



Leishmaniasis Risk Factors in Central Morocco: Urbanization and Socio-Economic Factors

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ABSTRACT

Caused by the *Leishmania* parasite and transmitted by the bite of sand flies, leishmaniasis is a multi-factor disease which causes a big health problem. Anarchic, accelerated, and unplanned urbanization, as well as inadequate environmental hygiene and important human migratory flows constitute risk factors for Leishmaniasis. From this point of view and through the present study, the risk factors of leishmaniasis that represent the impact of the population, urbanization, and poverty on the distribution of the disease in the study area have been evaluated. The health data for this study were obtained from the registers of the prefectural of epidemiology unit. However, the socio-economic data were obtained from the High Commissioner's Office of Morocco. The statistical analysis was carried out using SPSS software. The evolution of the annual number of leishmaniasis cases reported during the study period shows that the provinces most affected by this epidemic are the provinces of Taza and Taounate with 25%, as well as Boulemane (18%) and Sefrou (16%). In addition, the study of the risk factors of this epidemic shows a positive correlation between leishmaniasis cases reported and urbanization ($R = 0, 51$) and a weak correlation between demographic weight and leishmaniasis cases reported ($R = 0, 27$). However, there is no relationship between the distribution of leishmaniasis and poverty. These results show the impact of socioeconomic factors on the distribution of leishmaniasis in the Fez-Meknes region. Indeed, actors should take these results into consideration when determining risk areas in order to develop a leishmaniasis alert system.

Keywords: Leishmaniasis, Risk factors, Urbanization, Socioeconomic factors, Morocco.

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Introduction

Leishmaniasis is a vector-borne disease common to humans and animals, whose pathogen is a zooflagellate belonging to the genus *Leishmania*^{1,2}. These parasites are transmitted by the infecting bite of nematode insects, namely the phlebotomines. They are chronic diseases, which are difficult to treat, and which evolve over several months in endemic areas³. It is a public health problem in 88 countries in the world, 72 of which are developing countries.⁴ Leishmaniasis in its various forms is endemic in many regions,⁵ each with its own vectors and reservoir⁶.

Morocco is characterized by the existence of different ecological conditions that can influence the distribution of sandflies and

subsequently the distribution of the disease⁷. The report produced in 2010 by the Directorate of Epidemiology and Disease Control (DELM) of Morocco mentioned 8707 cases of cutaneous leishmaniasis [CL] caused by *L. major* and *L. tropica* or possibly *L. infantum*.

In 2016, Morocco was classified by WHO as a high burden country for cutaneous and visceral leishmaniasis, with an incidence rate of 5.62 for CL and 0.91 for VL with a population at risk of 14% for CL and 10% for VL⁸.

Urbanization, demographic density and poverty are among the main risk factors for the emergence of this epidemic⁹, and do contribute to a large extent to the persistence of the disease burden, particularly in anthroponotic foci. It is in this perspective that the present work aims to determine the link between these factors and the distribution of leishmaniasis in the Fez-Meknes region.

Materials and Methods

Study area

The Fez-Meknes region consists of two prefectures (Fez and Meknes) and seven provinces (Sefrou, Boulemane, Moulay Yacoub, Ifrane, El Hajeb, Taza, and Taounate) (Figure 1). The region covers an area of 39,027 square kilometers, that is to say 5.5% of the total area of the Kingdom.⁹

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Figure 1: Study area

This region, according to the last census conducted in 2014 had 4,236,892 inhabitants (12.5% of the total population of the country). The Fez-Meknes region has important natural assets, and it is characterized by a climate ranging from Mediterranean to continental with hot winters and summers, especially in the province of Boulemane.

Data acquisition

The epidemiological data for this study were extracted from the Prefectural Epidemiology Unit of the Ministry of Health. However, the socio-economic data used were taken from the publications of the population censuses by the High Commissioners' Office for Planning (2014). These data include the number of people, the poverty rate and the urbanization rate.

Statistical processing of data

In order to highlight the relationship between leishmaniasis and the risk factors, namely urbanization, poverty and demographic weight, we calculated the correlation coefficient, which gives us information on the existence of a linear relationship (in the form of a straight line) between the two quantities considered. The correlation coefficient is between -1 and +1. As we move away from zero, the correlation increases.

Results and Discussion

Leishmaniasis is a disease with a worldwide distribution; it is found in about 89 countries^{11,1}. Worldwide, 1.5 to 2 million new cases occur each year, 350 million are at risk of acquiring the disease, and leishmaniasis causes 70,000 deaths per year. WHO lists leishmaniasis as one of the neglected tropical diseases for which the development of new treatments is a priority. Major evidence gaps remain, and new tools are needed before leishmaniasis can be definitively controlled.

This study presents the epidemiological profile of leishmaniasis in the Fez-Meknes region. It aims to analyze the epidemiological profile, and in particular, the spatio-temporal monitoring of all cases of leishmaniasis. This is a retrospective analysis of leishmaniasis cases recorded between 2008 and 2016.

Evolution of the Leishmaniasis (2008-2016) in the Fez-Meknes region

The distribution of Leishmaniasis cases in the studied region shows that more than half of the cases were recorded in the two prefectures of Taounate and Taza with 25% (i.e. 1320 cases) and 29% (i.e. 1343 cases) respectively, followed by Sefrou 18% and Boulemane 16%. However, the other prefectures/provinces do not exceed 9% of the total number of cases recorded (Figure 2).

The study of the spatial and temporal distribution of leishmaniasis (Figure 3) shows that during the years of study a total of 4701 cases

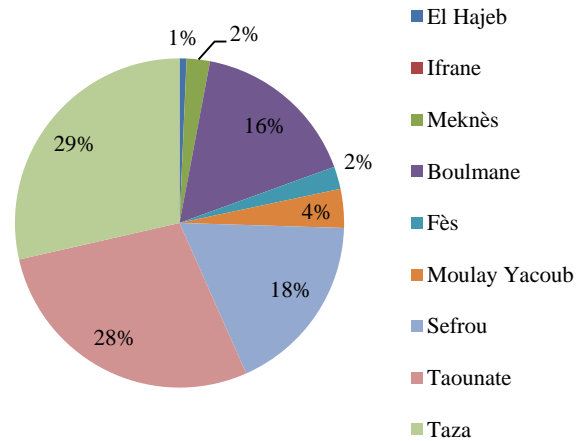


Figure 2: Distribution of Leishmaniasis in the Fes-Meknes region (2008-2016)

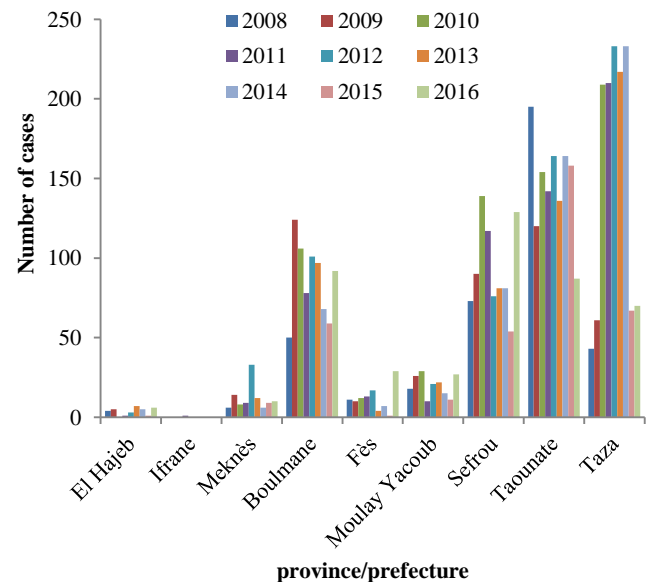


Figure 3: Spatial and temporal distribution of leishmaniasis during the period 2008-2016

were recorded in the Fez-Meknes region and that the number of cases was very high in 2010 and 2012 with 657 and 648 cases respectively, but in 2015 the total number of cases recorded was 350. It is also important to note that with the exception of the two prefectures of Ifrane and El Hajeb, the other prefectures and provinces were affected by leishmaniasis during all the years of the study.

These results could be explained by the rural character of the inhabitants of these provinces, and their socio-cultural habits in the management of their living environment. In fact, the unhygienic disposal of waste, and the presence of points of accumulation of garbage are factors promoting the contamination and infestation by parasitic diseases such as leishmaniasis. Indeed, the dispersion of the disease is closely linked to the environment. These results are consistent with other studies^{13, 14, 15}, which have noted the need to improve hygiene conditions for populations living in endemic areas to reduce transmission.

Also, the majority of rural people own dogs since they are very beneficial for guarding houses and fields, but they constitute one of the main reservoirs of *Leishmania infantum*. On the contrary, the province of Ifrane recorded only one case during the years of study. This could be explained by the fact that Ifrane has a very humid and temperate

climate with an annual rainfall of 1118.4 mm and an average annual temperature of 11.4degrees Celsius that is unfavorable to the proliferation of vectors. Similar, several previous studies have proven the impact of climatic factors in the distribution of leishmaniasis vectors^{16,17}.According to the High Commissioner's Office for Planning of Morocco, the region of Fez-Meknes recorded a significant increase in the urban population that surpasses the rural population, particularly in the prefectures of Fez and Meknes where the rate of urbanization is more pronounced, while in the provinces of Taounate, Moulay Yacoub, and Boulemane, it is the opposite. The urbanization rates in these three provinces are respectively about 13%, 14.4% and 33.2%.

Impact of socio-economic factors on the distribution of leishmaniasis
According to the High Commissioner's Office for Planning of Morocco, the region of Fez-Meknes recorded a significant increase in the urban population that surpasses the rural population, particularly in the prefectures of Fez and Meknes where the rate of urbanization is more pronounced, while in the provinces of Taounate, Moulay Yacoub, and Boulemane, it is the opposite. The urbanization rates in these three provinces are respectively about 13%, 14.4% and 33.2% (Table 1).Statistical analysis of the data from this study shows an average correlation between urbanization and the number of recorded cases with $R = 0, 51$ (Figure 3 A), and a very weak correlation between the population rate and the number of recorded cases with a coefficient $R = 0.27$ (Figure 3B).However, there is no correlation between poverty and the number of cases of leishmaniasis in the region ($R=0.00$) (Figure 4C).

According to the WHO¹⁸, the phenomenon of urbanization increases the risk of transmission of leishmaniasis. Indeed, poor environmental hygiene conditions create favorable environments for the multiplication of vectors^{16,19,20}.

Statistical analysis of the data from our study shows an average correlation between urbanization and the number of recorded cases, with $R = 0.51$ (Figure 3). This can be explained by the fact that the region of Fez-Meknes is divided between 2,564,220 urban dwellers and 1,672,672 rural dwellers¹⁰. This translates into an urbanization rate of 60.56% which is close to the national rate of 60.36%. These results are consistent with the work of Guessous-Idrissi *and al.* (1997) who

have shown since 1997 that this form of disease has started to appear in some peri-urban and urban sites²¹. Several other studies have also confirmed the positive correlation between urbanization and the incidence of cutaneous leishmaniasis^{22, 23}.

In addition, leishmaniasis is one of the most neglected tropical diseases, closely related to poverty²⁴, lack of resources and poor housing conditions²⁵.In general, high morbidity and low mortality of infectious diseases are well-known determinants of poverty²⁶. Indeed, poverty may increase the risk of leishmaniasis due to poor housing conditions that provide an environment conducive to the survival of the sandflies which are the vectors of leishmaniasis^{27, 28}. Poverty and lack of infrastructure seem to be among the main factors responsible for leishmaniasis²⁹. Several previous studies have shown that poverty can increase the risk of leishmaniasis due to poor sanitary conditions^{22, 29}.

Table 1: Socioeconomic factors of the provinces and prefectures of Fes-Meknes region

	Poverty rate (%)	Urbanization rate (%)	Demographic Weight(%)
EL HAJEB	14.1	49.3	5.8
MEKNES	14.7	82.3	19.7
SEFROU	13.7	54.3	6.8
BOULMANE	16	33.2	4.7
FES	6	98.2	27.1
MOULAY YAAKOUB	16.7	14.4	4.1
TAOUNANTE	13.5	13	15.6
TAZA	9.9	39.4	12.2
IFRANE	12.3	54.4	3.7

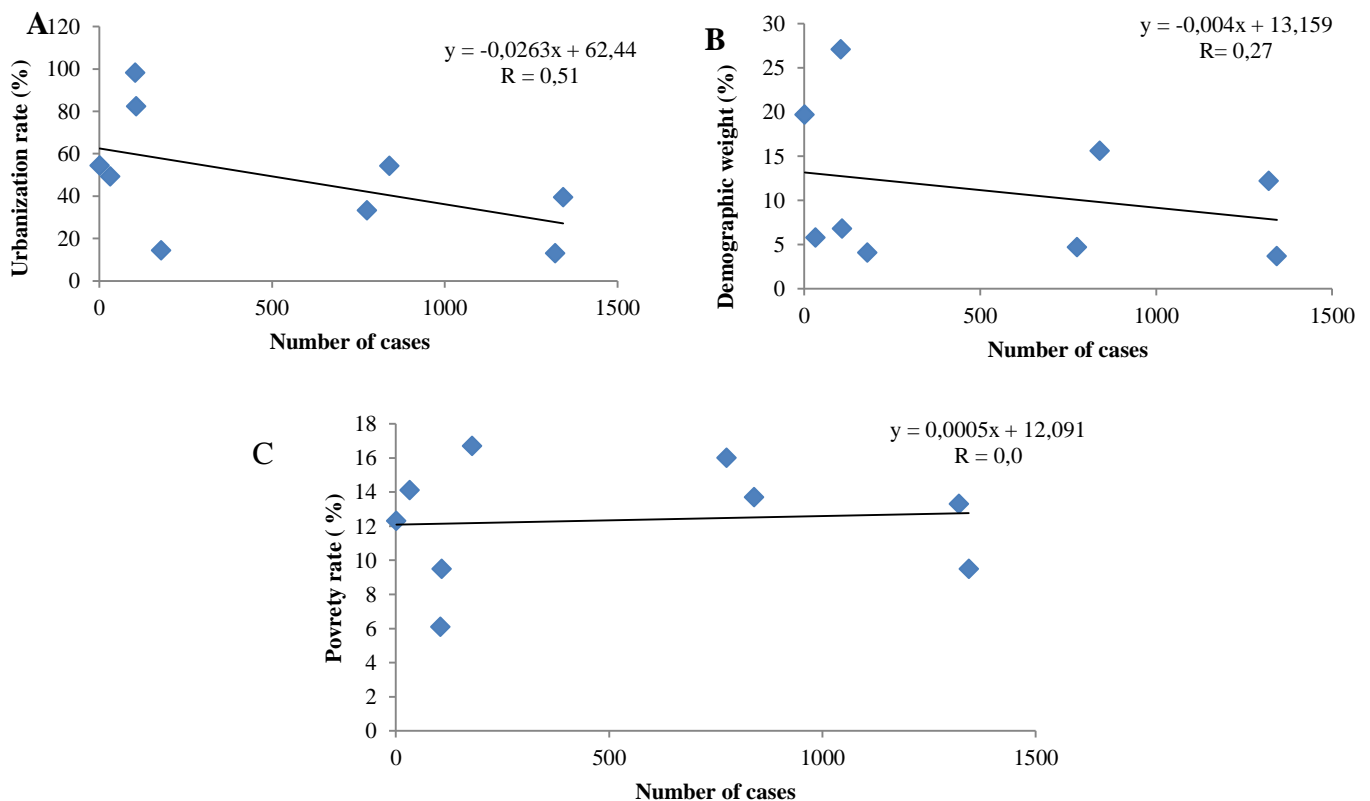


Figure 4: Correlation between the number of leishmaniasis cases and urbanization (A), Demographic weight (B), and Povrety (C).

These results are in disagreement with our results where the statistical analysis (Figure 4) shows that there is no correlation between poverty and the number of cases of cutaneous leishmaniasis in the region ($R = 0.00$).

Furthermore, a similar study in Morocco showed that there was no significant relationship between the distribution of the epidemic and poverty³¹, which confirms our results.

The distribution of the population by the province and prefecture shows the predominance of Fez and Meknes area, which concentrates 47% of the population of the region, followed by the province of Taounate, which is host to 15% of the population. The population of the region represents 12.5% of the population of the Kingdom. It is one of the top five most populated regions in Morocco. It occupies the fourth place in terms of demographic weight at the national level.

Statistical analysis showed a very weak correlation between the population rate and the number of recorded cases, with a coefficient $R = 0.27$. Therefore, the distribution of leishmaniasis within this region does not take into account the number of inhabitants per commune, but other studies have shown a strong correlation between the distribution of the disease and the number of inhabitants.³²

Conclusion

The retrospective study of the Fez-Meknes region has showed that the number of cases of leishmaniasis is very high in the provinces of Taounate and Taza while in the two provinces Ifrane and El Hajeb, the number of cases was low during all the years. Our study also shows the positive correlation between urbanization and the number of cases recorded. The efforts to control this disease require continuous monitoring of risk factors by encouraging research related to the impacts of socio-economic factors on the spatio-temporal dynamics of the disease.

Conflict of Interest

The authors declare no conflict of interest.

Authors' Declaration

The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

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