

Animal exposures and Rabies in the Eastern central Region of Tunisia (Monastir 2004-2022)

Expositions animales et rage dans le centre - Est de la Tunisie: Un appel pour une approche seule santé (2004-2022)

Cyrine Bennasrallah^{1,3}, Malek Ghouli¹, Syrine Doghri¹, Mariem Kacem^{1,3}, Samia Said Grira², Amani Maatouk^{1,3}, Wafa Dhoubi^{1,3}, Manel Ben Fredj^{1,3}, Issam Maalel², Ines Bouanène¹, Hela Abroug^{1,3}, Imen Zemni^{1,3}, Asma Belguith Sriha^{1,3}

1. University of Monastir, Faculty of Medicine of Monastir, Fattouma Bourguiba University Hospital, Department of Epidemiology and Preventive medicine, Monastir, Tunisia.
2. The Regional Direction of Primary Health of Monastir, Monastir, Tunisia.
3. Technology and Medical Imaging Research Laboratory - LTIM - LR12ES06, Monastir, Tunisia

ABSTRACT

Introduction-aim: Rabies is a neglected zoonosis; it is a fatal but preventable disease. Despite eradication efforts, it remains a major health problem in many developing countries, including Tunisia. We aimed to describe the epidemiological pattern of human exposures to infected animals from 2004 to 2022 and to assess the impact of COVID-19 pandemic on rabies control in the governorate of Monastir (center of Tunisia).

Methods: We conducted a descriptive study using surveillance data from 2004 to 2022 in Monastir Governorate. All suspected exposures in Monastir that were notified to the Regional Directorate of Primary Healthcare during our study were included.

Results: A total of 35 056 human suspected rabies exposures were reported with an average of 1872.32 ± 221.4 cases per year. The incidence rate of suspected rabid exposures was 320.7 per 100,000 inhabitants with a significant annual percentage change (APC) of 1.35 (95% CI: 0.28; 2.49). Dogs represented the main source of suspected exposures (64.58%). From 2004 to 2022, there was an increase in vaccinated and stray dog bites and a decrease in bites from unvaccinated dogs. Comparing the pre- and post-COVID-19 period, we found a significant increase in the average annual number of animal exposures after COVID-19 (1860.3 ± 217 vs 1933.96 ± 231.9) ($p < 0.001$). The animal rabies positivity rate increased significantly with an APC of 3.74 (CI 95% 0.67-6.89). During the study period, rabies was confirmed in 185 animals and three fatal human cases were reported.

Conclusion: Our study highlights the importance of implementing the "One health approach" to achieve zero dog-mediated rabies and prevent deaths by 2030.

Keywords: COVID-19, Epidemiology, Post-Exposure Prophylaxis, Rabies, vaccination

RÉSUMÉ

Introduction-objectif: La rage est une zoonose négligée, mortelle mais entièrement évitable. Malgré les efforts, elle demeure un problème majeur de santé publique dans plusieurs pays en développement, dont la Tunisie. L'objectif de cette étude était de décrire le profil épidémiologique des expositions humaines aux animaux suspects enrégistré entre 2004 et 2022 et d'évaluer l'impact de la pandémie COVID-19 sur la lutte antirabique dans le gouvernorat de Monastir (centre de la Tunisie).

Méthodes: Une étude descriptive a été réalisée à partir des données de surveillance collectées entre 2004 et 2022 auprès de la Direction régionale des soins de santé de base de Monastir. Toutes les expositions notifiées durant la période ont été incluses.

Résultats: Au total, 35 056 expositions humaines suspectes ont été enrégistrées, soit une moyenne annuelle de $1872,3 \pm 221,4$ cas. L'incidence était de 320,7 pour 100 000 habitants, avec une variation annuelle significative de 1,35% (IC95 % : 0,28–2,49). Les chiens représentaient la principale source d'exposition (64,6 %). Les morsures des chiens vaccinés et errants ont augmenté, alors que celles des chiens non vaccinés ont diminué. Après la COVID-19, le nombre moyen annuel d'expositions a augmenté ($1860,3 \pm 217$ vs $1934,0 \pm 231,9$; $p < 0,001$). Le taux de positivité animale a augmenté avec une variation de 3,74% (IC95 % : 0,67–6,89). Au total, 185 cas de rage animale ont été confirmés et trois décès humains ont été notifiés.

Conclusion: La rage reste un problème persistant en Tunisie. Le renforcement de la surveillance et la mise en œuvre de l'approche « Une seule santé » sont essentiels pour atteindre l'élimination des décès dus à la rage d'ici 2030.

Mots clés: COVID-19, épidémiologie, prophylaxie post-exposition, rage, vaccination

Correspondance

Cyrine Bennasrallah

University of Monastir, Faculty of Medicine of Monastir, Fattouma Bourguiba University Hospital, Department of Epidemiology and Preventive medicine, Monastir, Tunisia.

Email: cyrine.bennasrallah@gmail.com

INTRODUCTION

Rabies is a neglected zoonosis caused by a neurotropic virus of the family Rhabdoviridae, genus *Lyssavirus* (1). Rabies is a zoonotic disease that affects the central nervous system of mammals, including humans, causing an encephalo-meningitis and leading to imminent death (1).

Although all mammals can be a source of rabies virus, dogs are considered its main vector. Indeed, canine-mediated rabies is responsible for up to 99% of human rabies cases (2).

Despite rabies is preventable but it's a fatal disease which makes it a public health problem of high threat to people mainly in Africa and Asia (3). Worldwide, the Rabies virus is accountable for nearly 59,000 human fatality cases each year (4). Besides being neglected and underreported, it is described as the zoonosis of poverty (5). Therefore, low- and middle-income countries are the most affected areas (4), since more than 95% of cases occur in countries from Africa and Asia (6).

Strategies and programs were established over the years to eliminate the transmission of the rabies virus. Many developed countries in Europe and North America were declared rabies free (7). However, rabies remains a major burden in the developing world due to poor education, lack of healthcare access and the heavy economic cost of pre- and post-exposure treatment (4).

In Tunisia dog mediated rabies is still endemic (8). Due to the highly lethal potential of rabies, a national program was established since 1982, including the Ministry of Agriculture, the Ministry of Health and the Ministry of the Interior to implement the free annual mass vaccination of domestic animals, the post-exposure prophylaxis (PEP) free of charge in the public sector and the management of the free-roaming dog population respectively.

At the end of 2019, the COVID-19 pandemic was a major concern and severely impacted essential health services and detoured them from other diseases control. Indeed, the strategies implemented by the Government to contain the coronavirus infection have altered the rabies control program and all non-emergency health activities were interrupted (9). Moreover, the pandemic has disrupted the vaccine supply and prevented dog bitten victims from seeking PEP because of lockdowns and restrictions (10).

Numerous studies have addressed rabies epidemiology in Tunisia (11–13). However, the potential impact of the COVID-19 pandemic on rabies dynamics remains insufficiently explored. Understanding the local epidemiology is essential to guide control and prevention efforts. In Monastir, cases of human rabies have been reported in recent years, indicating a potentially alarming situation.

In this context, the aim of our study was to describe the epidemiological profile of human exposures to animals from 2004 to 2022 and to assess the impact of COVID-19 pandemic on rabies control in the governorate of Monastir (Tunisia).

METHODS

Study design and setting

We carried out a descriptive study using surveillance data over 19 years, from 2004 to 2022.

The governorate of Monastir is situated on the northeastern coast of Tunisia divided into 13 delegations (Bekalta, Bembla, Beni Hassen, Jemmal, Ksar Helal, Ksibet El Mediouni, Moknine, Monastir, Ouerdanine, Sahline, Sayada Lamta Bouhajar, Teboulba Zeramdine). Monastir governorate is an urban area including approximately 599,769 inhabitants (inh) in 2024 (14). The initial management of suspected dogs' exposures is carried out in the emergency units, which provide first aid, and the basic health centres (BHCs) coordinate the follow-up of the protocol. To ensure comprehensive follow-up, each delegation in Monastir has a designated monitoring centre responsible for monitoring the rabies vaccination protocol in collaboration with the Monastir Regional Directorate of Primary Health Care (MRD).

Participants

Inclusion criteria:

Rabies is a notifiable disease; all suspected exposures are notified to the MRD. In our study, all suspected dogs' exposures, residents in Monastir Governorate and notified to the MRD from January 1st, 2004 to December 31st, 2022 were included.

Exclusion criteria:

Cases residing in different governorates were excluded.

Operational definitions and variables

Rabies exposure refers to any contact with a suspected or confirmed rabid animal. This includes bites, scratches or contamination of broken skin or mucous membranes by an infected animal's saliva, nervous tissue, or other potentially infectious material. All animals are considered potentially infected due to the endemic nature of rabies in the country.

Stray dog definition: Stray dogs were defined as ownerless animals that do not receive regular veterinary care.

In this study, vaccinated and unvaccinated referred only to owned dogs with a known vaccination status. Stray dogs were recorded separately and as vaccination campaigns in Tunisia target only owned dogs and we do not have information about their vaccination status, they were considered unvaccinated.

All animals involved in human biting incidents should be placed under observation, regardless of vaccination status.

The pre-COVID-19 period was defined as the time before March 3, 2020, the date of the first reported COVID-19 case in the country. The COVID-19 period was defined as beginning on March 3, 2020, and covering the years 2020, 2021, and 2022.

Variables of interest were: Demographic variables (age,

sex, delegation of origin), offending animals and their vaccination history, type of exposure (bite, scratch, lick, other (including open wound or mucous membrane contamination)), exposure sites, reported human and animal rabies cases, as well as the annual post-exposure prophylaxis (PEP) protocol adopted (protocol A and B).

Protocol A and B are Tunisia's PEP protocols for suspected rabies exposure. The first one (A) is administered when there is contact with apparently healthy known animal that could be kept under surveillance. The second one (B) is used when the offending animal is unknown, lost, dead, or laboratory rabid confirmed.

A complete protocol was defined as the administration of all prescribed doses in accordance with the recommended regimen (A or B).

Data sources and measurement

Data were collected from the MRD and from the national referral laboratory for human and animal rabies diagnosis in Tunisia, part of The Pasteur Institute of Tunis. Confirmed cases were defined as rabid only if the Fluorescent Antibody Test (FAT) on brain tissue was positive, in accordance with World Organization for Animal Health (OIE) guidelines (15).

Data analysis

Data were analyzed using the Statistical Package for Social Sciences (SPSS) software, version 21 (IBM Corp., Armonk, NY, USA). The crude incidence rate (CIR) of suspected rabies exposures was calculated based on Tunisian National Institute of Statistics data and was expressed per 100,000 inh (14). To assess the association of categorical variables, the chi-squared test was used ($\alpha \leq 0.05$). The means of annual animal bites before and after COVID-19 were compared using an independent sample t test (16). Trends over time were evaluated by calculating the Annual Percentage Change (APC) using the Joinpoint Regression Program. Relative Risk (RR) was estimated using Excel (version 2019). The 95% confidence intervals (95% CI) for percentages were calculated using the normal approximation (Wald method) for large samples, with calculations performed in Excel (Version 2019).

A p-value of ≤ 0.05 was considered significant for all the statistical tests.

Ethical considerations

We examined anonymized aggregate data and confidentiality was fully respected. No experiments involving humans or animals were conducted in this study. The research was carried out in accordance with all relevant guidelines and regulations. The Ethics Committee of the Faculty of Medicine of Monastir approved the study protocol.

RESULTS

Characteristic of animal exposures

From 2004 to 2022, a total of 35,056 suspected rabies exposures were notified to the MRD, with an annual

average of 1872.32 ± 221.4 cases per year. The CIR of suspected human exposure to animals in Monastir was 320.7 per 100,000 inhabitants (inh). Dogs' attacks accounted for 64.6% of suspected rabid animal bites, followed by rats (17.02%), cats (15.13%) and others (3.25%).

Overall, the trend of suspected rabid exposures increased significantly over time with an APC of 1.38 (95% CI: 0.28; 2.49) (Figure 1).

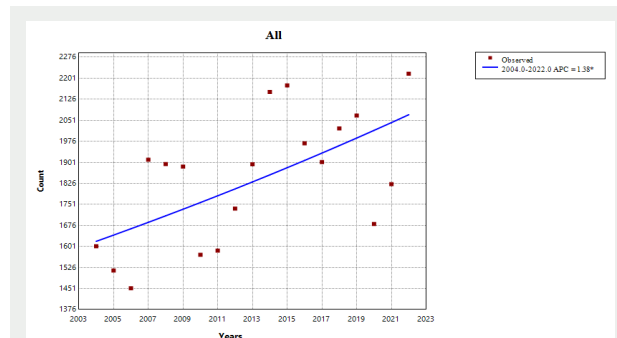


Figure 1. The annual percentage change (APC) of suspected rabid exposures (Monastir, 2004–2022).

During the study period, men (67.4%) were significantly more exposed than women (32.6%) ($p < 0.001$) and the most exposed age category was [5–14] years of age with a CIR of 556 per 100,000 inh and a RR of 2.744 (95% CI: 2.62–2.88). (Table 1).

Table 1. Crude incidence rates, relative risks, and trends of suspected rabies exposures according to victims and culprit animal's characteristics (Monastir, 2004–2022)

	N	(%)	CIR (95% CI)	RR
The Victims				
All	34956	100	320.7 (302.9–338.7)	
Gender				
Females	11516	32.6	232 (216.8–247.2)	1
Males	23538	67.4*	476 (454.2–497.8)	2.056 (2.01–2.10)*
Age groups				
1–4	1987	5.7	212 (197.5–226.5)	1
5–14	8981	25.7	556 (532.5–579.5)	2.744 (2.62–2.88)*
15–24	6443	18.4	356 (337.2–374.8)	1.891 (1.80–1.98)*
25–44	7618	21.8	248 (232.3–263.7)	1.269 (1.21–1.33)*
45–64	6926	19.9	378 (358.6–397.4)	1.845 (1.76–1.94)*
≥ 65	3001	8.6*	477 (455.2–498.8)	2.265 (2.14–2.39)*
Culprit Animal				
	N	(%)		
Animals				
Cats /Cattles	5943	17.08*	48.6 (41.6;55.6)	1
Dogs	22479	64.6	204.3 (189.9;218.6)	4.21 (4.08;4.35)*
Rats/ Others	6375	18.32	64.7 (56.7; 72.7)	1.33 (1.28;1.38)*
Status				
Vaccinated	9489	42.21*	87.1 (56.7;72.7)	1
Unvaccinated	8973	39.92	82.4 (73.3;91.4)	
Stray	4017	17.87	36.9 (30.8;42.9)	

CIR: Crude incidence rates, RR: Relative risk, 95% CI: Confidence interval change, *: p-value ≤ 0.05

By vaccination status, the majority of dog bites were caused by unvaccinated and stray dogs. Among targeted dogs, vaccination coverage was only 51% (9,489/18,462)

among culprit dogs in Monastir governorate. A significant increase in APC of bites by vaccinated 2.46 (95% CI: 0.44; 4.52) and stray dogs 4.74 (95% CI: 2.43; 7.10) was observed. However, there was a significant decrease in bites by unvaccinated dogs with an APC of (-1.30 (95% CI: -2.25;-0.34)).

Head, face and extremities accounted for 44.7% (n=15,694/35,109) of injury sites caused by animals. Most injury types were bites in 75.37% (26,414/35,047) of cases, followed by scratches and licks (19% and 4.38%, respectively). Injuries were superficial in 56.8% (19,449/34,244) of cases mildly severe in 32.35% (11,079/34,244) and deep in 10.85% (3,716/34,244) of cases.

Almost 90.8% (n=31,814/ 35,055) of animal bite victims sought medical attention within the first two days after the bite. Regarding PEP, 98.89% (n=34410) received a complete protocol (Table 2).

Table 2. Injuries characteristics and the applied post-exposure prophylaxis protocol characteristics (Monastir: 2004-2022)

	Number	%
Injuries characteristics		
Injury site (n=35,109)		
Head, face, extremities	15,694	44.70
Others	19,415	55.30
Injury type (n=35,047)		
Bites	26,414	75.37
Scratches	6,661	19.0
Licking / Others	1,972	5.63
Injury severity (n=34,244)		
Deep	3,716	10.85
Mildly severe	11,079	32.35
Superficial	19,449	56.80
Measures after rabies exposure		
PEP (n=35,088)		
Protocol A	21,815	62.17
Protocol B	13,273	37.82
PEP delay (Days) (n=35,055)		
≤ 2	31,814	90.75
> 2	3,241	9.25
Completion of PEP (n=34,795)		
Complete prophylaxis	34,410	98.89
Not complete prophylaxis	385	1.11

PEP: Post-exposure prophylaxis

Characteristics of animal exposures before and after the COVID-19

When comparing the pre- and post-COVID-19 pandemic periods, we found that the average annual number of animal exposures after COVID-19 was 1933.96 ± 231.9 , which was significantly higher than the average of 1860.3 ± 217 before the COVID-19 pandemic ($p < 0.001$). The characteristics of suspected rabid exposures before and after the pandemic showed that female exposure to animal bites was significantly higher before and after COVID-19 than male exposure ($p = 0.009$). Animal exposure did not differ significantly between individuals

aged ≤15 years and those >15 years, either before or after the COVID-19 period ($p = 0.11$). Higher rates of suspected rabies exposure after COVID-19 were statistically associated with unvaccinated /stray animal status ($p = 0.023$) and protocol A prescription ($p < 0.001$). In terms of PEP completion, incomplete protocols were found in 4% (n=181) of exposures after COVID-19 compared to 1% (n=204) before this period ($p < 0.001$).

After COVID-19, there was a significant increase in exposed individuals seeking medical care within 48 hours compared to the pre-COVID-19 period ($p < 0.001$) (Table 3).

Table 3. Characteristics of animal exposures before and after the COVID-19

Suspected rabies exposures (N)	Before COVID-19	After COVID-19	p-value
Gender (N=35,054)			
Male	19781 (67)	3757 (65)	0.009
Female	9552 (33)	1964 (35)	
Age (years old) (N=34,956)			
<15	1815(32)	9153 (31)	0.11
>=15	3806 (67)	20182 (69)	
Animal vaccination status (N=22,479)			
Vaccinated	7974 (42.5)	1515 (40.5)	0.023
Unvaccinated/stray	10768 (57.3)	2222 (59.4)	
Delay (Days) (N=35,056)			
≤2	26373 (89.9)	5441 (95)	<0.001
>2	2962 (10.1)	280 (5)	
Exposure category (N=34,244)			
Deep or severe	12586 (44)	2209 (39)	0.20
Superficial	15935 (56)	3514 (61)	
Protocol type (N=35,088)			
A	18163 (61)	3652 (64)	<0.001
B	11221(39)	2052 (35)	
PEP completion (N=34,895)			
PEP complete	29130 (99)	5380 (96)	<0.001
PEP incomplete	204 (1)	181 (4)	

PEP: Post-exposure prophylaxis

Animal rabies and human rabies cases in Monastir governorate

During the study period, a total of 370 animals were tested for rabies with a positivity rate of 49.73% (n=185). From 2004 to 2022, the positivity rate increased significantly with an APC of 3.74 (CI 95% 0.67-6.89).

Three human died from rabies in Monastir during the whole period of study after being bitten by two stray cats and a stray dog. None of the three victims benefited from the PEP. (Table 4).

Table 4. Reported human rabies cases from 2004 to 2022 in Monastir, Tunisia

	Notification's year	Sex of humans	Age (Years-old) cases	Source of exposure	Incubation period	PEP
Case 1	2008	Male	---	Stray cat	9 months	No
Case 2	2021	Female	60	Stray cat	3 months	No
Case 3	2022	Female	6	Stray dog	1 month	No

PEP: Post Exposure Prophylaxis

DISCUSSION

Key results

During the study period, 35,056 human exposures to rabies were declared to the MRD with an annual average of 1872.32 ± 221.4 cases per year. The total incidence rate of suspected rabid exposure was 345.42 per 100,000 inh with a significant upward trend. When we examined the pre- and post-COVID-19 period, we found a significant increase in the annual average number of animal exposures post-COVID-19. We also found that exposure to unvaccinated animals and the number of people who did not complete the PEP protocol were higher after the pandemic. Three fatal cases of human rabies were reported during the study period, two occurred during the COVID-19 period.

Interpretation

The incidence rate of suspected rabies exposures in Monastir was 345.42 per 100,000 inhabitants. This rate was comparable to the national incidence reported by Kalthoum et al. (17), lower than that observed in Kasserine governorate (694 per 100,000 inhabitants) (18), and higher than those reported in other countries of the MENA region like Lebanon (19).

The significant increase of suspected rabid exposure during our study period can be attributed to two substantial incidences. The Tunisian revolution resulted in a political and social instability that had negative consequences on disease surveillance and on vaccination coverage (19). Male individuals were the most exposed to animal bites, which was consistent with previous studies carried out in different endemic countries in Africa like Kenya and Ethiopia (20,21). The male predominance may be related to the type of outdoor activities men engage in. They tend to spend more time outside the home, have higher exposure to animals, and exhibit more conscious risk-taking behavior (22).

People aged between five and 14 years had the highest exposure rate to suspected rabid animals. This age group is generally more involved in outdoor activities and therefore more likely to interact with animals (23). Although the demographic structure in Tunisia is characterized by a female compared to males, our findings showed that boys were more frequently exposed than girls. This difference may be explained by behavioral

factors, as boys are often more prone to approaching or teasing stray animals.

Our study showed an increase in vaccinated and stray dog bites and a decrease in unvaccinated dog bites. Indeed, the rabies control strategy includes stray dogs culling to reduce the risk of infection to humans. Since 2015, the municipality of Monastir has reported substantial decrease in this practice. Animal rights defense groups debated this controversial practice after the revolution (2011), leading to its suspension and an increase in stray dogs. This increase may also be related to deficiencies in trash management in Tunisia and to the growing trend of pet ownership among Tunisian families, particularly during and after the COVID-19 period. Moreover, the pandemic disrupted the rabies control program, notably the surveillance system and the annual vaccination campaigns (9).

According to our findings, vaccination coverage among the targeted owned dogs was 51 % (9,489/18,462). This is far from the 70% coverage recommended by the World Health Organization (WHO) for effective rabies control and elimination (24).

The vaccination of canine population in Tunisia was 48% in 2015, which is higher than the rate observed in other countries (25). Since 1982, authorities have provided free vaccine for dog owners and have completely funded the rabies vaccination program. Still, it did not achieve the rate that allows for an effective canine rabies control for different reasons can intervene that negatively affect reaching the 70% threshold, such as the financial burden and the lack of human and logistic resources in certain regions. In our context, low vaccination coverage could be attributed to lack of awareness of the need to vaccinate animals and lack of penalties for non-compliance.

The adherence to vaccination protocols implemented by annual vaccination campaigns should be reinforced. In fact, Handous and al. evaluated the immune response of dogs after a mass vaccination campaign and concluded that primary immunization does not ensure durable seropositivity compared to dogs that had received multiple vaccinations (26). In Tunisia, mass vaccination campaigns are often conducted under difficult conditions. The door-to-door approach brings practical challenges. Owners may not be present at the time of the visit, and animals can be too agitated to allow proper administration of the vaccine. Another frequent issue is maintaining the cold chain, since vaccines can lose their effectiveness if exposed to high outdoor temperatures for too long.

Furthermore, the difficulty in assessing the whole dog population due to the lack of information regarding stray dogs and free roaming dog population and its significant turnover rate can influence the immunization coverage. Indeed, the government must set strict measures for their control by generalizing the vaccination of stray dogs, limiting their reproduction by opting for castration methods, allowing animal protection associations and members of the community to be part of stray dogs control plan and establishing legislations that regulate pets' ownership and their vaccination regimen. As it was the case in turkey where it was prohibited by law

to abandon pet and making a legal identification with a vaccination record mandatory (27). Sri Lanka, along with Turkey, both implemented neutering as a way of controlling stray dogs' population density(27,28).

Most animal bite victims (90.75%) sought medical care within the first 48 hours after the aggression. However, MRD records did not include human exposures that were not reported and consequently did not receive any PEP which may lead to overestimated results. Therefore, these results might be overestimated.

Our study assessed the impact of the COVID-19 pandemic on exposure to suspected rabid animals and on PEP. The results showed a significant increase in the yearly average number of animal exposures post-COVID-19. It also showed higher exposure to unvaccinated animals and higher rate of protocol incompleteness compared to before COVID-19.

These findings reflect the disruption of rabies surveillance program during the COVID-19 era around the world in result of prioritizing its control(29). Dog vaccination campaigns were interrupted and the access to healthcare facilities was limited to emergencies. Meanwhile, there was an increase in free roaming dogs due to the suspension of stray dog control strategies and the high number of abandoned owned dogs after the pandemic. Indeed, many families adopted pets during containment, but a large proportion were abandoned once restrictions were lifted.

During the study period, three cases of human rabies were notified. None of the cases received PEP and all of the animals responsible for the exposure were unvaccinated stray animals. This mirrored the lack of knowledge about rabies exposure and prevention. Our study highlighted the importance of implementing stronger strategies against rabies spread. We need to intensify awareness movements and educate younger individuals about the disease, its risks and how to act once exposed to a suspected animal.

Serious actions are needed to achieve the "Zero by 30 goal" (30). Achieving the goal of eliminating dog mediated rabies by 2030 requires a collaboration between human and animal health sectors while also including different members of the community using the concept of One health approach.

Despite several limiting factors, the rabies control program in Tunisia remains the only program that has effectively applied the One Health approach.

Limitations and strengthens

The present study provided comprehensive data for rabies situation in the past two decades and a projected trajectory to 2030. However, our study had a number of limitations that need to be mentioned. First, it did not include the victims who did not seek medical assistance post-exposure which may have caused an underestimation of the incidence rate of exposure, as well as the incidence rate of human rabies. Second, the animal bite surveillance system in Tunisia is passive resulting in underreported cases.

Lastly, our study is one of the few research projects that assessed the epidemiology of rabies exposure and the PEP practices in Tunisia. However, it only covered a restricted geographic region of the country.

CONCLUSION

Rabies remains a major public health concern in Tunisia. To reduce the risk of rabies, public education on rabies prevention should be promoted through the media and by organizing rabies awareness days. Vaccinating owned dogs has proven to be a cost-effective control strategy in the medium to long term. This approach should be combined with effective management of the stray dog population and ensuring access to post-exposure prophylaxis. These preventive measures should be implemented widely and maintained over time. Their application will depend on collaboration between human, animal and environment sectors. All of this, in order to reach the WHO goal of zero human deaths from dog mediated rabies by 2030.

Abbreviations

UVD: Unvaccinated dogs

SD: Stray dogs

PEP: Post-Exposure prophylaxis

MRD: Monastir Regional Directorate of Primary Health

95% CI: Confidence Interval

WHO: World Health Organization

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