Environmental impact on leptospirosis: modeling of environmental risk factors for leptospirosis in the Gharb region, North-West Morocco

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Abstract- Leptospirosis is a worldwide-distributed zoonosis affecting 100 million people per year in the world; it is caused by spirochetes of the genus Leptospira. Many serovars grouped into 23 serogroups have been implicated in human disease, and seven genomic pathogenic species were identified by hybridization studies deoxyribonucleic acid. Our retrospective study concerned a series of 77 observations for hospitalized patients at the service of Hygiene of the SAIPP Kenitra, Sidi Slimane, Sidi Kacem of 2010 to 2016. We analyzed through these files, the epidemiologic, clinical, biological, and therapeutic characteristics of leptospirosis. It will also be a question of determining the indicators of health and of determining the provinces and the common to risk. During the period of the study, 77 cases of leptospirosis were indexed.

Index Terms- Leptospirosis, zoonosis, ACM, risk factors, epidemiology.

I. INTRODUCTION

Leptospirosis is an emerging disease worldwide. Numerous epidemics have been reported worldwide in recent decades [1, 2]. According to international agencies, the World Health Organization (WHO) and the Global Burden of Disease (GBD) it is estimated that there are 1 million cases of leptospirosis per [3,4,5]. Currently, its presentation in urbanized areas is related to outdoor activities and contact with animals [6], it has geographic regions with the environmental conditions of temperature and precipitation favorable for Leptospira infection all along the year [7]. Leptospira has been isolated in many vertebrate taxa, including mammals, birds, amphibians, reptiles and fish [8,9]. The pathogen is transmitted through exposure to contaminated water or urine from infected animals and can survive for days or even months in fresh water, soil, or mud [10]. Livestock and agricultural practices are generally considered important factors in the endemic transmission of leptospirosis leading to human infections [11]. However, local environments facilitate leptospirosis transmission and how these are altered by various climatic regimes remains largely unknown. This apparent gap in our understanding of how local environments can facilitate transmission creates a disparity to stop transmission. this context, it seems interesting to conduct a retrospective study of the cases presented at the Kenitra Hygiene Department over seven years (2010-2016). At the same time, we plan to highlight the relationship between the rate of contamination and environmental factors.

II. MATERIALS AND METHODS

1. *Region of study*

The Gharb zone (study area) extends in central Morocco with an area of about six thousand square kilometers. It is located within the Rabat-Salé-Kenitra region, which covers an area of 17,570 km2, or 2.5% of the kingdom's surface area (Figure 1).

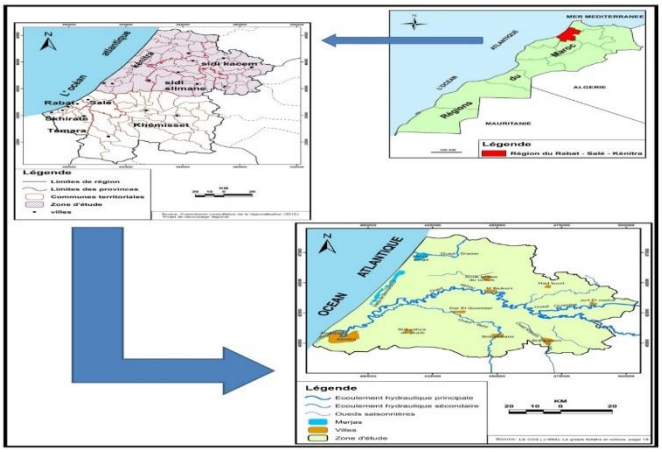


Figure 1: Location of the Gharb area (Monograph of the Rabat-Salé-Kénitra region)

It is bordered to the north by the Tangier-Tetouan region, to the east by the Fez-Meknes region, to the south-west by the Casa-Settat region, to the south-east by the Beni Mellal-Khenifra region and to the west by the Atlantic Ocean (Regional Directorate of Agriculture Rabat-Salé-Kenitra). In 2014, the region was populated by 4,580,866 inhabitants, or 13.5% of Morocco's population; 30% of which are in rural areas and the average density is 261 inhabitants/km2, i.e., 5.5 times higher than the national average.

2. *Data collection*

a. Case data

For this study, retrospective epidemiological only data on leptospirosis patients diagnosed at the Kenitra Provincial Hospital between 2010 and 2016 were used. The data were collected from the archives of the Provincial Epidemiology Unit (SRES Kenitra) after obtaining the necessary administrative authorizations from the Health Delegation and the National Education Academy of Kenitra. The study was carried out using a questionnaire for each patient diagnosed with leptospirosis, which essentially included data concerning the socio-demographic and clinical parameters related to the follow-up of patients as soon as their file arrived at the delegation of the Ministry of Health of the Provinces of Kenitra, Sidi Kacem and Sidi Sliman. Each file contains the necessary information for the entire care of the patient. Patient tells that: age, place of residence, date of onset of the disease and a brief description of the likely environmental sources of transmission of the infection.

b. Statistical analyses

The data were captured and analyzed by SPSS and XLSTAT software. On the other hand, the search for associations between different variables (factors) was carried out using the statistical correlation that characterizes the existence or absence of a relationship between two variables of values taken from the same group of subjects. The correlation coefficient makes it possible to quantify this relationship by the sign of the correlation (positive and negative), and by the strength of this correlation. The degree of correlation is measured on a scale from 0 to 1. Zero means a total absence of correlation between the two measurements, while 1 means a perfect correlation, i.e., knowing the value of one measurement allows us to know exactly the value of the other.

III. RESULTS AND DISCUSSION

Seventy-seven cases of leptospirosis were diagnosed during the study period. The annual distribution of leptospirosis cases over the seven years is shown in Table 1.

Table 1: Distribution of admissions during the study period.

	Effective	**Percentage %**
2010	26	33,8
2011	12	15,6
2012	4	5,2
2013	9	11,7
2014	10	13,0
2015	13	16,9
2016	3	3,9

The largest number of leptospirosis cases in the Gharb population, 26 cases (33.8%) were diagnosed in 2010 and 3 cases (3.9%) were diagnosed in 2015 as a minimum value. The Rural Region is the most concerned by leptospirosis due to the agricultural activity, it represents nearly 79.22% of the registered cases with a highly significant difference of cases in the Urban Region (=22.545 and ddl=2, P=< 10-3).

Modality	Number of people by modality	Frequency by modality (%)
Urban	16,000	21,053
rural	60,000	78,947

Unfortunately, the rate of contamination is very high in rural areas due to the poor hygiene conditions, the diversity of the animal and wild reservoir and the multiplicity of environmental sources of transmission.

- **Mode of contamination**

Contact with untreated water has a great influence on the contamination rate. The first type of contact with fresh water was with wells (37 cases), the second type of contact was via wadis, water sources (a patient may be exposed to one or more water resources), In fact, 53.2% of our patients (N=41/77) were in contact with potentially contaminated water in the workplace (Figure 2).

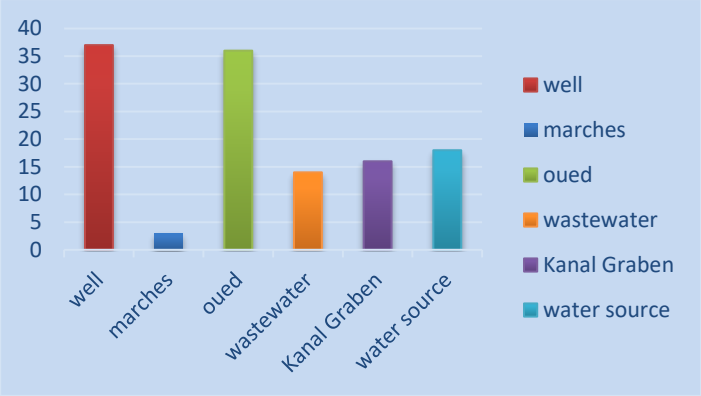


Figure 2: the nature of the waters in contact

To associate contamination rates with environmental conditions we used Multiple Correspondence Analysis (MCA) is a method that allows us to study the association between at least two qualitative variables. Multiple Correspondence Analysis is for qualitative variables while Principal Component Analysis is for quantitative variables. Indeed, it makes it possible to arrive at representation maps on which one can visually observe the proximities between the categories of the qualitative variables and the observations.

The results of the Multiple Correspondence Analysis (ACM) showed that leptospirosis incidence rates were significantly associated with seven environmental risk factors adjusted to the data. Water from wells, swamps, water source, wadi, contact with wastewater, ditch canal and public landfill.

The applied ACM shows that the factorial design F1F2 contains 50.50% of the information and the remainder is shared by the other designs (Figure 3). This leads to the conclusion that there is a strong correlation between the contamination rates and the environmental conditions of the patients.

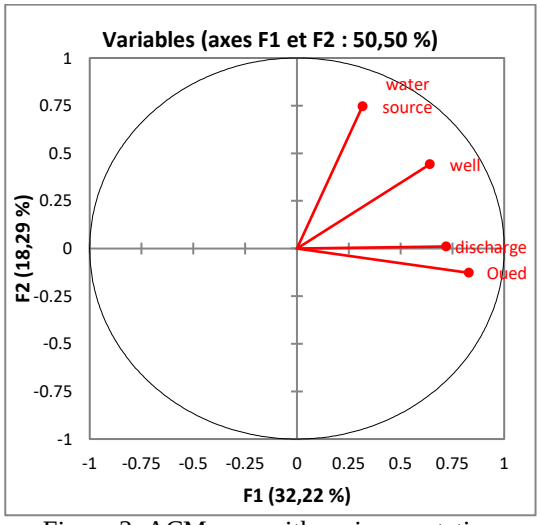
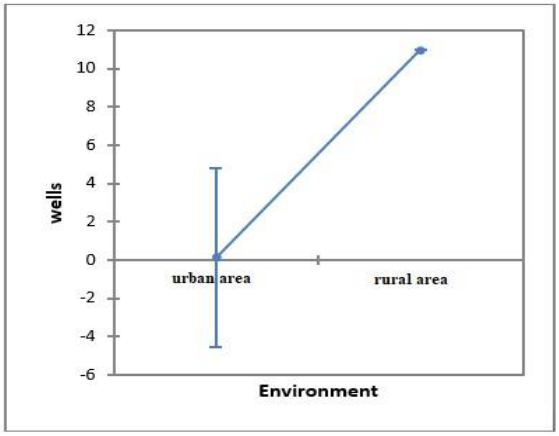
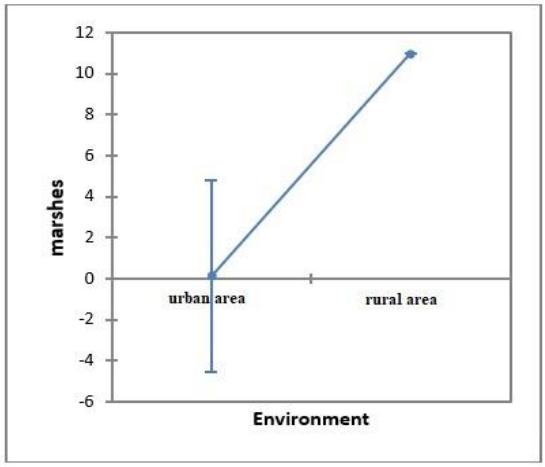


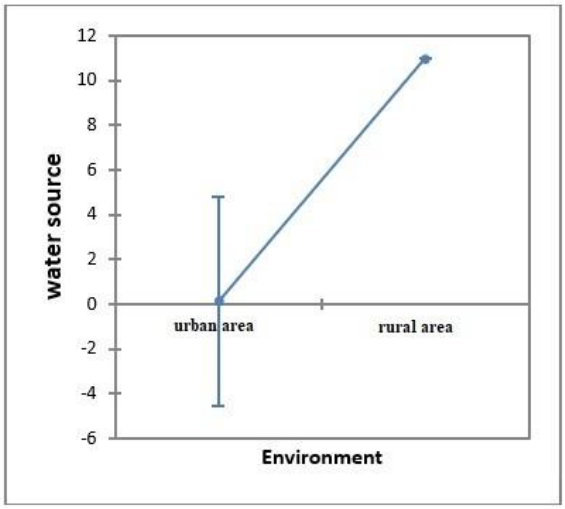
Figure 3: ACM map with varimax rotation

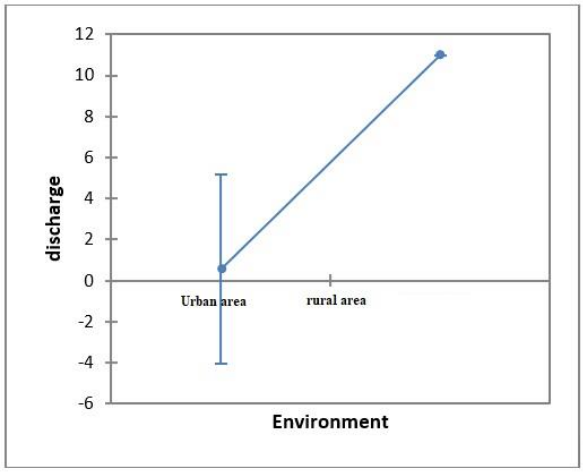
- **Modeling of environmental factors**

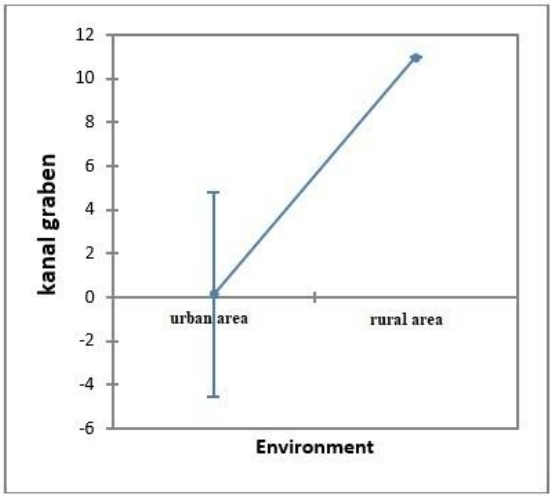
Factors that were significantly associated with leptospirosis based on linear modeling were found to be significantly associated with the observation that the population in the rural area with a very high risk.











In this study, the spatial heterogeneity of leptospirosis (rural, urban) was analyzed and associations between disease occurrence and environmental factors were investigated. The correlation analysis and linear modeling analysis showed that leptospirosis was correlated with the living environment and those rural populations are at greater risk than urban populations due to agricultural activity and soil contact, the results are consistent with

several studies that have shown that farmers are an occupational risk group and that outdoor activities are associated with agricultural activities, which is generally associated with an increased risk of leptospirosis infection [10, 11, 12]. Our study and consistent with the study of Goris MGA et al. on Dutch farmers is that farmers are the most affected [13]. As the main objective of this study was to investigate spatial patterns of leptospirosis risk, quantified using environmental impacts, we limited the analysis to spatial trends. Since the available environmental data are not comprehensive, likely, other environmental factors influencing the occurrence of leptospirosis infection were not examined. Since leptospirosis is primarily transmitted by rodents, especially rats [14], rodent density should further explain the observed spatial distribution of leptospirosis. The inclusion of rat distribution patterns or the spatial configuration of key habitats in the analysis could explain the association found between environmental conditions favoring leptospirosis transmission, as they would also provide suitable habitat for rats and other potential reservoirs. However, reliable data on rodent densities in Morocco are lacking, and a high spatial and temporal variation in rodent activity would add considerable complexity to the model and would require more complete data on spatial and temporal variations in leptospirosis infections in humans and animals and their prevalence. In aquatic and mammalian reservoirs.

Estimating the zoonotic transmission of leptospirosis could promote the use of ecological niche models following the fundamental niche concept of Hutchinson's [15]. Generating a species distribution model [16] for Leptospira spp. would require modeling of biotic and abiotic interactions between leptospira and a variety of reservoir hosts. As indicated in this paper, the outcome of interest is the emergence of leptospirosis rather than the distribution and abundance of leptospira. It is expected that the biotic and abiotic factors presented in this study will determine the distribution of reservoir hosts, leptospira survival and ultimately human exposure to the bacterium. However, the nature and strength of these associations will depend on behavioral factors affecting exposure and ultimately infection. The model presented here is not intended to describe an ecological niche in the distribution of pathogens. Rather, it is used to estimate risk patterns that are essential for effective control and prevention in populations at high risk of disease.

Despite the limitations of the model presented, the environmental factors of leptospirosis identified in this study provide valuable information for identifying potential areas of transmission and could be used to educate clinicians about the potential risk of leptospirosis.

VI. CONCLUSION

Our study, it turns out that leptospirosis is a frequent pathology. Especially in the rural environment, which is an environment conducive to the maintenance of the evolutionary cycle due to the presence of uncontrolled animals and the raising of livestock. In addition, the population is ignorant of the rules of hygiene and prophylaxis. although surveillance of the disease in humans with appropriate diagnostic methods can play an important role in the prevention and control of leptospirosis outbreaks. Also, appropriate diagnostic methods should be conducted for the animal to take into account the areas and periods of rodent abundance.

At the end of our study, it turns out that leptospirosis is a common pathology in rural areas, but the incidence and actual prevalence of leptospirosis, it remains difficult to assess in the absence of national seroprevalence studies and the presence of varied or atypical clinical forms that are often undiagnosed. Several cases of human leptospirosis are reported annually to the Epidemiology Directorate of the Moroccan Ministry of Health [17]. These cases have shown that occupational exposure is a significant risk factor for contracting the disease. However, preventive measures can help to minimize the likelihood of confronting the disease, such as the use of hygiene and prophylaxis means (use of personal protective means, workplace layout, deratisation, etc.).

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