservoir and vector due to changes in the environment. The climatic fluctuations affect the population of sand flies and reservoir hosts. The unusual weather may also cause a shift in the factors affecting transmission thus resulting in outbreaks of the disease. The migration and movement of people from endemic to non-endemic areas also increases the risk of infection because of ecological and environmental changes.<sup>[12,19,20]</sup>

This study of importance due to many reasons; first, it following the residence of the displaced population in new settlement (New Mansir area) which is previously uninhabited. Second, the study population had no history of CL in their old place (old Manasir).

The present survey revealed that the outbreak of CL occurred among the population who moved from dry areas to a new Manasir area where many agriculture schemes and irrigations are available. This environmental changes may encourage sand flies activity.

The prevalence rate of infection was determined by clinical examination in almost 90% of the resident population.

Considering that, the prevalence rate of 55.7% reported in this study seems to be high, and could reflect the occurrence of an almost severe outbreak of CL in the area. This finding was higher than the prevalence of CL in Morocco (42%), Pakistan (40%), and Yemen (18.8%).<sup>[19,21,22]</sup>

In the current study, it was observed that the highest outbreak of disease with 35.5% had occurred in children mainly in the age group of 6–15 years. This finding was similar to the study conducted in Iran where the highest outbreak of scars was observed in the age group of 10–14 years.<sup>[23]</sup> The highest infection is statistically significant ( $P, 0.00$ ) among males aged group of (6–15), but not in females of the same age group. This may be due to the increased activity of males aged than females during this age. However, the reasons for the highly significant and higher prevalence rate in younger age is probably due to the fact that they have poorly developed an immune system. They cannot prevent themselves from bites of sand flies and do not have enough knowledge of defending themselves. Similar results and discussion were observed in different studies.<sup>[24,25]</sup>

The results indicate that the outbreak of CL was different in gender among adults group. Women were more affected than men, this could be probably due to in rural areas women involve in agricultural activities as same as the men and are equally exposed to the infected bites. Also, due to the geographical site where water stream flows all year and the near distances between populations' houses the agriculture where sand flies can be found.<sup>[23,26-27]</sup>

In this outbreak, the majority of skin lesions were seen on the external extremities (hands and legs) of the body. The findings are compatible with the results of studies conducted in many endemic areas of disease.<sup>[28,29]</sup> However, in children less than 15 years old the common location of lesions was in the trunk of the body, this could be due to sleeping out of the covered area or house yards without using bed-nets during the summer. Furthermore, the extremities without any clothing can easily expose to the bites of sand flies.

This survey has identified that the outbreak of CL lesions in most of the cases has occurred in the winter. In fact, Sudan is located in the tropical area where the temperature is lowered only during the winter season and then it gives a chance for sand flies to breed. In contrast, in Western Iran most cases were infected during Autumn. This may suggest the peak of breeding of sand flies can extend from Autumn till Summer.<sup>[30]</sup> The main risk factor associated with the increase in the incidence of CL is the presence of sand flies. Therefore, the control of the vectors is a key factor in stopping and reducing the transmission of the disease, especially in the domestic and peridomestic context.<sup>[31]</sup>

In this survey, we found that the patients' knowledge about prevention methods was poor, few of them were aware of the correct method for control of CL (chemical or barrier methods). In fact use of the chemical method in the prevention of CL has a role to control the disease, but in Sudan, sand flies may have

developed resistance to insecticides. This can be attributed in part to intensive use of insecticides by malaria control programmes and in agricultural practice, especially in northern parts of the country.<sup>[32-34]</sup>

So for reduction of CL cases, the use of barrier methods (chemical and physical) is important to prevent bites, environmental management to prevent the proliferation of insects; avoiding stagnant water, elimination of waste dumps, improve housing conditions and raise the community awareness.<sup>[35]</sup>

### Limitations of the study

This study is not without limitations. Some of the cases had already healed lesions, therefore, a microbiological diagnosis was not possible. Another drawback was the lack of (antigenic and genomic) characterization of the *Leishmania* strains, in order to establish epidemiological links with other future outbreaks. Moreover, no field study in vector insects or potential reservoirs in order to identify the possible focus so as to facilitate the effectiveness of control measures.

### Conclusion

The findings of this study identified that via the movement of displaced population to New Manasir, many risk factors might have been created, that were associated with epidemics of CL. Such precipitating factors included environmental conditions, individual and behavioral changes and the arrival of the non-immune population to an endemic area. These factors could activate epidemics of old foci and induce new emerging foci.

We believe that essential measures should have been taken to contain the epidemics such as proper surveillance of diseases in the new settlement areas, the introduction of environmental measures to prevent the proliferation of sand flies, identification of the main reservoir, and personal protection systems.

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### Conflicts of interest

There are no conflicts of interest.

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