

The Effect of Age, Sex, and Geographic Area on the Prevalence of *Pseudomonas aeruginosa* Isolated from infected Ears of Dogs in Baghdad: A Field Study

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Abstract:

Background:

Otitis externa is one of the most common inflammatory disease of dogs around the globe, to which, *Pseudomonas aeruginosa* is a significant causative pathogen due to its natural resistance to many antibiotics and chronic persistent infection.

Aims:

This study aimed to investigate the effect of Age, Sex, Location, and Type of Husbandry on the presence of *P. aeruginosa* in otitis externa in canine patients in Baghdad, Iraq.

Results:

50 otitis externa affected dogs were recruited from veterinary clinics in Rusafa and Karkh districts. Ear swab specimens were taken to be processed to microbiological culture for biochemical identification using conventional methods and the Vitek 2 compact system. *P. aeruginosa* was isolated in 11 of the 50 subjects (22% prevalence). Analysis of age showed a U-shaped distribution, with a 22.22% prevalence in dogs of less than 1 year of age, 12.5% in young adult dogs of 1-2 years, and 31.25% in dogs of more than 2 years ($p = 0.0085$). Zonal distribution showed a Karkh district prevalence of 35.29%, while Rusafa district had a 15.15% ($p = 0.0237$) prevalence. Analysis of Husbandry type showed a 25.93% prevalence of *P. aeruginosa* in domestic dogs, 20% in stray dogs, and 15.38% in farm dogs ($p = 0.0078$). The sex distribution of the studied subjects was almost equal, with 48% males and 52% females, and a high prevalence of 20.83% in males and 23.08% in females.

Conclusions: Age, location, and type of husbandry were significantly associated with the prevalence of *P. aeruginosa* in canine otitis externa in Baghdad, and suggests the need for increased preventive

measures in these high risk groups.

Keyword: Otitis, dog age, sex, geographic area



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Introduction:

The condition known as Otitis Externa involves the external auditory canal (from the tympanic membrane to the pinna), which causes inflammation. (Bajwa, 2019) The condition is widespread and difficult to treat in both people and animals as evidenced by many clinical studies. Otitis Externa involves both acute and chronic inflammation. Acute inflammation is characterized by the presence of redness and mild pain, while chronic inflammation is associated with profound tissue remodeling, and the case is complicated by the presence of exudates, which is associated with high levels of morbidity in the patients (Nuttall, 2023, Saridomichelakis et al, 2007). The condition is complex (and in most cases not simple) due to its numerous causes which can be categorized as predisposing, primary, and perpetuating factors as proposed by Rosser (2004), The condition involves a cycle of inflammation, epithelial breakdown, and microbial ecosystem imbalance, which, in most chronic cases. The many factors that lead to the condition involve both host and external factors, and often .(require analysis of the external factors, which include micro-flora (Cole, 2009, Zur *et al.*, 2011

Otitis external is one of the most common presentations worldwide in veterinary clinics, with studies estimating the prevalence based on breed and geographical location. Hill et al. (2006) noted in the otitis external survey of the dermatological conditions in small animal practice throughout the UK that it is a significant clinical and economic condition, as it accounts for approximately 15-20% of dog dermatology consultations. O'Neill *et al.*, (2021) most recent study using UK primary veterinary .care data found that breed prevalence varied significantly

From acute lesions, which may include itching that responds to treatment, to more chronic refractory cases, which may include persisting pain, foul-smelling discharge, and significant tissue/histological changes that may include epithelial thickening, hyperplasia, histological changes including glandular hyperplasia, stroma fibrosis, and in advanced cases, mineralization of the cartilage (Harvey *et al.*, 2001; Ginel *et al.*, 2002). Nuttall (2023) and Bajwa (2019) also noted that chronic otitis externa is defined as disease lasting >3 months or recurring within that period, despite appropriate treatment.

Materials and Methods:

Study Design and Setting

This field study was conducted between December 2024 to June 2025 in Baghdad, Iraq. The study enrolled 50 dogs presenting with clinical signs of otitis externa to veterinary clinics in the Rusafa and

Karkh districts of Baghdad. Ear swap collected from clinical diagnosis of otitis externa confirmed by veterinary examination (presence of ear canal erythema, discharge, malodor, and pain on palpation of the ear base), no topical or systemic antimicrobial treatment within the preceding seven days to avoid interference with culture results.

Sample Size and Inclusion Criteria

A total of 50 dogs were enrolled in this study based on the following inclusion criteria: clinical diagnosis of otitis externa confirmed by veterinary examination (presence of ear canal erythema, discharge, malodor, and pain on palpation of the ear base), no topical or systemic antimicrobial treatment within the preceding seven days to avoid interference with culture results, complete demographic data available for analysis, and owner consent for sample collection. Exclusion criteria included recent ear cleaning or treatment that could reduce bacterial yield, known or suspected tympanic membrane rupture, and concurrent systemic illness requiring immediate hospitalization.

Data Collection and Sample Processing

Age of dogs, was recorded in months or years and subsequently categorized into 3 groups; less than one year, one to two years, and more than two years. Sex, was recorded as male or female. Husbandry type were categorized into three groups; domestic dogs, local stray or community dogs living freely without a single owner, and farm dogs living primarily outdoors on agricultural properties .

Samples were cultured onto nutrient agar, MacConkey agar, blood agar, then confirmed by Cetrimide agar, .Presumptive identification of *P. aeruginosa* was based on colony morphology, pigmentation, odor, Gram staining, catalase test, and oxidase test, Vitek 2 compact system.

Statistical Analysis

The Statistical Packages of Social Sciences -SPSS (2019) program was used to detect the distribution of sample study according of difference factors (Age groups, Marital Status, Location, Cultural Status and Sex). Chi-square test was used to significant compare between percentage (0.05 and 0.01 probability).

Ethical Considerations

The Scientific Ethical Committee of the College of Veterinary Medicine, University of Diyala, Iraq, approved this study (Approval no: Vet Medicine (241); August 2024, M and A).

Results:

Overall Prevalence of *Pseudomonas aeruginosa*

Of the 50 dogs with clinically diagnosed otitis externa, *Pseudomonas aeruginosa* was isolated in 11 cases. Therefore, the overall prevalence of *Pseudomonas aeruginosa* in the study population was 22%.

Age-Related Patterns

The analysis of age-related patterns showed a characteristic U-shaped distribution of *P. aeruginosa* across the canine age groups. The complete age distribution and patterns of bacterial isolation are provided in Table 1. As shown in Figure 1, the prevalence in dogs under one year (puppies) was 22.22, in young adult dogs of 1-2 years was 12.5, and in dogs older than 2 years was 31.25. The overall differences across the age groups were found to be statistically significant ($p = 0.0085$).

Table 1: Age Distribution and Prevalence of *P. aeruginosa* in Canine Otitis Externa (n = 50)

Age Group	Number of Cases (%)	<i>P. aeruginosa</i> Positive (%)	p-value
Less than 1 year	18 (36%)	4 (22.22%)	0.0085
1–2 years	16 (32%)	2 (12.50%)	
More than 2 years	16 (32%)	5 (31.25%)	

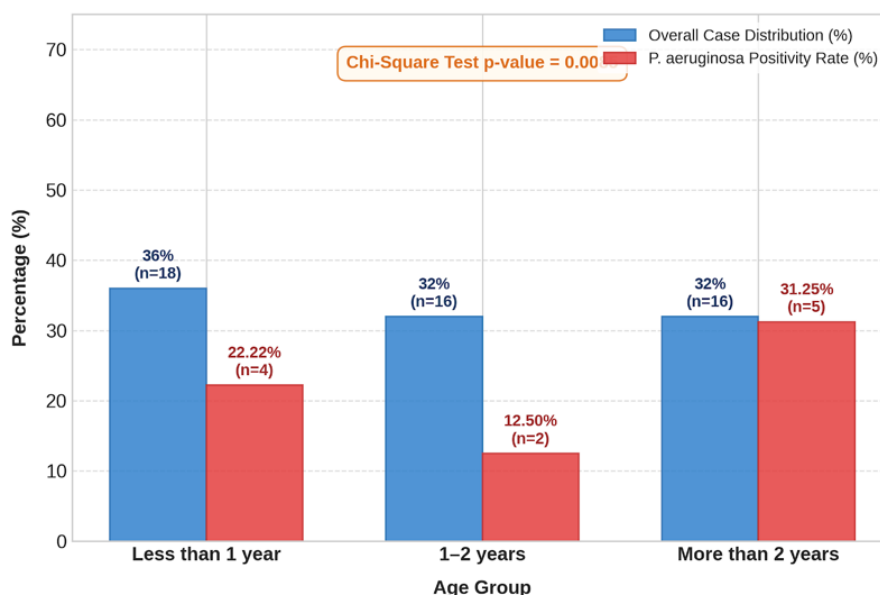


Figure 1: Presence of *Pseudomonas aeruginosa* in samples from canines with otitis externa of the various age groups. The figure shows a U-shaped distribution with the rate of *Pseudomonas aeruginosa* being the highest for puppies less than a year of age (22.22%), significantly decreased in young adults aged 1-2 years (12.5%), and the highest presence was in canines greater than two years of age (31.25%). Bars show percentage presence with a 95% confidence-interval.

Sex-Based Differences

The number of male and female dogs was almost evenly split (48% male, 52% female). Table 2 and Figure 2 show results by sex. The prevalence of *P. aeruginosa* was 20.83% for males and 23.08% for females ($p = 0.7773$). Analyzing the overall prevalence of all bacterial species by sex indicated a significant difference ($p = 0.0070$) and was attributed to the different prevalence of *E. coli* and *P. mirabilis*.

Table 2: Sex Distribution and *P. aeruginosa* Prevalence in Canine Otitis Externa Cases (n = 50)

Sex	Number of Cases (%)	<i>P. aeruginosa</i> Positive (%)	p-value
Male	24 (48%)	5 (20.83%)	0.7773
Female	26 (52%)	6 (23.08%)	

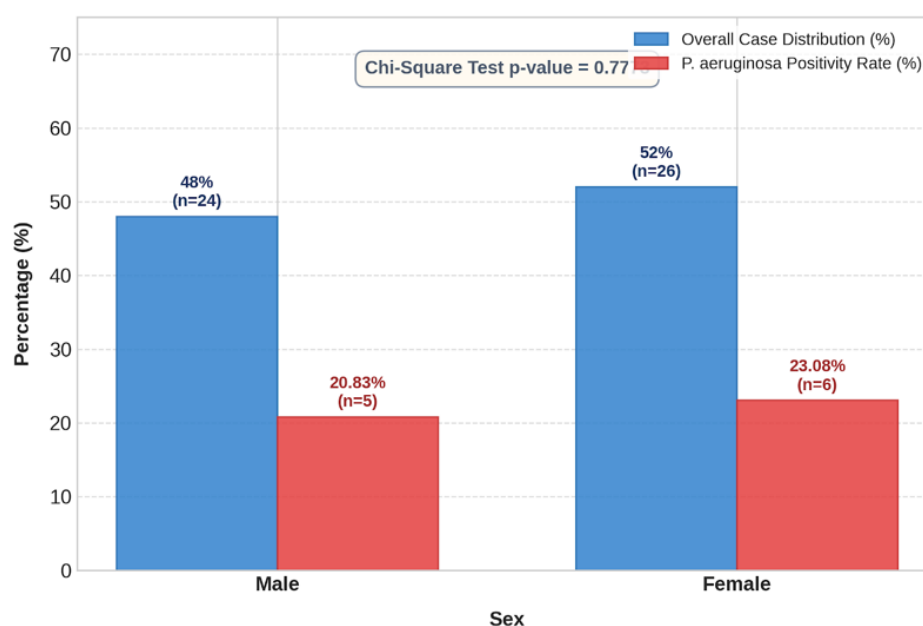


Figure 2: Distribution of bacterial isolates by gender in cases of canine otitis externa. Of the males, 37.5% have *E. coli*, as compared to the females, of whom 23.08% have *E. coli*. The females have *P. mirabilis* in 30.77% of the cases, as opposed to 16.67% in the males. The distribution of *P. aeruginosa* is 20.83% in males, and 23.08% in females.

Geographic Variation

There were clear contrasts in the two dominant districts in Baghdad. These results are shown in Table 3 and in Figure 3. The Rusafa district had 33 cases (66%) while Karkh had 17 cases (34%). In Karkh the prevalence of *P. aeruginosa* was 35.29% while in Rusafa it was 15.15% ($p = 0.0237$).

Table 3: Geographic Distribution and *P. aeruginosa* Prevalence in Canine Otitis Externa Cases (n = 50)

District	Number of Cases (%)	<i>P. aeruginosa</i> Positive (%)	p-value
Rusafa	33 (66%)	5 (15.15%)	0.0237
Karkh	17 (34%)	6 (35.29%)	

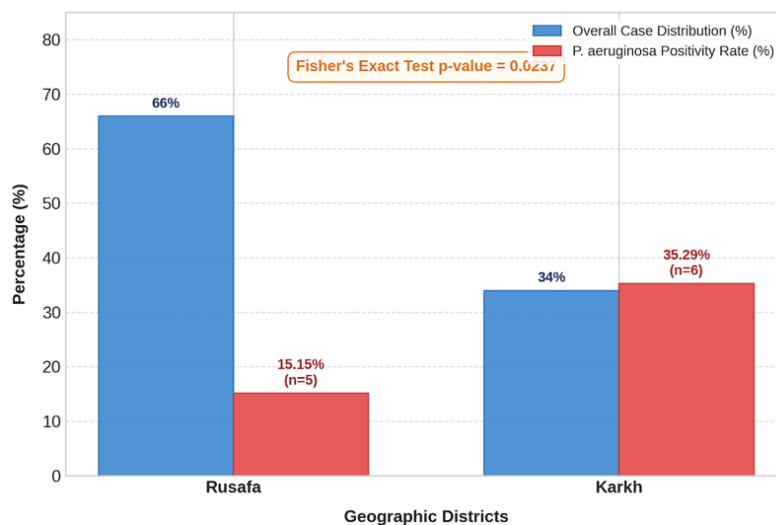


Figure 3: Districts in Baghdad and prevalence of *Pseudomonas aeruginosa*. In the Karkh district, prevalence was found to be greater than double (35.29%) than that in the Rusafa district (15.15%).

Influence of Husbandry Type

When examining infection risk in relation with living environment and type of husbandry, the results were also revealing as displayed in Figure 4 and Table 4. Domestic dogs had the highest prevalence (25.93%) while stray and farm dogs had a prevalence of 20% and 15.38% respectively ($p = 0.0078$).

Table 4: Husbandry Type and *P. aeruginosa* Prevalence in Canine Otitis Externa Cases (n = 50)

Husbandry Type	Number of Cases (%)	<i>P. aeruginosa</i> Positive (%)	p-value
Domestic	27 (54%)	7 (25.93%)	0.0078
Stray (local)	10 (20%)	2 (20.00%)	
Farm	13 (26%)	2 (15.38%)	

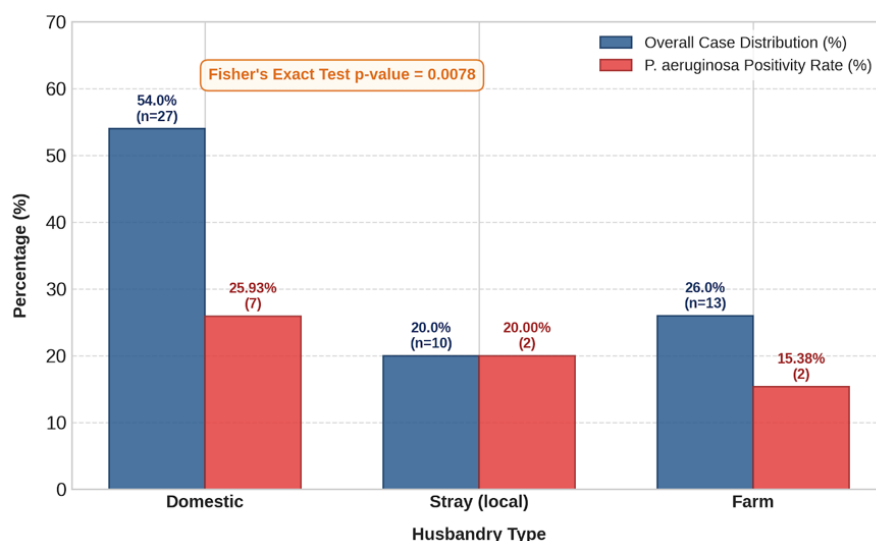


Figure 4: *Pseudomonas aeruginosa* prevalence by husbandry type. The figure shows that the prevalence of *Pseudomonas aeruginosa* is highest in domestic dogs (25.93%), followed by stray dogs (20%), and farm dogs (15.38%).

Discussion

This field study is the first to document the epidemiological details of *Pseudomonas aeruginosa* infecting cases of canine otitis externa in Baghdad, Iraq. This study identifies significant associations of demographic and geographic factors, and the risk of pseudomonal involvement.

The general prevalence rate of 22% is similar to newly published reports of the other Middle Eastern countries. The rate is higher than the expected prevalence in Europe and North America. In those countries, approximately 5% to 15% of the dog otitis cases report isolation of *P. aeruginosa* (Ganiere *et al.*, 2020; Datsiuk & Hunchak, 2025). There are multiple reasons why the rate is higher in Baghdad, which may include the climate that may be conducive to the persistence of *P. aeruginosa*, the antimicrobial availability and the use patterns in the Iraqi veterinary practice, and the chronicity of the cases that are presented to us (Solonin *et al.*, 2025).

The age distribution described in this study typifies patterns seen in other chronic infectious diseases. This distribution includes high prevalence rates in puppies under one year, dogs over two years, and low prevalence rates in young adults aged one to two years. Within this distribution, young puppies are prone to higher prevalence rates due to the underdevelopment of their immune systems. This leads to their inability to effectively respond to opportunistic pathogens, and is also a result of anatomical factors, such as narrow ear canals coupled with poor drainage (O'Neill, 2021). For dogs over the age of two years, the prevalence of *P. aeruginosa* likely corresponds with the cumulative effect of chronic inflammation and epithelial changes (Paterson, 2008). Young adults aged one to two years likely experience a relative immunity to *P. aeruginosa*. This is postulated to be a result of improved immune function, absence of chronic inflammation in the ear alongside relatively less exposure to pathogens (Hoff, 2025).

It was surprising to discover that *P. aeruginosa* was more prevalent in domestic than in stray or farm dogs. The finding violates most people's expectations. Unlike farm dogs, domestic dogs often receive antibiotics to treat conditions like otitis externa. With antimicrobial selective pressure, strains of *P. aeruginosa* can form resistance, colonizing the ear canal and persisting after the infection has been cleared (Guardabassi et al., 2004). The lower prevalence of *P. aeruginosa* in farm dogs, despite a higher likelihood of soil and water exposure due to farm life, indicates that the drivers of farm dogs' otitis externa are more related to antimicrobial selective pressure than the exposure itself (MSD Animal Health, 2025).

This study made some interesting observations about the geographic disparity between Rusafa and Karkh. Karkh exhibited more than a twofold rise in venereal pseudomonas infection cases compared to Rusafa. This indicates that the location of an individual's residence within the same city is a significant factor that drives the individual's risk of developing the infection. This disparity may be caused by numerous factors. Environmental conditions, such as water quality, humidity, and temperature, may affect the persistence of *P. aeruginosa* in the environment. There may also be differences in quality of water and drainage or climate in the two districts, which would affect the environmental burden of this organism. Differences in accessible veterinary care and differences in the availability and quality of antimicrobial drugs may also cause the disparity. This disparity may also be caused by differences in the shape, distribution, control, and management of the dog population and by differences in the dog owners' socioeconomic status in each of the districts.

Conclusion

The impact of age and husbandry type on the prevalence is most pronounced in the context of geographic region. This field study in Baghdad, Iraq, determined that the prevalence of *P. aeruginosa* was a significant (22%) otogenic pathogen, with a U-shaped age distribution. Puppies less than a year old and dogs over 2 years old should be closely monitored for a pseudomonal infection. The significant disparity in prevalence between Rusafa and Karkh, with Karkh demonstrating a prevalence of over two times that of Rusafa, supports the hypothesis that the infection is affected by environmental and/or health care accessibility factors at the district level. The prevalence of *P. aeruginosa* was also found to be higher in domestic dogs compared to stray and farm dogs, indicating the existence of a significant, possibly selective, antimicrobial pressure and/or pseudomonal emergence. Clinical implications: When empirically treating canine otitis externa in Baghdad, veterinarians must consider the factors of both district and age. Maintaining surveillance and implementing antimicrobial stewardship in targeted high-prevalence (Karkh district) and high-risk (domestic, old, and young) populations is imperative.

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