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Original Research Article

Prevalence Study and Overview of Rabies in the Province of Ouarzazate-Morocco

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Abstract

***Background*:** Rabies is a cosmopolitan anthropozoonosis for which humans are accidental victims. In Morocco, rabies is an endemic disease, with new cases of human rabies reported every year. The aim of our study is to analyze the epidemiological aspects of rabies in the province of Ouarzazate. ***Materials and Methods*:** This is a retrospective study using records available at the Ouarzazate Municipal Hygiene Office. It includes 1,759 cases of exposure to animal bites between 2016 and 2019. ***Results*:** We identified 1,759 cases of animal bites during the period of 4 years of study, representing an average annual exposure rate of 190/100,000 inhabitants. Most cases were rural (65%). The median age of bitten cases was 28 years, with people under 15 years of age exposed in 32% of cases. Males predominate, with 61.3% of cases. Dogs are the main animal aggressors at 47.8%, followed by cats at 33%. The upper limbs are the preferred sites of aggression (89.2%). Exposure was grade III in 76.8% of cases. Lesions were multiple in 52.1% and superficial in 62.6%. No cases of human rabies have been recorded since 2001, despite 20 cases being exposed to a biologically confirmed rabid animal during our study. ***Conclusion*:** Rabies remains a public health concern in the province of Ouarzazate, despite the presence of a national rabies control program. Effective control of this zoonosis requires strengthening education and community engagement, as well as close collaboration between animal health and human health sectors for integrated management of bite cases.

Keywords: Rabies, Zoonosis, Epidemiology, National Plans of Rabies Control.

INTRODUCTION

Rabies is an infectious disease, accidentally transmitted to humans, caused by a neurotropic virus of the genus Lyssavirus and family Rhabdoviridae [1]. It is a fatal anthropozoonosis, under-reported and neglected in endemic countries, responsible for over 55,000 human deaths every year [2]. The data underline the impact of poverty and underdevelopment in the global distribution of rabies, the African and Asian continents carrying the heaviest burden of deaths due to this disease, with over 95% of fatal cases reported worldwide. Around 40% of these deaths involve children under the age of 15 [3]. Dogs are the main reservoir and vector of the disease, transmitting the virus to humans in 99% of cases via saliva: through bites, scratches or direct contact with mucous membranes. In Morocco, rabies is still endemic, despite a national rabies control program launched in 1986 by the Ministries of the Interior and Health [4]. An average of 391 cases of animal rabies and 21 new cases of human rabies are reported each year by the Institut Pasteur du Maroc [5]. The four pillars of Morocco's rabies prevention and control strategy are: Prevention based on animal vaccination and post-exposure prophylaxis (PEP), epidemiological surveillance (animal and human), medical management of rabies cases and public education [4]. The aim of this work is to trace the epidemiological profile of rabies in the region, study the circumstances surrounding animal bite exposure managed at the Ouarzazate rabies center over four years between 2016 and 2019.

MATERIALS AND METHODS

1. Study Zone

The Ouarzazate region covers an overall area of 12,464 km², which represents approximately 14% of the total regional territory. It is subdivided into 2 urban and 15 rural communes [8]. In 2014, the province's legal population was 297,502, according to the 2014 general population and housing census (PHC). Its climate is semi-desertic with a strong continental influence. According to the 2014 PHC, the province's rural

population represents 61.8%, while its urban population is 38.2% [8]. Ouarzazate province has two rabies centers whose main mission is to manage people exposed to rabies and/or bitten by domestic or wild animals: Municipal Hygiene Office (MHO) and the Taznakhte health center **(Figure 1).**

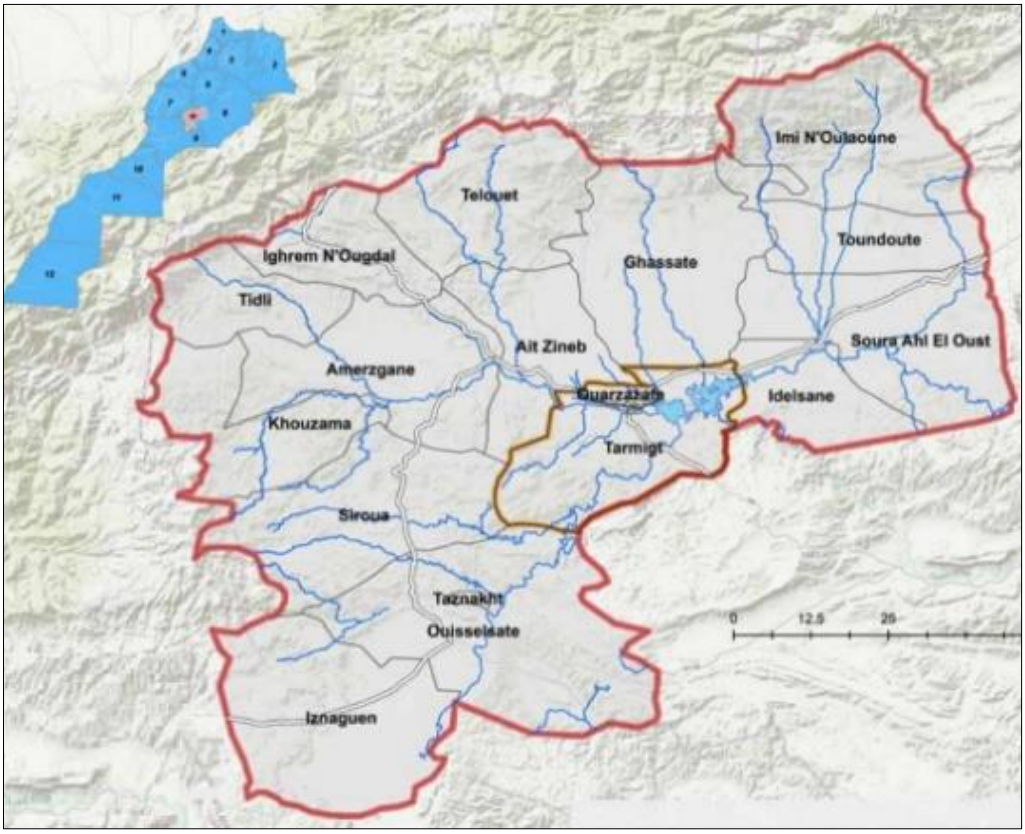

Figure 1: Study zone: Ouarzazate province

2. Data Sources

Data were collected from the registers-archives available at the Ouarzazate Municipal Hygiene Office, the department responsible for enforcing legal and regulatory provisions relating to public hygiene and safety. We included the records of patients exposed between 2016 and 2019, preserving their anonymity. Patients not originally from Ouarzazate province or exposed outside the study period were excluded. A data collection form was used to facilitate data collection, and comprises 4 sections: Section 1 concerns epidemiological information (age, sex, rural or urban residence). The 2nd section concerns details of exposure (date, place, site, nature, number and state of injury). The 3rd section details the treatment received (disinfection, stitches, antibiotic therapy, tetanus prophylaxis, serotherapy and rabies vaccination) and the final section concerns the biting animal (dog or other animal, domestic or stray). This study has been validated by the Ethics and Research Committee of the Avicenne Military Hospital in Marrakech.

3. Data Analysis

tatistical analysis was performed using SPSS Statistics version 20.0 (IBM Corp., Armonk, NY, USA). This analysis is split into two parts: a descriptive analysis and an analytical (univariate analysis by a binary logistic regression), using the chi-square test and Fisher's exact test for the comparison of frequencies. The significance threshold was set at 5% ($p \leq 0.05$)

RESULTS

1. Results Socio-Demographic Data

The survey identified 1,758 cases of bites between the years 2016 and 2019 in the Ouarzazate region. The average age of the victims was 31.12 years +/- 21.55. The male sex predominates with 61.3% i.e. (n=1076), against 679 cases (38.7%) for the female sex. The M/F sex ratio was 1.58. The same predominant trend was observed for each year of the study. The age group 5 to 14 was the most affected, accounting for 23.5% of total cases, with a median age of 28 years. Students were most exposed, with a rate of 40% (n=697), including 439 cases (63%) in rural areas, followed by housewives with a rate of 28.4% (498 cases), then workers with a rate of 7.5%, while in 17.7% of cases the occupation was undetermined **(Table 1).**

Table 1: Epidemiological data from the study

Variables	Frequency	Percentage
Age		
< 5 years	129	7%
5-14 years	411	23%
14- 24 years	245	14%
24 -34 years	245	14%
35 - 44 years	209	12%
44- 55 years	205	12%
> 55 years	308	18%
Gender		
Male	1076	61.3%
Woman	676	38.7%
Profession		
School	697	40%
Housewife	498	28.4%
Worker	132	7.5%
Farmer	116	6.6%
Undetermined	310	17.7%

2. Animal Rabies Prevalence Statistics

Analysis of the data collected about rabies in the Ouarzazate provine since 2016, has highlighted three evolutionary trends. A first phase characterized by a decrease in the number of cases in 2016 (366 cases) followed by a resurgence during 2017 (463 cases) and 2018 (508 cases) with a downward trend in 2019 (421 cases) **(figure 2).**

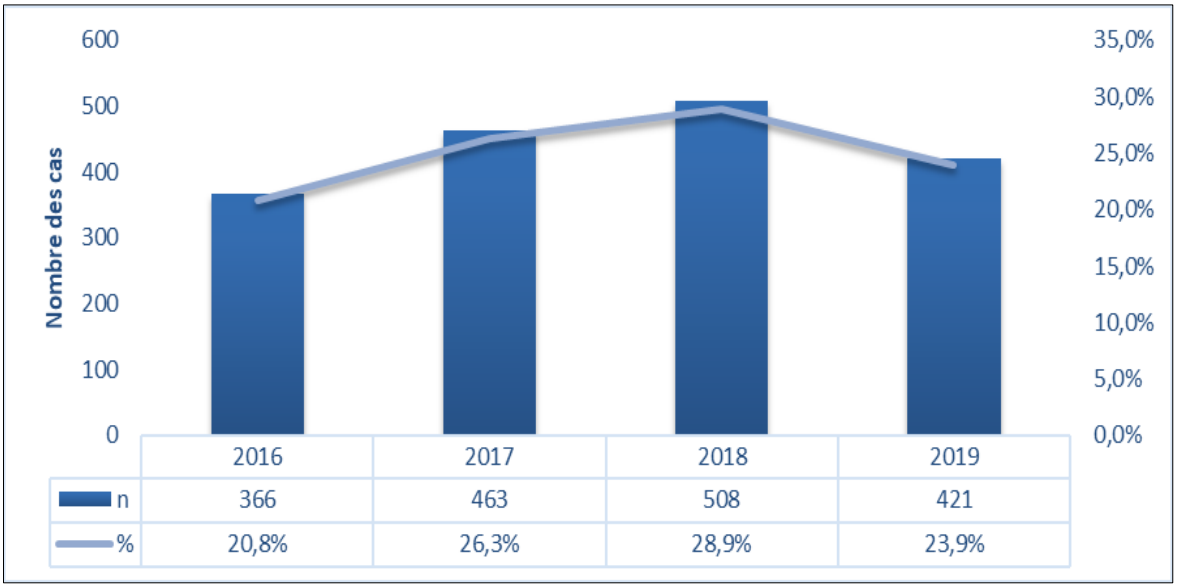

Figure 2 : Number of cases reported by year

The distribution of rabies cases across the communes was heterogeneous. The number of cases varies from one commune to another, and changes over the years. The most affected communes are Ouarzazate, SKOURA and TARMIGTE, with 518,295,275 cases respectively, i.e. 29.5%, 16.8% and 15.8%. By contrast, the lowest number of cases was recorded in the commune of IDELSANE, with just 26 cases, or 0.6% **(figure 3).** It should be noted that the rabies situation has improved in certain communes (IDELSAN, TOUNDOUNTE and GHASSAT) with a decrease in incidence, but the communes of TELOUETE, TIDILI and IGHREM N'OUGDAL are experiencing a resurgence of the disease.

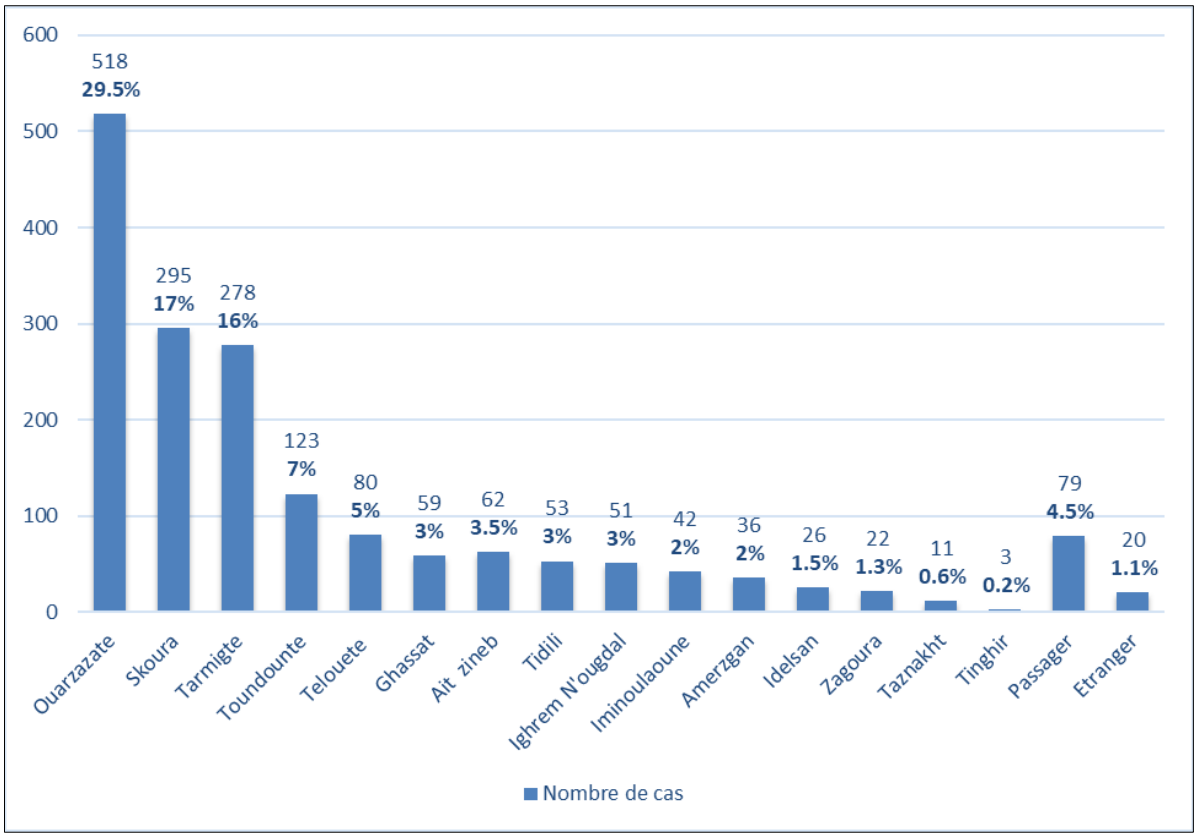

Figure 3: Distribution of cases according to municipality

Rural areas were identified as the main site of exposure, with a total of 1138 cases, corresponding to 65%. On the other hand, urban areas accounted for a total of 609 cases, corresponding to 35%. This finding was stable throughout the study period **(Figure 4).**

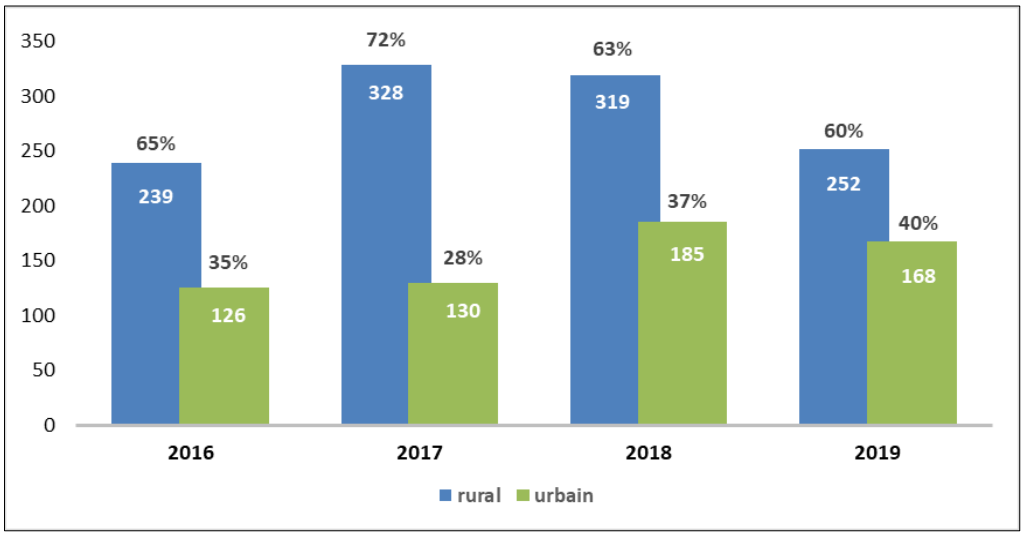

Figure 4: Annual distribution of cases according to exposure zone

3. Seasonal Distribution

Classification of rabies cases by season (summer, autumn, winter and spring) for each year reveals that the number of cases recorded is relatively constant during the winter and autumn seasons, with 755 cases recorded, followed by an increase in spring with 461 cases, and reaching a maximum of 542 cases in summer, or 30.8% **(figure 5).**

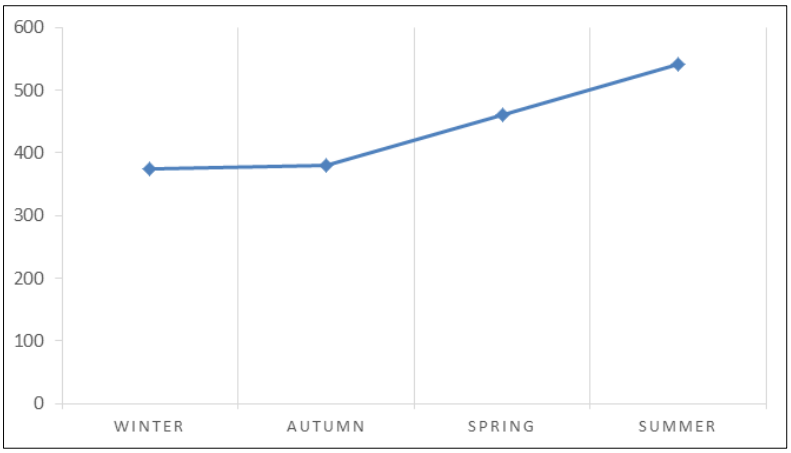

Figure 5: Seasonal distribution of rabies cases

4. Data Regarding Exposure Characteristics

In terms of the nature of exposure, bites make up 76.9%, scratches 17.9% and contact exposure 5.2%. The body part most frequently exposed is the upper limb, accounting for 49.4% of cases, followed by the lower limb, with 39.8%, then the head, in third place with 5.2%, and the trunk in fourth place with 4.6%. Finally, involvement of both (upper and lower limbs) and the genital organs, accounting for of 0.9% ans 0.1% of cases respectively **(Table 2).** Around 62.6% of lesions were deep, while 32.2% were superficial. Lesions were multiple in 52.1% of victims and single in 42.7%, while exposure caused no lesions in 5.2% of people (because of licking or contact with drool).

Table 2 : Distribution of rabies cases by site of exposure

	2016	2017	2018	2019	Total (n)	Percentage (%)
Head	15	25	27	25	92	5,2%
upper limb (UL)	168	211	258	231	868	49,4%
lower limb (LL)	157	192	197	153	699	39,8%
Trunk	20	31	23	7	81	4,6%
UL+LL	5	4	1	5	15	0,9%
Genitalia	1	0	0	0	1	0,1%
Total	366	463	506	421	1756	100,0%

5. Data Regarding Biting Animals

Our results show that various animal species are involved. Dogs are the main biting animal, causing exposure in 47.8% of cases. Cats came second with 33.6% of cases, and mules third with 15.3% **(Figure6).**

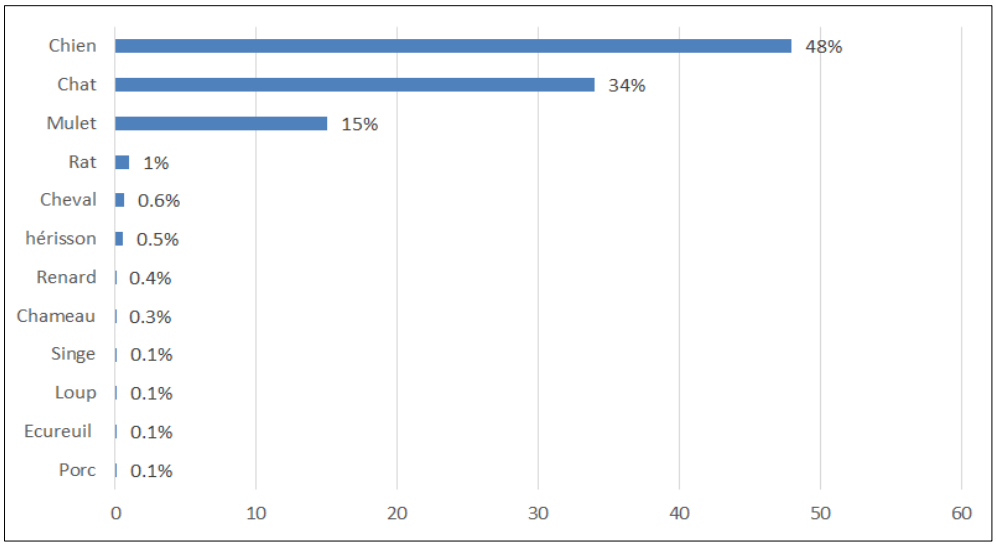

Figure 6: Distribution of rabies exposure cases based on species of animal involved

54.4% of bite victims were attacked by stray animals (n=951), while the biting animal was with its owner in 45.6% (n=798). Between 2016 and 2019, 1,714 biting animals were examined for suspected rabies. They belonged to three animal species: the vast majority were dogs (91.5%), cats (7.4%) and mules (1.1%). The diagnosis of rabies in animals is made clinically if the animal presents pathognomonic symptoms of rabies, in particular: hyperexcitation, agitation, hyper salivation, aggressiveness, self-mutilation in equids, bellowing in bovines. The diagnosis of rabies was confirmed by a molecular biology technique in only 20 cases (1.1%) at the Institut Pasteur du Maroc (IPM). Data on the fate of bitten animals showed that in 80.2% of cases the fate of the animal was unknown, in 15.3% of cases the animals were placed under observation, 1.1% were slaughtered, 1.8% disappeared and in the remaining cases the animal died (1.6%). 89.8% of victims of animal bites reported their exposure to the veterinary service.

DISCUSSION

This study showed that the rabies virus represents a real public health threat in the province of Ouarzazate. According to data provided by the provincial epidemiology unit, the last case of human rabies in Ouarzazate dates back to 2001, although an average of 420 bites are reported each year in the province [6].

The average exposure rate to animal bites in Ouarzazate province is estimated at 0.19% (190 per 100,000 inhabitants). This is in line with the national rate (185.71 per 100,000 inhabitants) according to the study reported by Emma Taylor *et al*., in 2017 [7], and higher than the rate reported by A.Elgasmie in the province of Rhamna in 2022, estimated at 0.13% (136 per 100,000 inhabitants [8]. The table below compares the various national and international exposure rates per 100,000 inhabitants **(Table3).**

Table 3: Exposure rates to animal bites according to different studies

Séries	Rhamna 2022 [8]	Sidi Kassem 2008 [9]	Tunisia 2004-2018 [10]	Brazil 2008-2017 [11]	Iran 2018 [12]	Iran 2015-2017 [13]	Our study
Average number of cases / year	431	687	3089	506	375	724	440
The exposure rate / 100000hab)	132	210	694	255	170	242	190

Several socio-demographic factors have been identified as influencing the risk of exposure. According to our results, age is a risk factor, the youngest individuals being the most exposed, with 32.1% of cases reported in the under-15 population. The international literature shows the same trends: Endalew Yizengaw *et al*., (46.3%) [14], Mathild Sopi Tetchi *et al*., (51%) [15], Stevens Kisaka *et al*., (46%) [16]. This can be explained by the lack of vigilance and provocation of dogs by this category of the population.

The gender distribution of cases showed a male predominance of 61.3%. This finding is confirmed by most studies on rabies, notably the study by tara Harouna Amadou *et al*., (70.5%) [17], Rabbanie Tariq Wani *et al*., (76.4%) [18], Ehsan Sarbazi *et al*., (80.4%) [57]. This disparity can be attributed to the importance of men's activity outside the home, particularly in rural areas.

A preponderance of animal bites (64.8%) was observed in rural areas. Dogs play a very important role in rural areas, particularly as guard animals, However, the health and living conditions of animals, including dogs, are often neglected.This could contribute to the high level of exposure in these areas. Findings from the literature diverge, with some studies suggesting that urban areas are more affected, citing 87% of cases coming from these areas [20, 21].

The dog is the main biting animal, incriminated in 70% of cases, followed by the cat with 27% of cases, and other animals including bovines, sheep, mules, horses, rats and pigs (28 bite cases, or 2%). These statistics are in line with national data showing that dogs account for 94% of animal bites causing human rabies in Morocco [60]. The same result was found in other studies. Kassir *et al*., (91%) [23], Cyrine Bennasrallah *et al*., (91%) [10], Kenza El bazi (70%) [26].

In many countries around the world, dogs are responsible for the majority of rabies cases. National data indicate that dogs are responsible for 94% of the biting animals responsible for human rabies in Morocco [5]. In our study, dogs were involved in 47.8% of exposure cases. Similar results have been observed in other studies, notably that of Kassir *et al*., (91%) [23], Cyrine Bennasrallah *et al*., (91%) [10], and Alladoumngar Madjadinan *et al*., (87%) [24]. In 54.5% of cases, the bites were caused by stray animals; a study carried out in Ethiopia obtained the same results (80%) [25].

The WHO has defined exposure to suspected or confirmed rabid animals in three categories **(Table 4)** [3]. Category III lesions accounted for 76.8% of all exposures. Lesions were multiple in 52.1% of cases and superficial in 62.6%. In the series by Stevens Kisaka *et al*., [16], 77.9% of lesions corresponded to category II, lesions were single in 63.6% of cases and superficial in 58%. In our series, 49.4% of exposures involved the upper limbs, explained by the instinctive use of the hand to defend oneself or to repel the animal, which increases the risk of bites in this part of the body. It is also

interesting to mention that in other studies, the lower limb has been identified as being the most affected [13-18].

Table 4 : Categories of exposure according to the WHO [3].

Catégorie I	Toucher ou nourrir l'animal, léchage de la peau saine	Pas d'exposition
Catégorie II	Mordillage de la peau nue, griffures ou égratignures superficielles sans saignement	Exposition miner
Catégorie III	Morsures ou griffures uniques ou multiples ayant traversé le derme, contamination des muqueuses ou d'une peau érodée par la salive après léchage par un animal, exposition par contact direct avec des chauves-souris	Exposition grave

CONCLUSIONS

The study highlighted the circulation of rabies virus in several animal species in Ouarzazate province, with the dog identified as the main vector and reservoir. In Morocco, despite the existence of a multisectoral national strategy and a free vaccine offer for both dog immunization and human disease, this strategy has a number of aspects to improve: the dog population is considerable and inadequately controlled, estimated at around 2,798,126, coupled with free movement and reproduction. In addition, the dog vaccination rate remains low, not exceeding 20%, and the lack of information among the population [5]. Mass vaccination of dogs is an effective way to break the rabies transmission chain, and it has been proposed that vaccination of 70% of dogs in endemic areas could considerably reduce the number of cases recorded per year [7]. In order to increase the effectiveness of rabies prevention and control, we advocate strengthening the synergy of action between stakeholders, notably human and animal health professionals, pet owners, local authorities and local communities. We also suggest undertaking more in-depth studies to assess the socio-economic impact of rabies, and to evaluate the quality of the control and surveillance system in Morocco.

Additional Information

Human Subjects

Consent was obtained or waived by all participants in this study. Comité d'éthique et de recherche-Hôpital Militaire Avicenne Marrakech. This is to certify that the research project described below has received the necessary human research ethics approvals as required by the Military Hospital Avicenne of Marrakech.

Animal Subjects: All authors have confirmed that this study did not involve animal subjects or tissue.

Conflicts of Interest: In compliance with the ICMJE uniform

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