Ecoepidemiology of Cutaneous Leishmaniasis Outbreak, Israel

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A total of 161 cases of cutaneous leishmaniasis caused by *Leishmania tropica* occurred in the Jerusalem district during 2004–2005; 127 (79%) cases were in a town just outside Jerusalem. Environmental models suggest that in the context of global warming, this outbreak has the potential to extend into Jerusalem.

Leishmaniasis is a zoonotic infection in which parasites of the genus *Leishmania* are transmitted from rodents and small mammals to *Phlebotomus* species sandfly vectors. Humans may inadvertently enter the zoonotic cycle and contract cutaneous leishmaniasis (CL). This disease manifests as a chronic ulcer, potentially leaving unattractive scars.

CL incidence throughout the 1990s remained at a relatively stable 0.5–2.5 cases/100,000 (*1*). *Leishmania major* is found in low-lying arid and semiarid deserts and has been responsible for most cases in Israel (*2*). *L. tropica,* typically anthroponotic, is more common in suburbs and villages, although in hilly rural areas, mammals may act as reservoirs (*3*). The sandfly *Phlebotomus papatasi* is vectorially competent for *L. major* only (*4*), and *Ph. sergenti* is specific for *L. tropica* (*5*). Sandflies are usually found within 200 m of their source.

Since the 1990s, *L. tropica*, either alone or in conjunction with *L. major*, has been implicated in several outbreaks of CL in the western regions of the Jordan Valley (*6*). We report a large outbreak of CL caused by *L. tropica* in a town on the outskirts of Jerusalem.

The Study

Jerusalem is located atop the Judean Hills, on the edge of the Judean Desert. The desert drops off steeply to the east, falling 1,200 m over a course of 20 km to a nadir of –400 m on the shores of the Dead Sea, the lowest point on land on Earth. On the edge of this region is Ma'ale Adumim, 5 km east of Jerusalem (population ≈33,000). The town is built along narrow ridges that fall away to deep ravines inhabited by wildlife. Houses on the periphery are often just meters from desert crags and crevices; none is more than 500 m from the wilderness.

All cases of leishmaniasis in Israel are required to be reported to the district health office, and a weekly national report is published by the Department of Epidemiology, Israeli Ministry of Health (*7*). We confirmed suspected cases by using stained smears, culture, or serologic analysis. Cases were plotted on the Ministry of Health geographic information system (Environmental Systems Research Institute, Redlands, CA, USA), adapted specifically for the Informatics and Computation Division of the Ministry of Health (Systematics Technologies Ltd., Tel Aviv, Israel). National population data were derived from the Israeli Central Bureau of Statistics. Local population data were supplied by the town municipality, and neighborhood incidence rates were derived and averaged for 2004–2005. Patients were interviewed by using a standardized national CL questionnaire (online Technical Appendix, available from www.cdc.gov/EID/content/14/9/1424-Techapp.pdf). Simple rate ratios (RRs) were calculated where applicable.

A total of 161 cases of CL were reported in the Jerusalem district in 2004 (n = 71) and 2005 (n = 90) compared with 1 or 2 cases in each previous year. Of the cases reported in 2005, microscopic examination was positive for 74 (82%). Forty-eight (53%) had positive cultures; 20 (41.6%) of these were serologically positive for *L. tropica*, and none was positive for *L. major*.

Average annual incidence of CL in Israel (excluding the Jerusalem district) increased from 0.95/100,000 in 1999–2003 to 1.61/100,000 in 2004–2005 (RR 1.63). Over the same period, however, rates for the Jerusalem district increased from 0.13 to 9.7/100,000 (RR 74.7). Rates for the Jerusalem district were lower than those for the rest of Israel during 1999–2003 (RR 0.14) but substantially higher during 2004–2005 (RR 6.1). In 2006, rates for the Jerusalem district decreased, and national incidence continued to increase; 2007 showed a trend to an increased incidence in the Jerusalem district (Figure 1).

Of the case-patients in the Jerusalem district, 54 (76%) in 2004 and 73 (81%) in 2005 occurred in Ma'ale Adumim, where the incidence was 214/100,000 in 2004–2005, compared with an annual average of 2/100,000 in preceding years. However, cases were not distributed evenly. The epicenter of the outbreak was a small neighborhood of 1,040 residents (A in Figure 2) in which 52 cases occurred over the 2-year period (attack rate 50/1,000); this attack rate was greater than in any other neighborhood. The second most affected neighborhood had 24 cases among 2,251 residents (attack rate 10.7/1000 for the 2-year period). All but 6 case-patients lived within 200 m of the ravines that encompass the town, and 3 of these case-patients had occupational

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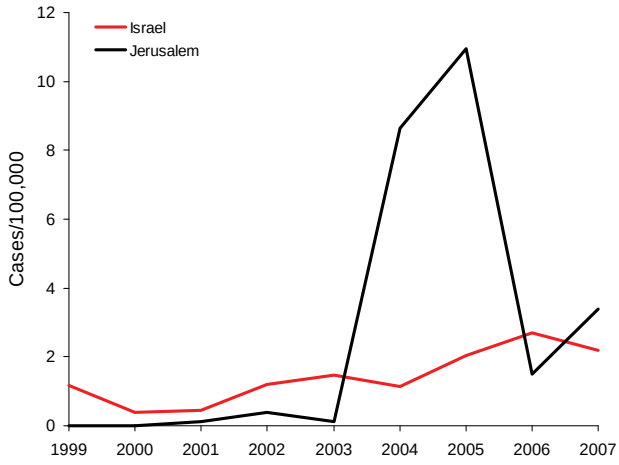

Figure 1. Incidence rates of cutaneous leishmaniasis for the Jerusalem district and Israel, 1999–2007. Rates for Israel do not include cases reported in the Jerusalem district.

exposure. In 2006 and 2007, 13 and 29 cases, respectively, were reported in the Jerusalem district; 5 (38%) and 9 (31%) of these case-patients, respectively, were infected in Ma'ale Adumim. The remaining cases were widely dispersed.

Age distribution of patients was not different from that of uninfected persons in the town (Table). More than one third of the patients (37.5%) reported a family member who was infected with CL in the same period. Most patients (62.2%) had >1 lesion, 70% reported having a private garden, 57.1% lived adjacent to public parks, 52.7% had a home that faced a wilderness area, 45.8% reported a construction site near their home, and 65.1% had intact insect screens on their windows. Eight patients (14%) (6 in neighborhood A and 2 in neighborhood B) reported seeing hyraxes near their homes (Figure 2).

Conclusions

We report a large outbreak of CL in Israel caused by *L. tropica* that was centered on a town just outside Jerusalem. This outbreak was observed in the context of increasing rates of CL in Israel. During the outbreak, highly visible environmental intervention and active surveillance were undertaken, which may have introduced detection bias, but it is unlikely that these alone could explain the dramatic increase in incidence.

The association between CL outbreaks and urban development has been noted repeatedly, and construction waste and soil humidity are considered intermediaries (*8*,*9*). A study in Colombia found that habitat degradation negatively affected phlebotomine populations but that medically important sandfly species were able to exploit modified environments (*10*). Ma'ale Adumim has undergone rapid development and expansion over the past decade, and sandflies are abundant in the area. A 2005 study collected 80,000 sandflies near the town, of which 85% were *Ph. sergenti* (*11*), the vector for *L. tropica*. Hyraxes were sighted most frequently in the worst CL-affected neighborhoods. Although environmental investigation is ongoing, we suspect that hyraxes infesting building sites were the source of this outbreak. This hypothesis is in accordance with current knowledge that associates *L. tropica* with urban outbreaks and hilly terrain. However, the pattern of this outbreak supports a zoonotic rather than anthroponotic source.

In 2006, Chaves and Pascual reported that climate was a valuable covariate in predicting incidence of CL (*12*). A 1996 computerized model examined the effect of warming of 1°C, 3°C, and 5°C on the likelihood of CL transmission at 115 southwest Asian sites. Sandflies are not known to reproduce in Jerusalem, but Cross and Hyams suggest that Jerusalem could support endemic transmission if the average temperature increased by 1°C (*13*). Since that model was proposed, the average temperature in Jerusalem has increased by ≈1°C (*14*). The spate of recent outbreaks sug-

Figure 2. Geographic distribution of cutaneous leishmaniasis cases in Ma'ale Adumim, Israel, 2004–2005. Each star represents 1 case. In dense areas, some marks may be missing because of technical limitations. Wilderness ravines (white areas) reach within meters of houses at the periphery of the neighborhood in all directions. A and B indicate neighborhoods with the highest incidence rates.

Table. Age distribution of cutaneous leishmaniasis case-patients in the Jerusalem district, Israel, 2004–2005

Age group, y	No. (%)
<1	4 (2.5)
1–4	12 (7.5)
5–14	40 (24.8)
15–44	46 (28.6)
45–64	29 (18.0)
≥65	19 (11.8)
Unknown	11 (6.8)
Total	161 (100)

gests that *L. tropica* is no longer an emerging pathogen but rather that it is an established pathogen in Israel. The proximity of the outbreak to Jerusalem, in light of the trend toward global warming (*15*), makes an outbreak of CL in Jerusalem a real and disturbing prospect.

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Cutaneous Leishmaniasis questionnaire

1. District Health Office _____
2. Date of notification to District Health Office ____/____/____
3. Name of reporting physician _____
4. Place of employment of reporting physician _____

Patient personal details

Surname _____ Given name(s)_____ I.D. _____

D.O.B. __/__/____ Sex [1] Male [2] Female

Nationality: [1] Jew [2] Non-Jew [3] Unknown Health insurance provider _____

Occupation (children – record daytime placement): _____

Current address: City/village/settlement _____

Street _____ House no.___

Clinical and laboratory information

Date of appearance of first signs of the disease: __/__/____

Date of definitive diagnosis: __/__/____

Site of lesion	Nature of lesion	No. lesions ___
Face [1] Yes [2] No	Ulcer [1] Yes [2] No	
Limbs [1] Yes [2] No	Nodule [1] Yes [2] No	
Other [1] Yes [2] No	Other [1] Yes [2] No	
If yes, specify _____	If yes, specify _____	

Was a laboratory diagnosis made? [1] Yes [2] No [3] Do not know

If so, what were the results of the following tests? Please record as follows:

[1] Positive result [2] Negative result [3] Not carried out

Test	Result	Date of test
1. Direct smear	[ ]	__/__/____
2. Histologic examination	[ ]	__/__/____
3. Culture	[ ]	__/__/____
4. Serology	[ ]	__/__/____
5. *Leishmania* skin test	[ ]	__/__/____
6. PCR	[ ]	__/__/____

Type of *Leishmania* (if identified):

1. *tropica*
2. *major*
3. *infantum*
4. Other _____

1. Epidemiologic data

Have you moved house in the 12 months preceding the diagnosis of the illness?

[1] Yes [2] No [3] Don't know

If you have:

Previous address _____

Date of move _____

Sites/areas of presumed infection* (specify precise address and period spent in that place)

Address Period spent at that place

_____

_____

_____

* e.g., Near home, on military reserve duty, holidays, sleeping out in the open, sitting on porch or in garden

Were you bitten by an insect other than a mosquito? [1] Yes [2] No [3] Don't know

If yes, describe the insect _____

If yes, please fill out the following table:

Place (precise location and description, e.g., garden, lawn, beach etc.)	Season when bitten	How do you know you were bitten?	Time of day when bitten	Were other people in the same place bitten at the same time?
	☐ Spring ☐ Summer ☐ Fall (Autumn) ☐ Unknown	☐ Pricking feeling ☐ Itch ☐ Mark on skin ☐ Other	☐ Evening ☐ Night ☐ Morning ☐ Unknown	☐ No ☐ Only a few ☐ Most of them ☐ Unknown
	☐ Spring ☐ Summer ☐ Fall (Autumn) ☐ Unknown	☐ Pricking feeling ☐ Itch ☐ Mark on skin ☐ Other	☐ Evening ☐ Night ☐ Morning ☐ Unknown	☐ No ☐ Only a few ☐ Most of them ☐ Unknown

	☐ Spring ☐ Summer ☐ Fall (Autumn) ☐ Unknown	☐ Pricking feeling ☐ Itch ☐ Mark on skin ☐ Other	☐ Evening ☐ Night ☐ Morning ☐ Unknown	☐ No ☐ Only a few ☐ Most of them ☐ Unknown

Do you use personal protective measures against mosquito, sandfly, or other insect bites?

Fans	Insect repellent on skin (in the home)	Insect repellent on skin (outside the home)	Vaporizing tablets or liquid	Repellent candles or coils	Spraying within the house	Spraying outside the house	Other
☐ Yes ☐ No ☐ Sometimes	☐ Yes ☐ No ☐ Sometimes	☐ Yes ☐ No ☐ Sometimes	☐ Yes ☐ No ☐ Sometimes	☐ Yes ☐ No ☐ Sometimes	☐ Yes ☐ No ☐ Sometimes	☐ Yes ☐ No ☐ Sometimes	☐ Yes ☐ No ☐ Sometimes

Are there screens on the windows and doors in your home? [1] Yes [2] Partial [3] No

If yes, are they intact and in good condition? [1] Yes [2] No

Does your home have a private garden? [1] Yes [2] No [3] Don't know

Is there a public park near your home? [1] Yes [2] No [3] Don't know

Do you tend to spend time outdoors: in the garden, near your home, in the neighborhood ? [1] Yes [2] No [3] Don't know

During what hours of the day? [1] Morning [2] Afternoon [3] Evening [4] After sunset or at night

Information on other family members, relatives, community members, hiking companions etc. who visited or were together with the infected person in the above places, and developed cutaneous leishmaniasis

Name	Sex	Age	Relationship	Address	Date disease onset

Do you consent to the information obtained from this interview being given to inspectors from the Environmental Protection Department?

Yes/No

If yes, please sign here _____

If the consent was by telephone, please state.

Name of interviewer _____

Position _____