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Rabies Surveillance and Dog Population Management: Insights from a Survey of Roaming Dogs in Qatar 2024

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Abstract

In 2024, a total of 1,333 roaming dogs were sampled across Qatar to estimate their population size and test for rabies. Surveyed areas were randomly selected to ensure representation across all municipalities and zones, encompassing 419 of 4,000 total blocks. A portable laboratory device analyzed biological samples directly in the field. The results showed that all tested dogs were free of rabies, with male and adult dogs being more prevalent. Most sampled dogs were in relatively good health, exhibited friendly behavior, and had strong appetites. This study prioritized animal welfare by vaccinating all examined dogs against rabies, following protocols approved by Qatar University's Institutional Animal Care and Use Committee (IACUC). The absence of both rabies and leishmaniasis suggests the effectiveness of disease control measures, with significant implications for public health and policy-making. These findings support a high level of confidence that the prevalence of these diseases within Qatar's canine population is low or nonexistent. The results underscore the importance of ongoing monitoring and preventive measures to sustain Qatar's rabies-free status and highlight the need for sustainable population management of roaming dogs to minimize zoonotic risks, thereby enhancing public health and safety.

Keywords: Dog population, Rabies, Qatar and roaming dogs

INTRODUCTION

Rabies (RABV) is a fatal zoonotic disease and a significant global public health concern. Ranked among the most lethal infectious diseases 26,18, it is a viral encephalitis caused by viruses of the genus LYSSAVIRUS within the RHABDOYIRIDAEae family. Rabies can infect all mammals, including humans, and is responsible for at least 59,000 human rabies-related deaths annually worldwide, though the true burden is likely higher due to diagnostic challenges, particularly in rabies-endemic regions 18 , 34. Rabies not only poses a human health risk but also affects livestock populations, particularly cattle, sheep, and goats, in regions such as South America 6. Lyssaviruses are transmitted through saliva, making it the preferred sample for studying viral shedding 14.

Since no effective treatment exists once neurological symptoms appear, rabies has a near 100% case-fatality rate, making it the deadliest zoonotic disease in the world. Canine-mediated rabies accounts for tens of thousands of human deaths annually, particularly in Asia and Africa, where an estimated 99% of human rabies cases are linked to canine transmission 35. In contrast, in North America, parts of Western Europe, and Australia—where transmission by dogs is largely controlled—bats and other wildlife species serve as the primary reservoirs 19 , 35 . However, in many developing nations, especially in Africa and Asia, dogs continue to be the predominant RABV reservoir 10. After India, China reports the highest annual incidence of human rabies cases, with dogs playing a pivotal role in transmission, driven by socioeconomic and climate factors 16. Areas with inadequate waste management, such as poorly maintained or substandard landfills and slaughterhouses, provide a stable food source for roaming dogs, increasing their population density and elevating RABV transmission rates23. Additionally, climatic conditions influence rabies epidemiology, with higher temperatures positively correlated with increased rabies incidence, while greater precipitation is associated with lower transmission rates25.

The RABV virus, along with other lyssaviruses, is a negative-sense, single-stranded RNA (-ssRNA) virus. These RNA viruses exhibit high mutation rates and rapid evolutionary changes through natural selection and recombination, enabling them to adapt efficiently to new hosts and cellular environments. Given these evolutionary dynamics, controlling rabies transmission requires sustained surveillance and proactive intervention strategies.

Dog-mediated rabies transmission is influenced by multiple factors, including dog population density, shared national borders, poverty levels, and infrastructure, including road density2, 21. Asia accounts for approximately 59% of global rabies deaths, followed by Africa at 36% 33,35 . While dog population density plays a role, other research has emphasized that the mere presence of dogs—regardless of their density—can be a primary factor in transmission. Furthermore, the geography of a given area may enable or constrain virus diffusion 7. In countries with poor monitoring and diagnostic capacity, responses to suspected rabies outbreaks have often relied on mass culling of dogs. However, such reactive strategies have been found to be largely ineffective 28, 27.

Street dogs are generally not classified as purebred breeds. Instead, they fall into two broad categories: mixed-breed dogs and unbred landraces, such as the Indian pariah dog (Pal, 2001). A landrace is a domesticated, locally adapted canine variety that has adapted over generations to both its natural and cultural environments, such as agriculture and pastoralism, and in isolation from other populations of the species15 . As a result, landrace populations often exhibit distinct physical and behavioral traits shaped by their respective ecosystems.

The defining characteristic of a stray dog is the absence of ownership, rather than any specific physical trait such as size, coat type, or color (Wildlife Education and Directory of Wildlife Experts, 2020). Regardless of ownership status, canines exhibit significant morphological variation, influenced by breed, lineage, and environmental conditions. They may have elongated or flat faces, floppy or upright ears, compact or lanky bodies, and tails that are fluffy, curled, or absent altogether. 8classified dog breeds based on size, categorizing them as follows: toy and miniature (e.g., Chihuahuas, Pomeranians), medium-sized (e.g., terriers, spaniels), large (e.g., retrievers, shepherds, setters), and giant breeds (e.g., mastiffs, Komondors, Saint Bernards). This spectrum spans a weight range from 5 to 250 pounds (2.3 to 114 kilograms), with the heaviest dog ever recorded being an Old English Mastiff, weighing 314 pounds (142 kilograms).

Larger breeds are uncommon in Qatar. To better reflect the local dog population, SESRI consulted veterinary and animal research experts from the Ministry of Municipality and the Ministry of Environment to develop a

regionally relevant weight classification:

- Small: up to 22 pounds (10 kilograms).
- Medium: 23 to 55 pounds (11 to 25 kilograms).
- Large: 56 to 99 pounds (26 to 45 kilograms).
- Giant: 100 pounds (46 kilograms) or more.

This classification accounts for potential differences due to health status. For example, an overweight dog may exceed the typical weight range but does not necessarily belong to a larger breed category. Within breeds, size variability exists, with males generally larger than females. Mixed-breed dogs also encompass a broad range of sizes due to diverse genetic influences. A prevalent breed type in Qatar is known as the "Local" dog ("Mahali" in Arabic), a regional variety of the pariah dog lineage found in South Asia. These medium-sized dogs have inhabited the Middle East for centuries, naturally adapting to the region's extreme temperatures through natural selection.

Beyond ownership status, a dog's physical condition often serves as the primary indicator of whether it is a stray or a pet. Stray and roaming dogs often appear emaciated, with prominent bones or a swollen midsection, typically caused by parasitic infections rather than adequate nutrition. Their coats are often unkempt and dirty. Long-haired dogs or those with thick undercoats may develop severe matting, leading to secondary health problems. Certain breeds may also exhibit noticeable eye or nasal discharge, and overgrown nails may curl into the paw pads, causing discomfort. In summary, signs of neglect and environmental exposure are key indicators of a stray or roaming dog. These characteristics, combined with the type of locations where they are observed, serve as the primary means of identifying them.

Objectives of the Study

The primary study aim is to estimate the size of the roaming dog population; however, this paper focuses on the following objectives:

1.Rabies Testing: Assess the prevalence of rabies in roaming dog populations using field-based portable laboratory devices.

2.Health Assessment: Evaluate the overall health and welfare of roaming dogs based on physical indicators such as body size, behavior, and appetite.

3.Disease Surveillance: Monitor for the presence of other zoonotic diseases, such as leishmaniasis, in addition to rabies.

4.Demographic Analysis: Examine the distribution of sex and age within the roaming dog population.

5.Informing Policy and Public Health Interventions: Use findings to support public health policies and animal welfare strategies in Qatar.

2- Methodology and Materials

This study was conducted with the permission of the Institutional Animal Care and Use Committee at Qatar University (QU-IACUC) and was approved under Ethics Commission No. (QU-IACUC 010/2024). The Institutional Review Board (IRB) also approved the sedation protocol for aggressive dogs, which was applied in the study. Veterinarians participating in the study were certified by the Collaborative Institutional Training Initiative (CITI Program). As a safety measure, study personnel were vaccinated against rabies.

All dogs within the sampled areas were captured irrespective of temperament or disposition. A specialized veterinarian evaluated each captured dog based on its behavior, and the results indicated that approximately 11% of the dogs exhibited aggressive behavior, while most dogs were calm, with many displaying friendly behavior. Dogs were captured using nets and cages and then marked with identification tags. In cases of

severe aggression, sedation was administered following the approved protocol before handling.

To assess body condition, the Purina Body Condition Score Chart, a 9-point system, was used to evaluate canine health. Following rabies testing, all dogs were vaccinated and safely released back into their environment.

Sampling

The State of Qatar is administratively divided into eight municipalities, which are further subdivided into 98 zones. These zones are geographically structured according to a housing sample frame, consisting of 4,497 blocks.

The research team conducted an exploratory survey of roaming dogs across all geographic zones of Qatar. The survey aimed to update the mapping of roaming dog populations and collect a representative sample from all zones. In total, this survey covered 4,497 census blocks across eight municipalities.

Following the exploration phase, a random sample of 419 geographical blocks was selected see attached (1) selected area map. Table (1) presents the distribution of these sampled blocks across various municipalities. The sample predominantly covers Doha and Al Rayyan, which together account for nearly 68% of the surveyed blocks. This distribution aligns with Qatar's housing density, as the majority of residential units are located in these two municipalities. The remaining municipalities contribute smaller, yet proportionate, shares to the overall sample.

Table 1: Number of Sample Blocks according to Municipality

Municipality	**Number of Blocks**	**Percentage**
Doha	183	43.7
Al Rayyan	101	24.1
Al Wakrah	34	8.1
Umm Sala	18	4.3
Al Daayen	17	4.1
Al Kour and Al Dhakhira	29	6.9
Al Shamal	10	2.4
Al Sheehaniya	27	6.4
Total	419	100

Data Collection

Data were collected from October to November 2024. Field teams were deployed across municipalities and zones in Qatar according to the probability sample. A total of 22 teams participated in the study, including those responsible for rescuing unhealthy or injured dogs for treatment.

Each team consisted of a veterinarian, three laborers responsible for capturing dogs, and a data entry specialist. All teams were trained in research-based handling techniques to ensure both worker safety and the welfare of the dogs.

The data entry specialist used a mobile application to record laboratory test results, document each dog's characteristics, and log its capture location using the Global Positioning System (GPS). A customized field tool was developed specifically for this study to record detailed descriptions, characteristics, and images of

dogs.

Biological Sample Collection and Diagnostic Techniques

The diagnostic protocol included a Rabies Antigen Rapid Test for all sampled dogs. Had any dog tested positive, a chromatographic immunoassay (Rabies Ag Canine Test Kit, Bionote, Korea) would have been conducted following the manufacturer's instructions30. Had any positive results been found, they would have been confirmed using the gold standard test—the direct fluorescent antibody test and brain sample collection, in accordance with the WOAH Terrestrial Manual (2018, Chapter 2.1.17).

Roaming dogs, particularly those exhibiting nervous or aggressive behavior, were captured using live traps or catch poles. Sedation was administered intramuscularly (I.M.) at a dosage of 5–30 µg/kg using Medetomidine Hydrochloride (1 mg/ml) (Ilium Medetomidine, Troy, Australia), as described in 24.

3- Results

Sample Management

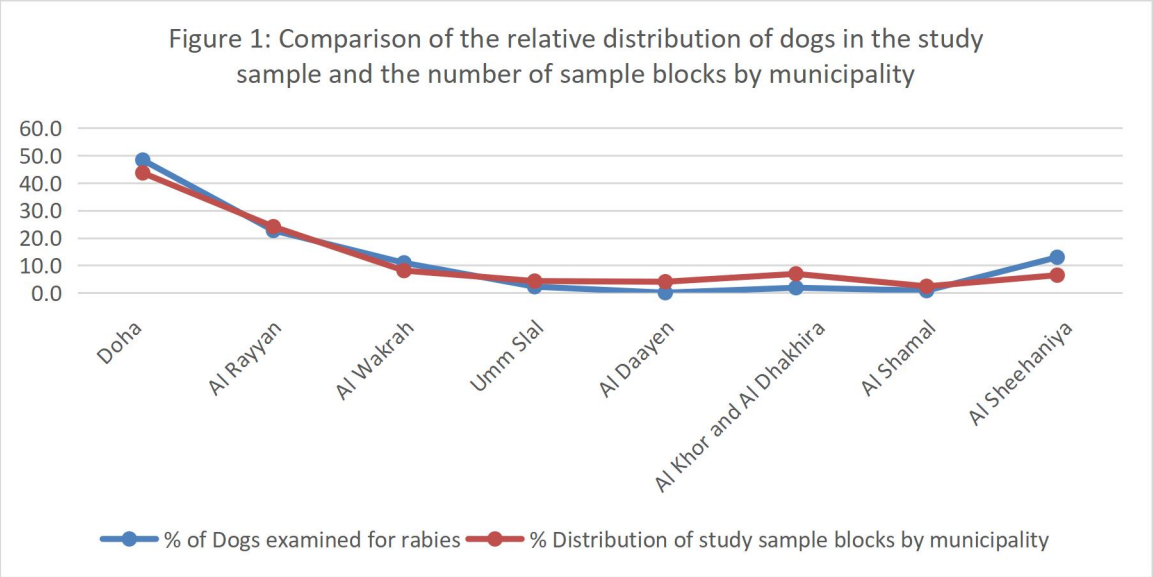


Figure 1 shows that the Municipality of Doha had the highest percentage of dogs examined for rabies (48.4%) and the largest proportion of the study sample blocks (43.7%). Al Rayyan had the second-highest proportion, with 22.7% of dogs examined for rabies while accounting for 24.1% of the study sample blocks. The other municipalities had smaller shares in both rabies examinations and the distribution of study blocks. Overall, all municipalities and zones were represented in the study sample.

Dogs Characteristics

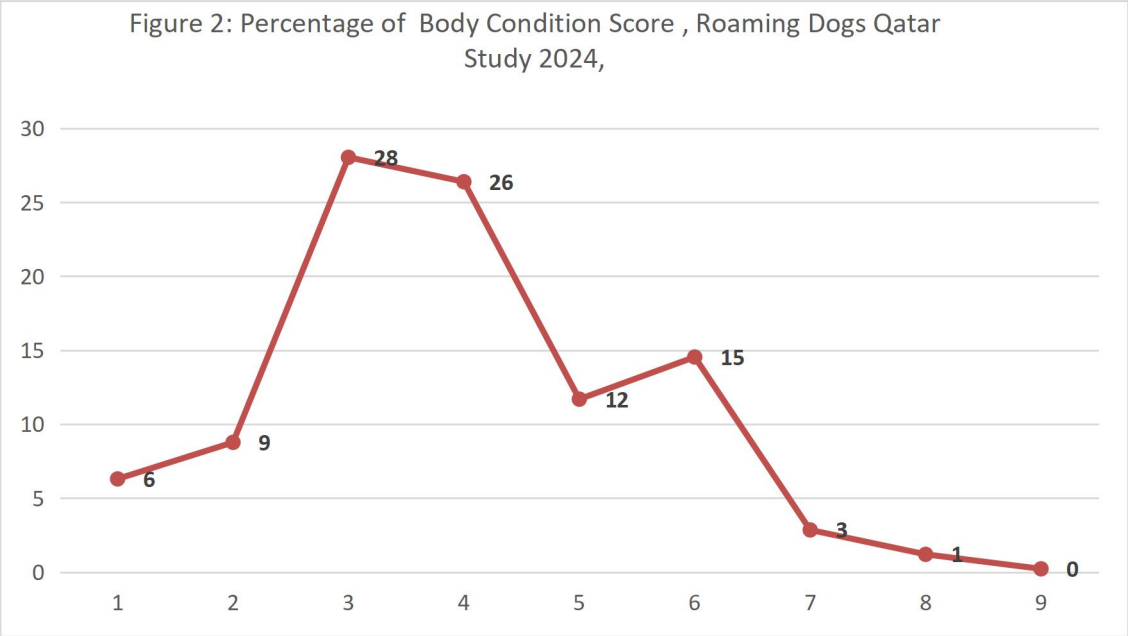
Table 1: Roaming dog characteristics

Dog Characteristics	**Categories**	**Freq**	**Percent**
Sex	Male	767	57.5
	Female	566	42.5
Age Group	Puppy	449	33.7
	Adolescent	344	25.8
	Adult	540	40.5
Dog Size	Small	332	24.8

	Medium	571	42.8
	Large	430	32.2
Dog behavior	Aggressive	153	11.4
	Frightened	386	28.9
	Friendly with good appetite	742	55.6
	Anxious	47	3.5
	Other	5	0.37
Breed type	Crossing breed	979	73.4
	Local	209	15.6
	Sloughi	33	2.4
	Canaan	51	3.8
	German Shepherd	11	0.8
	Other	50	3.8
Total		1,333	100

The data allow for an analysis of roaming dogs based on their characteristics, including sex, age, size, breed, and observed behavior. Table 1 presents the descriptive statistics for the total number of 1,333 dogs examined, including 767 male dogs (57.5%) and 566 female dogs (42.5%). A plurality of the sampled roaming dogs were adults (40.5%), followed by puppies (33.7%), while adolescents comprised 25.8% of the sample. The majority of roaming dogs were categorized as friendly with good appetite (55.6%), followed by frightened dogs (28.9%). A smaller proportion exhibited aggressive behavior (11.4%) or anxious behavior (3.5%), while five dogs (0.37%) whose behavior could not be characterized were placed into the “Other” category.

Table 1 also summarizes the size distribution of the sampled dogs. Medium-sized dogs were the most common (42.8%), followed by large dogs (32.2%), while small dogs made up 24.8% of the sample. The "Crossing breed" represented the majority at 73.4%, followed by local breeds at 15.6%. Other specific breeds included Sloughi (2.4%), Canaan (3.8%), and German Shepherd (0.8%), with "Other" breeds comprising 3.8%. Finally, the majority of sampled roaming dogs were classified within body condition scores of 3 (28.04%) and 4 (26.39%), indicating that most dogs fell into mid-range body condition categories (Figure 2).



Rabies Test Results

During the study, all 1,333 sampled stray dogs were tested for rabies infection using the Rabies Antigen Rapid Test and polymerase chain reaction (PCR). All samples collected from these dogs tested negative for rabies. These results indicate that rabies was not detected in this representative sample during the study period.

4. Discussion

This study underscores the ongoing and effective management of stray dog populations in Qatar. These findings align with this study4, who include Qatar alongside Bahrain and the United Arab Emirates as exceptions to the general regional trend of rabies presence. Nevertheless, findings from other studies in the region highlight the need for continued vigilance given how rapidly the disease can spread if not properly monitored. The roaming dog population in Qatar—categorized by sex, age, size, and breed—largely aligns with findings from other studies, which report a higher number of males than females, a greater prevalence of mixed breeds, and most dogs being in good health based on size. These factors are largely attributed to the availability of shelter and food, particularly in the industrial area of Doha Municipality. Additionally, they reflect centuries of adaptation and the intelligence of the species. Stray dogs and cats have been shown to obtain sufficient food even in poorly managed urban environments, contributing to population growth. Street dogs display a marked preference for proteins over carbohydrates when foraging (Bhattarai et al., 2021), with vaccination campaigns potentially influenced by canine nutrition and infrastructure capacity17. Overall, male dogs tend to exhibit higher survival rates than females. In an older study from the Zaghouan Governorate in Tunisia, the prevalence of male dogs was much higher than in this study, with a sex ratio of approximately 2.75 males per female—more than twice the ratio found in Qatar (1.35:1) (Artois, 1986, cited in S. Kalthoum, 2021.

While the results from Qatar suggest either a low prevalence or an absence of rabies during the study period, studies from elsewhere in the region indicate that rabies remains a serious concern. For instance, Darkaoui et al. (2017) documented over a century of efforts to combat rabies in Morocco, yet in 2015, the country still officially recorded 248 cases, confirming 82% of them. Similarly, confirmed 37% of 91 suspected cases in Saudi Arabia, while a study in Yemen (Al-Shamahy et al., 2013) found that 63% of 180 suspected animal brain samples tested positive for rabies. In Oman, 13found that 54% of 64 animal samples tested positive for

rabies between 2017 and 2019, though the majority of cases were not from canines. Notably, these studies primarily involved retrospective testing of suspected cases rather than random samples, which limits direct comparability. Nevertheless, they support the conclusion of 4 that rabies remains endemic in the region, including in countries of the Arabian Peninsula, with stray dogs consistently identified as a major reservoir for the virus. Given the persistent public health challenge posed by rabies in free-roaming dog populations across the region, comprehensive rabies control programs—including mass dog vaccination, public awareness campaigns, and effective management of stray dog populations—remain crucial, along with continuous monitoring 18. A vaccination target of 70% of canines has frequently been cited as the benchmark for cost-effective and sustained control17,9,29.

Although no rabies cases were found among the sampled roaming dogs in Qatar during this study, the risk of rabies introduction underscores the need for sustained vigilance, as a single rabid dog could alter the epidemiological landscape. Indeed, in both 2018 and 2019, Qatar documented cases of workers diagnosed with RABV contracted in Nepal31. Sustained surveillance programs serve as an integral component of long-term rabies control and prevention strategies. Such measures offer a proactive approach in contrast to reactive strategies that rely on testing suspected cases only after an outbreak has occurred. Furthermore, concurrent efforts to promote animal welfare and public health, including mass vaccination campaigns, will reduce the likelihood of future outbreaks. Ethical and sustainable population management methods, backed by legislative and policy support, can further strengthen these efforts. As exemplified by the well-known Prophetic teaching, “Tie your camel and trust in Allah,” prudent preparation goes hand in hand with faith, mirroring the Western adage that “an ounce of prevention is worth a pound of cure.”

5. Conclusion

In addition to indicating that Qatar likely has no active rabies cases among its roaming dog population, this study provides valuable insights into the characteristics and behaviors of these dogs in the surveyed areas. The key findings are as follows:

Rabies (and Leishmaniasis) testing: All 1,333 roaming dogs sampled across the State of Qatar tested negative for rabies, and no cases of leishmaniasis were detected. These results suggest that disease control measures are effective and that Qatar is likely free of these infections.

Population Demographics: Male and adult dogs are more prevalent among roaming populations, reflecting behavioral and environmental influences on their movement patterns and survival rates.

Breed and Size Distribution: Medium-sized and local or mixed-breed dogs constitute the majority of the population, highlighting the need for welfare programs and management strategies tailored to these groups.

Behavioral traits: Most roaming dogs display friendly behavior, an important consideration for shaping approaches to community-based care initiatives.

Body Condition Scores: The majority of dogs exhibit moderate body condition, with relatively few in severe states. This finding reinforces the importance of environmental and dietary factors in supporting canine health.

Adaptability and Resilience: Roaming dogs demonstrate diverse characteristics and strong survival skills, highlighting the importance of flexibility in addressing individual needs when implementing management or rescue programs.

The findings from this study underscore the need for targeted interventions, breed-specific programs, and ongoing research to understand better the factors shaping roaming dog populations, improve animal welfare, and safeguard public health. Integrated management programs, including mass vaccination, continuous monitoring, and community engagement, should be maintained and strengthened to sustain Qatar’s rabies-free status and reduce zoonotic risks more broadly.

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Attached 1 : Sampled Area Map- State of Qatar Map