Rodent control operations against zoonotic cutaneous leishmaniasis in rural Iran

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BACKGROUND: Zoonotic cutaneous leishmaniasis (ZCL) is a serious and increasing public health problem in many rural areas of Iran. Previous studies showed that rodent control operations are effective in destroying rodents and reducing the incidence of ZCL on a small scale and in special circumstances. The objective of this study was to determine suitable timing for rodent control operations in reducing the incidence of ZCL in an endemic area in Badrood, Iran.

METHODS: We conducted rodent control operations by baiting rodent holes using zinc phosphide once a month in May, June, July and September in 1997 within a 500-meter circle of houses in the intervention area. From 1999 to 2002, the numbers of active rodent holes were counted in May and October in the intervention and control areas. When the numbers of rodent holes increased to 30% or more of the number before the first baiting in May 1997, holes in the intervention area were baited again with zinc phosphide in the intervention area; no baiting was done in the control village. Case findings were done by house-to-house visits once every season during 2000 to 2002.

RESULTS: Changes in the number of rodent holes over time in the intervention and control villages were statistically significant ($P<0.000001$). There were also significant differences in the incidence of ZCL between the intervention and control villages ($P<0.005$) during 2000 to 2002. The incidence of ZCL was unchanged in the years 2000 and 2001, but increased in one village in 2002 after an increase in the number of rodent holes.

CONCLUSION: We suggest that rodent control operations using zinc phosphide be done within a 500-meter circle of houses once every two years before the beginning of the active season of sandflies, which begins in late April.

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Zoonotic cutaneous leishmaniasis (ZCL) is common in many rural areas of Iran, including 15 of the 30 provinces. About 80% of leishmaniasis cases reported in our country are of the ZCL form. One of the stable endemic foci of ZCL is located around the town of Badrood (Natanz district) at the foothills of the Karkas mountains in central Iran.[1] The incidence of the disease among 726 inhabitants in two villages was calculated at 142.4 per thousand in 1996. Three small mammals, *Meriones libycus* (58%), *Rhombomys opimus* (40%) and *Hemiechinus auritis* (2%) were present around the selected villages. *Meriones libycus* and *R. opimus* are the main reservoir hosts in the area.[2] *Phlebotomus papatasi* is the main proven vector of the disease and *Leishmania major* zymodeme MON-26 has been isolated from naturally infected *P. papatasi*, *M. libycus* and humans in this endemic focus.[1-3]

Unfortunately, despite significant progress in understanding leishmaniasis such as the biochemistry and molecular biology of the parasite, host immune response, the life cycle of the vectors and reservoirs, and the epidemiological relationships between vector, reservoir and host, effective control measures have been rarely applied, and even more rarely, monitored and evaluated. Leishmanization has been recommended in Iran only for military personnel in very high-risk areas.[4] Other methods of intervention such as autoclaved *Leishmania major* (ALM) vaccine with BCG have not protected against ZCL,[5] and the safety and efficacy of this vaccine with adjuvants is being evaluated at present.

A field trial was carried out for the control of ZCL around the town of Badrood between April 1997 and January 1999. The control strategies consisted of the destruction of the colonies of gerbilline rodents by digging in a radius of 500 meters from houses. Opened rodent holes were baited with zinc phosphide[6-7] in the intervention area. Our evaluation demonstrated that the control program reduced the incidence of ZCL 12-fold in the treated village compared with a control village at the end of the first year of operation, and to more than one-fifth of its original level after two years.[8] Since determination of the optimal time intervals for rodent control operations requires a longer period of evaluation, three more years were required for the present study. The objective was to determine a suitable alternation time for rodent control operations for the purpose of reducing the incidence of ZCL in the area.

Methods

This study was conducted from 1999 to 2002 in the two villages of Abbasabad and Matinabad in the rural district of Badrood in Isfahan province, central Iran. Abbasabad village, with a total of 300 residents, and the land around Immamzadeh were selected as the intervention area, while Matinabad village, which is 20 kilometers away with 400 residents, was selected as the control area. The initial conditions of the intervention and control areas were similar; the incidence of ZCL was 146.3 and 138.5 per 1000 persons in Abbasabad and Matinabad villages, respectively.[8] Badrood is situated at an altitude of 1056 meters among the foothills of the Karkas Mountains (altitude 3898 meters). The area has a desert climate, hot in summer and cold in winter. In 2002, the maximum and minimum mean monthly temperatures were 40.5°C and -1.2°C in August and December, respectively. The total annual rainfall was 193.1 millimeters. The minimum mean monthly relative humidity was 16% (October) and the maximum was 75% (December).

In early April 1997, we counted the number of rodent holes in a 500-meter circle from the houses.[8] Rodent control operations were carried out using a mixture of grain with 2.5% zinc phosphide (manufactured by Zhechem Company, 37 Qingchun Road – 310009, Zhejiang, The People's Republic of China) once a month in May, June, July and September in 1997 in a 500-meter circle from the houses in the intervention area. During 1999 to 2002, we counted the numbers of active rodent holes twice a year (first half of May and first half of October) in the intervention and control areas. When the number of rodent holes increased to 30% or more of the number before the treatment in May 1997 (Abbasabad, n=8139, Imamzadeh, n=5074 before treatment)[8] we baited the holes again with a mixture of grain with 2.5% zinc phosphide, 12 to 15 grams per hole to a depth of 10 centimeters in the intervention area. The date of baiting and the number of opened burrows were recorded. The village of Matinabad was used as control and there was no baiting of rodent holes, but holes were also counted in this village for comparison with the intervention area.

Case findings were done by house-to-house visits in Abbasabad and Matinabad once every season during 2000 to 2002. All inhabitants of the villages were examined and a questionnaire was completed. The questionnaire included identification information and questions regarding presence or absence of scars or active lesions of cutaneous leishmaniasis. In each case with cutaneous lesions, smears were prepared and examined later at the laboratory of the Leishmaniasis Unit, Department of Medical Entomology and Vector Control, Tehran University of Medical Sciences after staining with Giemsa. The results of microscopic examinations of active lesions were recorded and the incidence of the disease was calculated. Only new cases of ZCL, i.e., the number of patients with new lesions, were recorded on each visit. Yearly incidence of the disease was determined separately in both villages at the end of 2000, 2001 and 2002, and these were compared with each other. The calculation of annual incidence of disease included only persons with active lesions; persons with scars were excluded. The chi-square test for linear trend was used to compare the number of rodent holes in the intervention and control villages. The same test was used to compare the incidence of the disease between the two villages.

Results

In the village of Abbasabad, the number of holes reopened by rodents in May of each year from 1999 to 2002 was less than 30% of the number before the treatment in May 1997 (Table 1). The treated area around this village was 150 hectares. In October of 2002, the number of reopened holes increased to more than 30% of that in May 1997, so rodent control was carried out by placing 115 kilograms of poisoned bait in the holes. In May 1999, the number of reopened holes in the land around Imamzadeh, including 144 hectares, increased to more than 30% of that in May 1997, and 58 kilograms of poisoned bait were placed. During October of 1999 and 2002, the number of reopened holes in the land around Imamzadeh increased to more than 30% of the May 1997 number and rodent control was carried by placing 86 kilograms of poisoned bait in 1999 and 72 kilograms in 2002. Changes in the number of rodent holes in the intervention and control villages were statistically significant ($P<0.000001$). Significant differences were also observed between the changes in number of rodent holes in the land around Imamzadeh (intervention area) and the control village ($P<0.000001$).

The incidence of ZCL in the intervention village (Abbasabad) was considerably less than in the control village (Matinabad) during 1998 to 2002, and the differences were statistically significant ($P<0.005$) (Table 2). Treatment was provided for all individuals with a parasitologically determined diagnosis of leishmaniasis in the control village during the study period.

Discussion

This is the first study to attempt to determine the best time interval for rodent control operations using zinc phosphide against ZCL caused by *L. major* in an endemic focus in Iran. The incidence of the disease was unchanged in the years 2000 and 2001, but increased in 2002 in Abbasabad because of an increase in rodent holes by more than 30% of the number before rodent control operations in May 1997. No rodent control operations were carried out in the area during 1999 to 2002 so the population of gerbils, which supports the sandfly vector, increased.

Table 1. Comparison of the number of rodent holes in the intervention and control villages, Natanz county, Iran.

	1997	1998	1999	2000	2001	2002
Abbasabad						
May	9652	793	967	555	733	798
October	ND	ND	1421	1395	1454	3329*
Imamzadeh						
May	3541	871	3629*	741	378	705
October	ND	ND	2742*	496	719	2073*
Matinabad (control)						
May	18 992	18 940	5602	5697	1833	1836
October	ND	ND	8657	6074	2356	7255

*Number of rodent holes increased by 30% or more of the number of holes before treatment in May 1997 (ND, not determined).
$P<0.000001$ changes in number of rodent holes from year-to-year in intervention and control villages.

Table 2. Comparison of the incidence (per thousand persons) of zoonotic cutaneous leishmaniasis (active lesions) in the intervention and control villages, Badrood rural district, Natanz county, Isfahan, Iran.

	1998		1999		2000		2001		2002	
	n	per 1000	n	per 1000	n	per 1000	n	per 1000	n	per 1000
Abbasabad (Intervention area)	8	50.3	23	163.1	1	10.8	2	15.5	5	56.8
Matinabad (Control area)	36	191.5	58	297.4	24	208.7	20	109.3	32	410.3

$P<0.005$, intervention vs. control villages

In the control village (Matinabad) the incidence also increased in 2002 because of the increase in rodent holes. No rodent control operations had ever been done in this village.

We took a careful history of all leishmaniasis cases to determine their origin. All had contracted the disease within their villages of residence. The reports of hospitals, physicians and district health centers in Isfahan and other neighbouring provinces also showed few cases during 2000 to 2001.

Based on these results, we suggest that rodent control operations be conducted using a mixture of grain with 2.5% zinc phosphide[6,7,9,10] within a 500-meter circle of houses in active holes once every two years before the beginning of the active season of sandflies in late April. In other similar foci, such as in mesoendemic and hypoendemic areas of ZCL in Iran, rodent control operations should be done once a month for four months in May, June, July and September in the first year and once every two years before the beginning of the active season of sandflies in the coming years. This method is simple and safe and can be applied in the field to prevent outbreaks.

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