


ORIGINAL ARTICLE

Estimation of the prevalence and determination of risk factors associated with demodicosis in dogs

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ABSTRACT

Objectives: Demodicosis is a vital skin problem in dogs. The present study has determined the prevalence and associated risk factors of demodicosis in dogs and the response to treatment.

Materials and Methods: A total of 100 skin scrapings were collected from dogs having dermatological lesions brought to the Teaching and Training Pet Hospital and Research Center of Chattogram Veterinary and Animal Sciences University for treatment purpose. The collected scrapings were dissolved in 10% potassium hydroxide to detect mites through microscopic examination. Various risk factors like breed, age, sex, hair type, health status, and management system (indoor and outdoor) were analyzed using the logistic regression model. Positive cases were treated with oral ivermectin (Scabo[®]; at 0.6 mg/kg/day) along with amitraz 12.5% (Ridd[®]) diluted to 0.05% for rubbing on the body after bathing with chlorhexidine shampoo (PetHex[®]). Clavulanate amoxicillin (Moxaclav[®]) and omega-3 fatty acids (OMG-3[®]) were also suggested to prevent secondary bacterial infection and to maintain skin and hair coat integrity. The recovery rate was observed every 2–4 weeks of treatment upto 11–13 weeks.

Results: The overall prevalence of demodicosis was recorded as 27%. Hair type, health status, and management system were significantly ($p < 0.05$) associated with the occurrence of demodicosis in dogs. Following treatment, the first negative skin scraping for mite was noticed at 8–10 weeks of treatment, and in all cases, clinical signs completely disappeared at 80–90 days of treatment.

Conclusion: A good percentage of the dogs having dermatological lesions was determined as demodicosis. Long-term oral ivermectin and topical amitraz, an oral antibiotic, and nutritional therapy are effective against canine demodicosis. Keeping long-haired dogs with good body condition and indoor management is highly suggestive of preventing and controlling the disease.

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Introduction

Dogs are considered the nearest creatures to humans due to their reliable social behaviors [1]. Distinctive dog breeds serve various manners like draught dogs assist in work, guard dogs protect, assistant dogs help visually impaired and physically disabled individuals, and detective dogs support criminal inquiries. Above all, pet dogs are regarded as trustworthy acquaintances by their masters [2]. Most owners are very close to their pets and like to invest their

free moments in cuddling them. However, these dogs are occasionally confronted with numerous dermatological problems that often force them to isolate themselves from their masters. Dermatological affection constitutes 12%–75% among all other cases in small animals [3], and among them, demodicosis is a major skin problem in dogs. The prevalence of demodicosis was recorded as 65% and 35.4% in two separate studies on stray dogs of Dinajpur, Bangladesh [4,5]. The different mites of *Demodex* spp.

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cause this disease, which includes *Demodex canis*, *Demodex cornei*, and *Demodex injai* [6].

Even though they are the typical microfauna in the skin of healthy dogs, over-population and other various inclining factors may prompt this severe ailment. Demodicosis in dogs is mainly caused by *D. canis* residing on the hair follicles than other species [7,8]. Factors that allow the development of demodectic mites are not well understood yet. However, it is assumed that they are associated with cell-mediated immunity faults [6]. The infection is usually observed in both old dogs and young puppies aged 3 months to a year. Defect or suppression in the skin's immune system helps multiply mites, leading to clinical demodicosis [9]. It is not contagious and is acquired from the dam during nursing [10]. A diseased dog's innate immune system is impaired as *D. canis* digs into the skin and secretes a substance. The infection is recognized as hereditary due to frequent observation in short-haired, oily-skinned, and pubescent canine breeds and occasionally puppies. Both male and female dogs transmit genetic material to their offspring such as demodicosis [2]. In the localized form of canine demodicosis, lesions are characterized by scattered alopecia, comedones, and erythema, but in the generalized form of infection, lesions are found in whole skin areas [11].

Young dogs are habitually affected by a localized form of demodicosis but frequently recover [6]. On the contrary, the generalized form could be severe and life-threatening because of the addition of secondary bacterial infection [9]. The clinical manifestations of demodicosis are local or diffuse erythema, alopecia, crusts, or scales linked with pustular or papular dermatitis [12]. The situation advances until significant body areas are affected and the dog shows alopecia along with wrinkled and thickened skin with a 'mousy' odor [6]. Demodicosis can be diagnosed through clinical history, signs, and laboratory tests, such as deep skin scraping test, where the scraping dissolves into potassium hydroxide (KOH) or hydrogen peroxide (H₂O₂) to let out the mites [2]. Drugs such as ivermectin, amitraz, moxidectin, doramectin, and milbemicinoxine are prescribed to treat canine demodicosis [13]. The treatment lasts for several weeks to a month and is monitored every 2–4 weeks for negative skin scrapings [14]. Due to the increased use of amitraz in the generalized form of demodicosis in dogs, it becomes resistant [15]. The present report suggests the combined use of acaricides and macrocyclic lactones and nutritional supplements in generalized demodicosis cases [15].

Topical application of amitraz (at 0.025%–0.05%) for every 7–14 days is recommended [16]. Ivermectin did not show a better response rate in weekly injections. On the contrary, oral dose of ivermectin (at 0.3–0.6 mg/kg/day) showed satisfactory results in demodicosis used in several previous studies. Compared with other macrocyclic lactones, ivermectin causes an adverse neurological effect.

That is why it is strongly advised to begin with a low dose of 0.05–0.1 mg/kg and then gradually raise the dose to 0.3–0.6 mg/kg for the next 4 days in the first 4 days [14].

Veterinarians face major difficulties in managing demodicosis in canines. Moreover, owners are confronted with more difficulties as it requires more money and time to treat and cure the disease. So, it is important to know the risk factors related to canine demodicosis that can help take preventive measures against the disease. Few studies have been conducted and limited information has been found available on canine demodicosis in Bangladesh. Hence, the study aimed to estimate the prevalence and associated risk factors of demodectic mange in dogs and its efficacy toward treatment. The extracted information may help practitioners as well as owners concerned.

Materials and Methods

Ethical consideration

In the current study, skin scraping samples were collected with dogs' minimum distress for diagnostic and treatment purposes in the Teaching and Training Pet Hospital and Research Center (TTPHRC) of Chattogram Veterinary and Animal Sciences University (CVASU), Chattogram, Bangladesh. Therefore, verbal consent from animal owners and the director of clinics was taken.

Study period and animals

The study was conducted from July to December 2019 on dogs presented to the TTPHRC of CVASU (Fig. 1A) having dermatological lesions like inflammation, erythema, alopecia, lichenification, pruritus, scaling, and different patches in the body. Dogs of different breeds (based on origins like pure, mixed, and local breed); different age categories like young (<6 months), adult (6 months to 5 years), and old (>5 years); both sexes (male and female); different hair types (long, medium, and short-haired); different management systems (indoor management like indoor housing, feeding, rearing, etc. and outdoor management like outdoor housing, feeding, rearing, etc.); and different health statuses (good and poor) were included in the study. Outdoor-managed dogs were also included, both housed and stray dogs. Health status was measured based on vaccination and deworming history and clinical examination of the mucous membrane, nasal, or ocular discharge, and general appearance. A closed-ended questionnaire was used to collect information like breed, age, sex, hair type, management system (indoor or outdoor), and health status.

Sample collection

A total of 100 skin scrapings were collected from the skin lesions of infected dogs. At first, hair from the collection

site was removed or clipped with scissors. Scraping of skin was carried out in the direction of hair growth till bleeding. A drop of liquid paraffin was put on the center of the glass slide. The edge of the scalpel was dipped into liquid paraffin. For releasing mites from the samples, the skin scrapings were pressed with the thumb and index finger.

Sample processing and microscopic examination

The mites were identified according to the methods described by Nayak et al. [17]. In brief, at first, skin scrapings were taken in the test tube and added with 10% KOH until the sample submerged. The solution was then firmly heated (up to boiling) with continuous shaking until all the debris dissolved. After that, the solution was cooled and centrifuged at 2,000 rpm for 10 min. The supernatant was removed and the sediments were placed onto a glass slide with a coverslip and examined under the microscope at 10× objects to identify mites.

Therapeutic management

The owners were suggested to give the dogs a bath with Chlorhexidine shampoo (PetHex®). After the dogs were dried up, the owners were encouraged to rub them smoothly with a wipe cloth medicated by amitraz (Ridd®) (0.05% concentrations; 12.5% amitraz diluted at 4 ml/l water) once a week for 28 days. Ivermectin (Scabo® 6 mg) was given orally (at 0.6 mg/kg sid) for 28 days. The initial dose was started at 0.1 mg/kg/day and gradually increased at a rate of 0.1 mg/kg/day to 0.6 mg/kg/day. Clavulanate amoxicillin (Moxaclav® 375 mg) was also given bid orally for 14 days to check for secondary bacterial infections. Omega-3 fatty acid at 30 mg/kg/day and zinc preparation at 1.6 mg/kg/day (Nid®) were given orally for 10 days to boost immunity. Regular follow-up of the treatment was noted by collecting skin scrapings at 2–4 weeks to determine the recovery rate. During treatment at 2–4 weeks, two consecutive negative skin scrapings were taken which showed complete recovery from demodicosis.

Statistical analysis

The obtained information was imported and stored using Microsoft Excel 2016 to 'R' language 3.5.1 version for analysis [18]. Logistic regression was conducted to compute odds ratio associated with potential risk factors. The prevalence was presented in percentage with a *p*-value for the chi-square test and 95% confidence interval (CI) measured by the modified Wald method using the Graph Pad software Quick Cales. Variables that presented $p \leq 0.10$ in the univariable analysis were considered for inclusion in the multivariable regression model. The forward stepwise selection method was incorporated to build the final model. Variables with a *p*-value less than 0.05 were taken as significant and kept in the final model. The logistic regression analysis was conducted using the glmer function from the lme4 package in R version 3.5.1 [18].

Results

Prevalence of demodicosis in dogs

Out of 100 skin scraping samples, 27 were found positive for *Demodex* spp. in microscopic examination (Fig. 1C). Overall, the prevalence of demodicosis was recorded as 27%.

Risk factors analysis

Various risk factors like breed, age, sex, hair type, health status, and management system (indoor and outdoor) were considered in the univariable logistic regression analysis. Factors that had $p \leq 0.10$ in the univariate analysis were further evaluated for the multivariate analysis. Among the risk factors, hair type, health status, and management system were significantly ($p < 0.05$) associated with dogs' demodicosis in both univariate and multivariate analyses. No significant relationship was observed among breed, age, and sex for demodicosis in the dog.



Figure 1. (A) Papular, erythematous, and inflammatory swelling around eyes, lips, face, and legs. (B) Disappearance of clinical signs and lesions in the skin after treatment. (C) *Demodex* spp. under a microscope (arrows) in 10× objects.

The prevalence of demodicosis was significantly greater in short-haired (48.48%) and medium-haired (17.50%) dogs in comparison to long-haired dogs (14.81%) ($p < 0.05$) (Table 1). In the multivariable logistic regression analysis, the odds ratio for short-haired and medium-haired dogs was 6.62 and 1.95, respectively (Table 2). The occurrence of demodicosis is about seven and two times higher in short-haired and medium-haired dogs than long-haired dogs.

The study revealed that the prevalence of demodicosis was significantly higher in dogs with poor health (48.48%) than dogs with good health (16.42%) ($p < 0.05$) (Table 1). The odds ratio for poor health dogs was 3.93 in the multivariable logistic regression analysis (Table 2). This finding indicates that the chances of getting demodicosis are about four times higher in dogs with poor health than dogs with good health.

Regarding the management system, the prevalence of demodicosis was found to be significantly higher in outdoor-managed dogs (53.13%) than indoor-cared dogs (14.71%) ($p < 0.05$) (Table 1). The odds ratio was 5.42 for outdoor-managed dogs in the multivariate analysis (Table 2). The chances of demodicosis in outdoor-cared dogs are about five times higher than indoor-cared dogs.

Therapeutic response

Following the 4-week treatment, all 27 cases responded well. Clinical signs subsided gradually. Loads of mites were reduced in the skin scraping test. The first negative test for *Demodex* spp. in the skin scraping test was found in all cases after 8–10 weeks of treatment. The clinical signs

disappeared entirely in all circumstances between 80 and 90 days of treatment (Fig. 1B).

Discussion

A total of 100 skin scraping samples were examined to estimate the dog's prevalence of demodectic mange. The overall prevalence was recorded as 27% in this study. This finding is lower than the report of Ali et al. [5] and Islam et al. [4], where they recorded 35.4% and 65% prevalence, respectively, in stray dogs in Bangladesh. This variation is justifiable as pet dogs are less prone to infestation due to their good care and proper nourishment than stray dogs. The prevalence of our study is close to the prevalence reported in India (25.4%), Nepal (29.1%), and Korea (25%) [6,19,20]. However, our study's finding was higher than the report of Gunaseelan et al. [21], where they reported a 10.5% prevalence of demodicosis in dogs

Table 2. Multivariable logistic regression model output of risk factors associated with demodicosis in dogs.

Explanatory variable	Co-variable	OR	95% CI	p-value (χ^2 test)
Management system	Indoor housed	Ref.		0.002
	Outdoor roaming	5.42	1.89–16.58	
Health status	Good	Ref.		0.014
	Poor	3.93	1.34–12.13	
Hair type	Long	Ref.		0.011
	Medium	1.95	0.45–9.90	
	Short	6.62	1.68–32.58	

Table 1. Univariable logistic regression analysis of risk factors associated with demodicosis in dogs.

Explanatory variable	Co-variable	Total	+ve	Percentage (95% CI)	OR (95% CI)	p-value (χ^2 test)
Breed	Local	16	3	18.75 (5.80–43.80)	Ref.	0.399
	Mix	32	7	21.87 (10.73–39.04)	1.21 (0.28–6.35)	
	Pure	52	17	32.69 (21.47–46.30)	2.10 (0.58–10.07)	
Age	Adult	37	9	24.32 (13.17–40.31)	Ref.	0.285
	Old	23	4	17.39 (6.37–37.74)	0.65 (0.16–2.33)	
	Young	40	14	35.00 (22.08–50.55)	1.67 (0.63–4.65)	
Sex	Female	59	12	20.34 (11.88–32.42)	Ref.	0.072
	Male	41	15	36.59 (23.55–51.92)	2.26 (0.93–5.64)	
Hair type	Long	27	4	14.81 (5.30–33.10)	Ref.	0.003
	Medium	40	7	17.50 (8.43–32.26)	1.22 (0.33–5.10)	
	Short	33	16	48.48 (32.50–64.78)	5.41 (1.65–21.60)	
Health status	Good	67	11	16.42 (9.25–27.23)	Ref.	0.001
	Poor	33	16	48.48 (32.50–64.78)	4.79 (1.90–12.60)	
Management system	Indoor housed	68	10	14.71 (7.99–25.20)	Ref.	<0.01
	Outdoor roaming	32	17	53.13 (36.45–69.13)	6.57 (2.56–17.87)	

in Chennai, India. Besides, our finding was also higher than the results of Chee et al. [22], who recorded 4.9% demodicosis in Gwangju City, Republic of Korea. Several factors like seasonal and weather changes, geographical variation, and differences in sampling and information collection might be responsible for such differences.

The prevalence of demodicosis was higher in the pure breed (32.69%), followed by mixed (21.87%) and local (18.75%) breeds, which was statistically insignificant. This observation is supported by an earlier study where they showed pure breeds are more susceptible to demodicosis than cross and local breeds [19]. The study's findings were opposed by some studies where recorded mongrels are more susceptible to demodicosis than pure and mixed breeds [6,23]. The variation among the studies may be due to climatic and geographical differences.

Age-wise prevalence of demodicosis revealed a higher prevalence in young dogs (35%) than adult (24.32%) and old (17.39%) dogs, but was not statistically significant. Similar observations were reported by Sharma et al. [24], where they recorded a 36.36% prevalence in young dogs, followed by adult (31.82%) and old (13.64%) dogs. Another study reported a 70% prevalence in <2-year-old dogs, 20% prevalence in 2–4-year-old dogs, and 10% prevalence in >4-year-old dogs [25]. Accordingly, Ali et al. [5] reported a higher prevalence in young (68.9%) dogs than adults (52.6%). Mites are sebopilic in nature that influences higher infestation in young dogs because sebaceous glands become more stimulated during puberty [24]. Underdeveloped immunity in young animals in comparison to old animals is another factor for higher infestation.

Elevated prevalence was recorded in male dogs (36.59%) than females (20.34%), although it was not statistically significant. These results agree with several studies, for example, 36.7% in males and 22.9% in females in Nepal, 55.5% in males and 44.5% in females in India, and 66.6% in males and 57.1% in females in Bangladesh [5,6,26]. More susceptibility of males might be due to hormonal and behavioral influences. An increased plasma testosterone level is responsible for high parasitism [27]. The higher prevalence in female dogs (72.73%) than male dogs was also recorded in another report (55.56%) [4]. However, Nayak et al. [17] reported no direct effect on demodicosis by the sex of dogs.

Our data showed a significant association between different hair types of the prevalence of demodicosis in dogs ($p < 0.05$). A higher prevalence of demodicosis was recorded in short-hair breeds (48.48%) compared to medium-hair (17.50%) and long-hair (14.81%) breeds. This statement is in accordance with the study of Shrestha et al. [6], who recorded that demodicosis was higher in short-hair breeds (40.7%) than medium-hair and long-hair breeds. It is assumed that the higher incidence of demodicosis in

short-hair breeds of dogs is possible due to well-developed sebaceous glands in these breeds [3]. The growth of mites might affect short-hair breeds than long-hair breeds due to their higher skin temperature [6].

The health status showed a significant effect on the occurrence of demodicosis in dogs ($p < 0.05$). The infestation is higher in dogs with poor health status (48.48%) than dogs with good health status (16.42%). Other studies suggested similar findings where they recorded that dogs with poor health status were more susceptible to demodicosis than dogs having normal body conditions [5,6]. The current study supported previous researches where undernourished animals are more prone to any infection due to their low immunity [5].

The management system also showed a significant association with demodicosis in dogs ($p < 0.05$). Outdoor-managed or free-roaming dogs (53.13%) had a higher prevalence of demodicosis than indoor-cared dogs (14.71%). Some other reports agreed with our results, stating that higher infestation of demodicosis in free-roaming or stray dogs than indoor-managed or owned dogs [6,23]. Similar results were also reported by Islam et al. [4] in stray dogs (65%) in Bangladesh. The stray or free-roaming or outdoor-managed dogs can transmit diseases and microorganisms due to their constant contact with one another which can reduce the animals' immunity that influences more skin diseases [6].

The clinical signs gradually subsided after 4 weeks of treatment and the mite load in skin scraping test was reduced in all cases. The first negative skin scraping test for *Demodex* spp. was found at 8–10 weeks of treatment in all cases. Complete recovery was noted at 80–90 days of treatment in all cases. Similarly, a visible recovery occurred on the 32nd day after the treatment of the disease, which was confirmed as negative for mites in a skin scraping examination [24]. Our study's longer recovery period might be related to several factors like the difference in individual dog immunity, under-nourishment during the treatment period, little irregularity in dosing, and timing during treatment. Ivermectin (at 0.3–0.6 mg/kg/day, orally) was effective for generalized demodicosis [28]. Plumb's Veterinary Drugs Manual recommends that treatment should be given until two consecutive negative skin scrapings at 4–6 weeks [29]. Topical amitraz is used every week until no live demodectic mites are found in skin scrapings examination [16]. Omega-3 fatty acids and vitamins were also suggested for improving immunity and skin integrity [24]. A similar treatment protocol was followed in this study.

Conclusion

Demodicosis is prevalent in dogs having a dermatological problem. Short-haired, poor health conditions, and

outdoor-managed dogs are significant risk factors associated with canine demodicosis. Long-term oral administration of ivermectin adjunct with topical amitraz, oral antibiotics, and nutritional therapy are effective treatment methods in canine demodicosis. Keeping long-haired dogs with good body conditions and indoor management is suggestive of preventing and controlling the disease.

List of abbreviations

TTPHRC - Teaching and Training Pet Hospital and Research Center; CVASU - Chattogram Veterinary and Animal Sciences University; KOH - Potassium hydroxide; mg - Milligram; Kg - Kilogram; R - Registered; *D.* - *Demodex*; *p*-value - Pearson's value; CI - Confidence interval; % - Percentage.

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Conflict of interest

The authors declare that there is no conflict of interest toward the publication of this article.

Authors' contribution

MR planned, designed, and arranged the current study, did laboratory work, statistical analysis, and preliminary writing. EAR, AAMS, AM, and MMAH helped review the literature and results explanation and gave critical suggestions for the manuscript writing. MBB and AD were involved in the samples and information collection and assisted in the clinical examination of dogs and laboratory tasks. MYEC supervised the whole study. The manuscript was read and approved by each author before submission.

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