

## The prevalence and risk factors of canine demodicosis: A retrospective long-term study of 409 cases

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**Abstract.** Canine demodicosis is a common skin disorder with multiple risk factors, including age and breed predisposition. There is relatively limited information about the risk factors for canine demodicosis in large canine populations. This retrospective case-control study was conducted by searching the electronic records of dogs with skin lesions for the presence of *Demodex* mites in skin scrapings. Diagnosis of demodicosis was based on the presence of skin lesions and mites in skin scrapings. Multivariate analysis was conducted using logistic regression analysis to estimate the relative risk and odds ratio of variables hypothesized to influence the risk of canine demodicosis, such as age, sex, breed, season, and parasitic infection. The results of multivariate logistic regression analysis showed a positive correlation between the dogs' age and demodicosis. Dogs older than three years, as well as puppies, had a high risk of demodicosis ( $P < 0.05$ ). However, no significant association was found between sex and demodicosis ( $P > 0.05$ ). Breeds with the greatest association (odds ratio) with demodicosis included the American Staffordshire Terrier (OR=0.9) and Moscow Watchdog (OR=0.2). The presence of intestinal parasites, such as *Diphyllobothrium latum*, was significantly associated with demodicosis.

### INTRODUCTION

Canine demodicosis is a frequent and often serious skin disease, resulting from the excessive proliferation of skin mites, called *Demodex canis* (Ferrer *et al.*, 2014). Stress, debilitating diseases, immunodeficiency, poor living conditions, and concomitant infections and infestations are the main causes of demodicosis. Other risk factors suspected to contribute to canine demodicosis include genetic predisposition, breed predisposition, short coat, and geographical factors (Gortel, 2006; Ferrer *et al.*, 2014).

There are two clinical forms of demodicosis: localized and generalized. The localized form is characterized by small

skin lesions with alopecia, often scaly or hyperpigmented, localized on the face and forelegs. A rare localized form of demodicosis is associated with otitis externa. This condition frequently occurs in young dogs (3-6 months) and rarely progresses into a generalized form. On the other hand, the generalized form of demodicosis consists of severe skin lesions, which can be frequently found in dogs younger than 18 months. Cutaneous changes in both young and old dogs are diverse and include comedones, papules, pustules, crusts, pustules, and folliculitis (Shipstone, 2000; Gortel, 2006).

The mange infestation in dogs has been recorded in different forms around the world, especially in Russia. However, there is limited information about its prevalence in

dogs with demodicosis in Vladivostok, Russia. The main objective of this study was to investigate the epidemiology of canine demodicosis in a large primary-care dog population in Vladivostok.

## MATERIALS AND METHODS

The study population included 2572 pet dogs, aged one month to 12 years. Data were collected from 1992 to 2017. This retrospective study was conducted to assess the risk factors, clinical signs, and lesion localization, based on the records available in the database of a large veterinary practice network in the laboratory of parasitology (Vladivostok, Russia). The standardized electronic records included gender, age, breed, clinical signs, and results of laboratory tests.

Demodicosis was diagnosed based on the presence of skin lesions and mites in skin scrapings, identified via examination of deep skin scrapings. Bivariate logistic regression analysis was conducted using Stata MP Software. A logistic model was developed with variables hypothesized to influence the risk of canine demodicosis, including sex, breed, age, season, and intestinal parasites. Confidence intervals were estimated for each odds ratio (relative risk). The level of statistical significance was set at  $P < 0.05$ .

## RESULTS

A total of 2572 dogs were examined for the presence of demodicosis from 1992 to 2017. Demodicosis was documented in 409 dogs, aged one month to 10 years. The overall prevalence of demodicosis was estimated at 15.9%. The highest prevalence was reported in puppies (<1 year) (26.4%; 284/1076) and dogs aged 1-3 years (9.5%; 87/918). Conversely, the lowest prevalence was found in dogs aged >3 years (3.63%; 14/417). Males were more frequently affected than females. Overall, 237 (17.3%) out of 1388 male dogs and 165 (13.9%) out of 1186 female dogs were affected.

The highest prevalence of demodicosis was documented in spring (19.1%) and winter (18.6%), whereas the prevalence decreased in autumn (14.3%) and summer (14.2%); the highest prevalence was reported in May (22.7%). No significant association was found between sex and demodicosis (Table 1). Breeds which showed the greatest association with demodicosis included the American Staffordshire Terrier (OR=0.9) and Moscow Watchdog (OR=0.2) (Table 2).

There was no significant correlation between season and demodicosis. On the other hand, a significant correlation was found between the presence of demodicosis and *Diphylllobothrium latum* infection ( $P < 0.05$ ), whereas other parasitic infections

Table 1. The risk factors for canine demodicosis

Risk factors	Adjusted OR	P-value	CI
<b>Age</b>			
>3 years	0.2	0.09	0.1–0.7
Puppies	0.1	0.00	0.02–0.4
1–3 years	0.6	0.39	0.2–1.9
<b>Gender</b>			
Female	0.8	0.1	0.6–1.1
<b>Infection</b>			
<i>Ancylostoma caninum</i>	1	0.5	0.01–0.02
<i>Diphylllobothrium latum</i>	0.2	0.2	0.01–2.3
<i>Dipylidium caninum</i>	2.8	0.2	0.6–13.1
<i>Taenia</i> spp.	0.4	0.3	0.07–2.2
<i>Toxocara canis</i>	1.3	0.6	0.4–3.9
<i>Uncinaria stenocephala</i>	0.4	0.04	0.1–0.9
<i>Cystoisospora</i> spp.	1	0.8	0.1–0.2

Table 2. The odds ratio (OR) of breed as a risk factor for demodicosis in a multivariate model

Breed	OR	95% CI	
Moscow Watchdog	0.1710726	0.0269915	1.084263
Newfoundland	0.1137007	0.0114105	1.132982
Pekingese	0.2037313	0.0322087	1.288672
American Pit Bull Terrier	0.923459	0.1511508	5.641894

were not associated with demodicosis ( $P>0.05$ ) (Table 1).

Various clinical signs were registered in *Demodex*-positive dogs, including alopecia (71.6%), hyperemia (24.2%), seborrhea (18.3%), pigmentation (9.5%), scales (8.9%), pustules (7.5%), and skin nodules and swelling (1.2%). Pruritus appeared in 11.5% of the dogs. The generalized form of demodicosis only appeared in 10.7% of the dogs, while other dogs had the localized form. The most frequently affected areas included the head, back, neck, thighs, and forelegs.

## DISCUSSION

The overall prevalence of demodicosis in the present study is comparable with the rates reported from Kathmandu Valley (Nepal) (29.1%) and Mexico (23%) (Rodriguez-Vivas *et al.*, 2003; Shrestha *et al.*, 2015). Male dogs were more frequently affected than females. In contrast, previous studies reported an equal prevalence in females and males (LemariÉ *et al.*, 1996; Nayak *et al.*, 1997; Tsai *et al.*, 2011).

Demodicosis is often diagnosed in puppies and young dogs (Scott & Paradis, 1990; Shipstone, 2000; Shrestha *et al.*, 2015). There are two types of demodicosis, including the localized (often found in puppies) and generalized forms. The present results indicated the high prevalence of demodicosis among dogs aged <3 years (Scott & Paradis, 1990; Chee *et al.*, 2008).

The existing literature on the breed predisposition of canine demodicosis is limited and often controversial. In this regard, a study on a very small canine population with demodicosis showed that old English dogs had a high risk of demodicosis (Miller

*et al.*, 1992), whereas another six-year study revealed that Lhasa-Apso, Shar-Pei, and Rottweillers were exposed to a higher risk of demodicosis than other breeds (Muller *et al.*, 2001; Mueller, 2004). In the present study, breeds including American Staffordshire Terrier and Moscow Watchdog were predisposed to demodicosis. Bowden *et al.* (2018) showed that breeds, including the West Highland White Terrier and Pit Bull Terrier, were predisposed to demodicosis. Some breeds, which were previously reported to be at risk of canine demodicosis, including Rottweiler, Shar-Pei, and Great Danes (Miller *et al.*, 1992; LemariÉ *et al.*, 1996; Plant *et al.*, 2011) were not exposed to an increased risk in this study.

We can speculate that living conditions and ecology, apart from breed, potentially influence the development of demodicosis. In the present study, there was no significant correlation between season and demodicosis; however, the prevalence of demodicosis was high during spring and winter. The literature also suggests that photoperiod and temperature can influence the mite activity (Shiels *et al.*, 2019).

Evidence shows that *Demodex* mites have negative phototaxis (Wu *et al.*, 1992). Some studies have demonstrated season variations in the cell-mediated immunity of dogs, with peak activity reported in summer with a 12-hour photoperiod (Garsd & Shifrine, 1982; Shifrine *et al.*, 2008). The cell-mediated immune response is a major mechanism in the control of *Demodex* mite proliferation (Bowden *et al.*, 2018). Therefore, the short photoperiod in winter and spring contributes to the reduction of cell-mediated host immunity and increase of mite proliferation (Cen-Cen *et al.*, 2018).

In the present study, the most frequent area affected by demodicosis was the head (forehead and behind the ears). In contrast, previous studies (Chen, 1997; Tsai *et al.*, 2004) demonstrated that the back had the highest infection rate, which can be related to the high number of sebaceous glands localized in the back, especially around the root of the tail. However, this hypothesis was not supported by other studies (Tsai *et al.*, 2004; Tsai *et al.*, 2011).

Other risk factors for demodicosis include intestinal parasites (Gortel, 2006; Plant *et al.*, 2011; Bowden *et al.*, 2018). Nevertheless, there is limited information regarding the effects of different parasites on demodicosis. In a study conducted by Plant *et al.* (2011), coccidiosis and hookworm infestation were significantly associated with demodicosis. In the current study, a significant association was found between demodicosis and *D. latum* infection. These findings can help future studies on the genetic risk factors for canine demodicosis and highlight the cofactors of this disease.

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