Original Article

Effect of integrated pest management on controlling zoonotic cutaneous leishmaniasis in Emamzadeh Agha Ali Abbas (AS) District, Isfahan province, 2006-2009

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Abstract

Background: Cutaneous leishmaniasis (CL) is still considered as a health problem in the world. Several methods of control in different regions, together with obtaining integrated information on its natural foci, are needed to decrease its prevalence. This study was designed to evaluate the effects of simultaneous interventions on CL control.

Materials and Methods: A standard questionnaire was used to identify patients among pilgrims to Emamzadeh Agha Ali Abbas (Isfahan Province, Iran). Subsequently, three methods of controlling the disease, including, spraying residential buildings with Baygon, baiting with zinc phosphide poisons, changing the vegetative cover of the region, improving the environment, and mounting a mesh on all doors and windows of buildings in residential areas were used. The control measures were then evaluated by comparing the number of pilgrims affected by CL after and before the interventions.

Results: While 23 pilgrims (1.4%) were affected with CL before the intervention (pretest), five (0.3%) persons were found to have CL after taking control measures. The Chi-square test did not indicate any significant difference in the relative frequency of CL ($P = 0.731$).

Conclusion: The only scientific method for preventing and controlling zoonotic CL (ZCL) is a combination of the control methods (improving the environment and fighting off the disease districts and vectors) together with changing the vegetative cover of the region. Any measure for controlling this disease must be taken and programmed in accordance with the relevant experts' views, in coordination with the participation of other organizations and the society.

Key Words: Integrated pest management, Iran, zoonotic cutaneous leishmaniasis

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INTRODUCTION

At present, cutaneous leishmaniasis is still considered as a hygiene problem in the world. For preventing

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its prevalence, several methods of control from different regions are needed, together with obtaining integrated information on its natural districts.[1] Desert-removing measures and changing the natural ecosystem have caused dispersion of the districts' rodent territories resulting in vector frequency and increase in the cases of human disease.[2] Several reports comprising of pilgrims suffering from cutaneous leishmaniasis[3] in Emamzadeh Agha Ali Abbas' (AS) Holy Shrine in Natanz County, 5 km from Badroud City, and in the season of activity of the sand fly, disease transmission has made it necessary for sanitary and preventive interventions to be imposed in this holy atmosphere. Since 1993, zoonotic cutaneous leishmaniasis has been prevalent in the village of Emamzadeh Agha Ali Abbas (AS), Natanz County. Results obtained from Nilforoushzadeh *et al*.'s researches in 1995, indicate that the integrated pest management (IPM) has decreased the disease's incidence to 1/17, after the intervention, and to 1/12 after the elapse of one year.[4] The presence of sexual-plantation in the north of Badroud part, from Abbas Abad village to Matin Abad village and around the Holy Shrines of Agha Ali Abbas (AS) have been resulted in the rodents' population increase in the region. What can be stated and what has somehow affected an increase in the population of mice and in particular the sand fly, are the wrong methods of disposal of human waste, unsanitary waste, and dung, and also the low level of awareness of the society with respect to preventive measures.

Therefore, with regard to lack of vaccines having a high influence and by paying attention to the ecological conditions of the district and its sensitivity, this study has been designed with the objective of inspecting the simultaneous effects of several controlling methods, such as spraying, against the disease's vectors, fighting off the district's rodents, improving the environment, and changing the ecosystem.

MATERIALS AND METHODS

The present study is an interventional one. The sample areas under study is: The locational limitation of Emamzadeh Agha Ali Abbas (AS) comprising of locations of the pilgrims (humans) and the geographical limitation around them, which consist of the vegetative cover of the region and the colonies of rodents in the district that cause disease. The human statistical area under study comprises of pilgrims of Emamzadeh during 2006-2007, and 2008-2009, who were examined and interviewed with respect to the demographic specifications and the existence of cutaneous leishmaniasis lesions. We conducted the pretest stage in two phases, because cutaneous leishmaniasis had an incubation period from 2-6 weeks up to 6 months. In the first phase a questionnaire was filled by the pilgrims to collect demographic data. In the second phase data was collected from the patients who were infected with *leishmania*.

Periods of the study: The year before the intervention (2005), year of intervention (2006, 2007), and the years for evaluating the interventions performed (2008, 2009), which totaled to four successive years.

The executive stages of the present project had been designed in the form of a research puzzle encompassing five parts, as follows:

The pretest stage of human infection

In the first year of study, a standard questionnaire was applied for gathering information on the statistical area of the pilgrims of Emamzadeh. Persons having appropriate conditions for being under study were selected through a simple random method by the medical research group, at one of the entrances to Emamzadeh. At the beginning of the study, the pilgrims were examined by physicians who were the project's coworkers, and after being made aware of the importance of the project and the area's conditions, their correspondence address and telephone numbers were obtained. This was followed up every three to four months until the end of one year. In the pretest stage of human infection the patients were followed up with an interview by phone and the questionnaire was filled in by the researcher. The patients who were infected with the leishmania parasite were referred to the laboratory in their city and a positive report from a direct smear taken in the laboratory was held as laboratory evidence.

In that study, the criterion for diagnosing leishmaniasis was the view of the dermatologist resident in the area of the patients' residential place, based on the clinical and laboratory evidence. The causes for being out of the study were lack of access to patients due to death, displacement or movement to the endemic areas of cutaneous leishmaniasis during one year. For solving this problem, the number of samples was initially calculated by 20% more.

The stage of environmental interventions

Controlling rodents

In 2007, controlling rodents was performed through applying zinc phosphate around the Holy Shrine and the measure was repeated every three months until the end of 2007. Zinc phosphide (Zn_3P_2) is an inorganic chemical compound. Rodenticide-grade zinc phosphide usually comes as a black powder containing 75% zinc phosphide and 25% antimony potassium tartrate, an

emetic to cause vomiting if the material is accidentally ingested by humans or domestic animals.[5] It may be formulated as a grain-based bait, as scrap bait or as a paste. Rodenticide baits usually contain 2.0 percent zinc phosphide.[5-7]

In this study, the number of the rodent holes within a radius of two-kilometers around the shrine was counted and bait was placed in the holes. For each hole, the prepared poisonous bait of zinc phosphide was utilized. Regarding the operations, the baiting was done every three months and thrice totally, in the seasons of spring, summer, and autumn. The baiting was not done in winter because rodents were not active then, as they were in hibernation. We conducted rodent control operations by baiting rodent holes using zinc phosphide once every month in May, June, July, and September, in 2007, within a 500-meter circle of the houses in the intervention area.[8,9]

Controlling vectors

Spraying was done with Baygon 0.2% in May, in the interior places of the Holy Shrine, before the start of the seasonal activity of sand flies, and repeated once in the second six months of 2007. A suspension of Baygone was applied using pumps. Propoxur [Trade name- Baygon®, 2 (1-methylethoxy) phenol methyl carbamate)] is a carbamate insecticide developed by Bayer AG, Germany, and registered by the US.[10,11]

Improving environment

In 2007, improving the environment around the shrine was performed, which included, (a) cleaning places contaminated with human and industrial residues; (b) changing the vegetative cover of a 500 meter-limitation around the shrine from locoweed (or sexual) into pine, and (c) grading the uncultivated lands located in the above-mentioned limitation. With respect to the activities in Iran, Haloxylon plants have been used for desertification. The long roots of the plant below the soil contain moisture and are suitable as reservoirs for rodents, which carry the disease. Studies in the field of animal science have shown that pine is toxic to rodents.[12]

Post-test stage of human infection

Again in 2008 and 2009, in cooperation with the physician coworkers of the project, we embarked on the screening of pilgrims to the Holy Shrine suffering with the disease and compared them with the periods prior to the operations. The instruments of gathering information included a standard questionnaire, which had items on cutaneous leishmaniasis applied by the Tehran University of Medical Sciences. This was completed by the physician coworkers of the project during the years of pre-intervention and post-intervention by applying the method of examination and interview, on the pilgrims of Emamzadeh Agha Ali Abbas (AS). We prepared the standard questionnaire for collecting data from patients. The sample size comprised of pilgrims of the Holy Shrine during the years 2006-2007 and 2008-2009, which through using the relevant formula with 20% increasing approximation, was equal to 2000 persons. In this study we followed up patients by telephone and when it was proved that the patients were infected with leishmania we referred them to the research center. The patients were visited by the doctor coworkers in the project.

We used the SPSS version 15 for data analysis. We analyzed the data with Chi-square test (x^2) and analysis of variance (ANOVA) test; the *P* value level was less than 0.05.

RESULTS

During 2005 (before the intervention), that is, the pretest stage, 2990 questionnaires were filled out by the pilgrims of Emamzadeh Agha Ali Abbas (AS), from July to September. Then, in the second phase of the pretest stage (before the intervention), from December 2006 to March 2007, all the 2990 pilgrims were telephonically questioned, among whom 23 persons were affected by cutaneous leishmaniasis. We conducted the pretest stage in two phases because cutaneous leishmaniasis has an incubation period. In the first phase we filled the questionnaire for collecting the demographic data from the patients. In phase two we collected data from patients who were infected with *leishmania*. The age range of the 2990 pilgrims of Emamzadeh was between 1 and 77 years. Two thousand one hundred and seven persons stayed in the rooms of the pilgrim-house –170 out of Emamzadeh, 706 were in the enclosure, and seven unknown [Table 1].

Of the 2990 pilgrims of Emamzadeh, in the first stage, before intervention (pretest), 1404 persons had a telephonic conversation and 1586 persons did not. One thousand five hundred and eighty-six pilgrims were endemic and residents of the endemic area of cutaneous leishmaniasis, in the Isfahan Province and other neighboring provinces. Data collected from patients in the post-test are observed in Table 2.

Of the 1404 persons in Stage two, 42 persons (1.4%) encountered cutaneous problems, and 1362 persons (45.6%) did not. These 42 persons were referred to the physician. Twenty-three persons suffered from cutaneous leishmaniasis in 2006. The frequency of human infection of the pilgrims suffering from

Table 1: Demographic data of 2990 pilgrims of Emamzadeh before the intervention

Demographic data of pilgrims to Emamzadeh	Number
Sex (%)	
Women	1338 (44.7)
Men	1652 (55.3)
Married status(%)	
Single	1234 (41.3)
Married	1756 (58.7)
Place of residence (%)	
Urban	2174 (72.7)
Villager	816 (27.3)
Education status (%)	
Illiterate	343 (11.5)
Under high school	1749 (58.3)
Diploma	641 (21.4)
Associate of Arts	107 (3.6)
B.A. or B.S. and higher	138 (4.6)
Illitrate	17 (6.6)
Duration of stay in Emamzadeh	
Stayed less than one day	708
Stayed one to three days	2016
More than three days	221
Unknown	45
Place of rest	
The first floor of the pilgrim-house	749
On the second floor	654
In a tent	327
Under a mosquito-net	199
In a car	60
In the open air	993
Did not rest	8
Travel status (%)	
Have previously traveled to the endemic area	1321 (44.2)
Have not traveled	1669 (55.8)

Table 2: Demographic data of the 23 patients of Emamzadeh after the intervention

Demographic data of pilgrims to Emamzadeh	Number
Sex	
Women	13
Men	10
Place of lesions	
On their hands	12
On their feet	10
On their face	5
On other places of the body	6
Education status	
Illiterate	4
Under high school	13
Diploma,	4
Associate of Arts	2
Duration of stay in Emamzadeh	
Stayed less than one day	7
Stayed one to three days	15
More than three days	1
Place of rest	
On the first floor of the pilgrim-house	8
On the second floor	2
In a tent	2
Under a mosquito-net	1
In the open air	10
Duration of the disease (weeks)	
1-2	1
3-4	6
5-6	3
7-8	13

cutaneous leishmaniasis in terms of age, in 2006, was specified to be between one and 52 years. Frequency of the places of stay of the pilgrims, affected by cutaneous leishmaniasis, in 2006, was specified as 13 persons in the rooms of the pilgrim-house, eight in the enclosures, and two out of it.

Of the 2318 pilgrims at the second stage after intervention (post-test), 2064 persons had a telephonic conversation, and 254 did not. Two hundred and fifty-four pilgrims were natives, being residents of the endemic districts of cutaneous leishmaniasis, in the Isfahan Province and the neighboring provinces.

In the statistical area of the pilgrims of Emamzadeh Agha Ali Abbas (AS) during the stages before intervention (pretest) and after it (Post-test), 23 (1.4%) and five (0.3%) persons were affected by cutaneous leishmaniasis, respectively. The Chi-square statistical test did not indicate any significant difference between the relative frequency of the two statistical areas of persons affected by critical zoonotic cutaneous leishmaniasis (PV = 0.7310).

DISCUSSION

Since 1993, zoonotic cutaneous leishmaniasis has been prevalent in the village of Emamzadeh Agha Ali Abbas (AS), Natanz County. In 1995, for the first time and through designing an executive plan, the operations of battering nests and baiting in the area were conducted, for fighting off mice from the districts, in an area of approximately 800-1,000 square meters. Also, spraying was done on a house-to-house basis in the Badroud County, to fight against the sand fly (the vector), resulting in reducing the disease's incidence in that year. Results obtained from Nilforoushzadeh *et al.*'s researches in 1995 indicated that the IPM had decreased the disease's incidence to 1/17 after the intervention and to 1/12 after the elapse of one year.[3] From 1997-1998 also, similar measures were taken. Furthermore, the project of planting pine plants by replacing the plants with sexual orientation was performed around the Holy Shrines of Agha Ali Abbas (AS) and Mohammad (AS) for the purpose of changing the flora of the area and consequently,

pushing back the mice population from human residences. Since 1998, up to now, some measures such as spraying, baiting, nest battering, sanitary waste and dung disposal, instructional activities, and changing the flora have been undertaken at the eastern and north-eastern side of Emamzadeh, in an area of six hectares, which enjoy expert views of experts from the Natanz's hygiene network and intercounties cooperation and cooperation of the Emamzadeh's Custodianship and Board of Trustees, purposing to fight off the vectors and the district's factors of the disease.

Regarding the present research, some measures such as controlling rodents, controlling vectors, and improving the environment were taken up in the area by Nilforoushzadeh *et al.*, during 2006-2009. Concerning the measures taken in the area, there was no significant difference observed, (PV = 0.731) between the relative frequency of persons affected by critical zoonotic cutaneous leishmaniasis in the statistical area during the two stages, that is, before and after intervention. According to the studies performed by Mohebali *et al.*, in 1997, with respect to controlling zoonotic cutaneous leishmaniasis in the Maraveh Tappeh area, Golestan Province, the methods of baiting against desert rodents, spraying for decreasing the vector (sand flies), instructing hygiene workers, public instruction, attracting people's participation, testing, and curing affected persons were applied. Results indicated that the rate of the disease incidence in 1976, that is, before applying the control methods, decreased from 7.13% to 0.71% in 1977.[13]

Regarding Jalilian *et al.*'s study and application of IPM for controlling cutaneous leishmaniasis in Dehloran County for the period 1999-2001, it was specified that IPM (instruction, rodent-killing, and spraying against vectors) had caused the entire cases of the disease, which had been 520 cases in 1999, to be reduced to 268 cases in 2000, and to 18 ones in 2001.[14]

According to the information published by the World Health Organization, similar projects performed in England, Karshin district, purposing to control cutaneous leishmaniasis, through application of rodent-killing; the disease's incidence in more than 900 square kilometers reduced from 1/6 to 1/10 times during one year.[4] The studies conducted by Kamhawi *et al.*, on the effects of improving the environment for controlling the ZCL disease in districts have indicated that destruction of the rodents' nests within a two-kilometer radius of the disease districts together with uprooting local Chenopods (vegetative cover) have resulted in a positivity rate of 33.3% in the Leishmanin skin tests (LST) in the area under operations and negative, 80.2%, in the control lot.[15]

Results obtained from Teoder *et al.,* study indicated that environmental changes that took place in the ZCL disease districts in Brazil had caused an 89.8% decrease in the frequency of vector sand flies in the relevant districts.[16]

Regarding all the measures taken in this project, such as, spraying the rooms of the pilgrim-house, pine planting around Emamzadeh, baiting and destruction of the rodents' nests, sanitary waste and dung disposal, mounting mesh on the doors and windows of the pilgrim-house and Holy Shrine, and training activities in the region, mentioned are simultaneously taken up every year by the hygiene network of the region, enjoying the patronage of the province's hygiene assistance, and Board of Trustees, Custodianship, and the Hygiene Unit of Emamzadeh, resulting in a decrease in the frequency of the disease. Comparison between the results of this study and the previous one performed in the area indicates that the only scientific method for preventing and controlling zoonotic cutaneous leishmaniasis is a combination of control methods (improving environment, fighting off the disease in districts and its vectors) together with changing the vegetative cover of the area. Any measure for controlling disease must be taken and programmed in accordance with the relevant experts' views, in coordination with other organizations, and with the society's participation. With regard to the effectiveness, practicality, and profitability of the fight operations, these operations are significant for selecting the fight method and for preventing and decreasing unwanted side effects. A combination of several methods of fighting must be used and all measures must be repeated in the area every year.

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