



Investigating the Status of Contamination With *Pulex irritans* and *Xenopsylla cheopis* in Pets, Guard and Stray Dogs in Tabriz, Iran

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Abstract

Introduction: Fleas are the most prevalent ectoparasites indoors and outdoors due to their high reproductive rate, ability to feed on different hosts, and the unpleasant effects of their bites.

Methods: This study was conducted on 360 dogs in and around Tabriz to find the rate and type of human flea contamination in these dogs, which were divided into three categories: pets, guards, and stray dogs. After fleas were identified in the dogs' skin, they were taken with glue and fixed on the slide with glue. When the number of fleas was large, the captured fleas were transported to a test tube and treated with 70% alcohol. Dehydration of fleas was performed with ascending percentages of ethanol from 50 to 100% absolute and was kept inside each alcohol percentage for 10 to 20 minutes.

Results: Regarding the dogs studied in this research, the rate of actual contamination in guard dogs was 76.67% (92 dogs were contaminated with flea feces). However, 74 dogs (about 15%) were infested with different fleas. Unfortunately, the rate of contamination in stray dogs was 100%. The rate of real contamination based on the separation of fleas and flea excrement from the body of this group of dogs was equal. The rate of flea infestation in pet dogs was 14 out of 100 dogs, representing 14% contamination.

Conclusion: It should be acknowledged that, unfortunately, flea infestation is expected in the region's dogs, depending on the type of dogs kept. Infestation with these insidious skin parasites with varying rates and symptoms is common, which, in addition to the economic damage of spending time and money on medicine for disease in animals, causes environmental pollution, increases the likelihood of disease transmission by these parasites, and increases the possibility of human infection and disease transmission from them to humans, as well as environmental pollution.

Keywords: Dogs, Flea, *Pulex irritans*, *Xenopsylla cheopis*, Tabriz

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Introduction

Fleas include 2500 species that live as external parasites on mammals and birds. Fleas are blood-sucking and die in the environment within a few days without eating blood. Adult fleas are about 3 mm long, usually brown, and have "flattened" bodies on the side or narrow, allowing them to move through their host's fur or feathers. They lack wings, and their hind legs are well adapted for jumping. Their claws prevent them from moving, and their mouthparts are adapted for piercing the skin and sucking blood. They can jump 50 times their body length.

The eastern rat flea, *Xenopsylla cheopis*, is a vector of *Yersinia pestis*. The disease was transmitted to humans by rodents, such as black rats, bitten by infected fleas. Therefore, flea contamination can significantly transmit zoonotic disease and disease to humans and other animals.

Fleas lay tiny, white, oval eggs. Larvae are small and pale, with hairs covering their worm-like bodies. They lack eyes and have mouthparts suitable for chewing.

Larvae feed on organic matter, especially the feces of adult fleas, which contain dried blood. Adults only feed on fresh blood. Most flea infestations come from newly created fleas in the pet's environment (1).

They are holometabolous and go through four life cycle stages: egg, larva, pupa, and adult. In most species, female and male fleas are not fully mature at first but must feed on blood before they can reproduce (2). The first blood meal causes the ovaries to mature in females and the testicular plug to dissolve in males, and soon mating takes place (3). Some species reproduce throughout the year, while others coordinate their activities with the life cycle of their host or with local environmental factors and weather conditions (4). Flea populations are approximately 50% eggs, 35% larvae, 10% pupae, and 5% adults (5).

When the flea reaches adulthood, its main purpose is to find blood and reproduce (6). Female fleas can lay 5000 or more eggs in their lifetime, increasing their numbers rapidly (7). Generally, an adult flea lives only



2 or 3 months. A flea's lifespan can be as short as a few days without a host to provide a blood meal. Under ideal temperature, food supply, and humidity conditions, an adult flea can live up to a year and a half (7). The optimum temperature for the flea life cycle is 21 to 30 °C, and the optimum humidity is 70% (8).

The human flea (*Pulex irritans*) is universal and, despite its common name, has a wide host range (9).

Pulex irritans are holometabolous insects, and the eggs are laid by the female in the environment and turn into larvae within 3 to 4 days. Larvae feed on organic matter in the environment. The larvae eventually pupate in cocoons that are often covered with environmental debris (sand, gravel, etc). The larval and pupal stages are completed in about 3–4 weeks when adults emerge from the pupa and then must seek out a warm-blooded host for blood meals. If conditions are unfavorable, the cocooned flea can remain dormant in the pupal stage for up to a year. Adult insects are approximately 1.5 to 4 mm long and are laterally smooth. They are dark brown, wingless, and have piercing mouthparts that help feed on the host's blood. Both genal and pronotal combs are absent, and the adult flea has a rounded head. Most fleas are distributed in egg, larval, or pupal stages.

Fleas are parasites that cause an itchy sensation in their host, leading to discomfort and scratching near the bite site. Flea bites generally cause raised skin, swelling, and itching. The bite site has a puncture point in the center. Bites often appear in small clusters or rows and can remain inflamed for several weeks.

This species bites many species of mammals and birds, including domestic species. It has been found in dogs and wild dogs, captive monkeys, opossums, domestic cats, captive feral cats, chickens, black rats and Norway rats, wild rodents, pigs, free-tailed bats, and other species. It can also be an intermediate host for the flea tapeworm cestode (*Dipylidium caninum*). Fleas can spread quickly and move between eyebrows, eyelashes, and pubic areas. Hair loss due to itching is common, especially in wild and domestic animals. Anemia is also possible in severe cases of high-volume contamination (10).

Plague, a disease that affects humans and other mammals, is caused by the bacterium *Yersinia pestis*. Human fleas can carry plague bacteria. The plague is notorious for killing millions of people in Eurasia in the middle ages. Without prompt treatment, this disease can cause severe illness or death. Today, human plague infection still occurs in the western United States, but significant cases occur in parts of Africa and Asia.

Materials and Methods

Dog Selection

Dogs were selected after coordinating and contacting pet dog and guard dog owners. In the case of stray dogs, sampling was done with the help of the animal shelters

and the dog-keeping department of the Faculty of Veterinary Medicine of the Islamic Azad University.

Most of the sampled pet dogs lived at home, but some were in gardens or dog breeding places. All of these were tested, and the results are presented. The area for sampling pet dogs was Tabriz, Iran, and samples were taken from different regions of the city, so samples of pet dogs were randomly taken from multiple areas of the city.

The breeds of the sampled dogs were very different; a high percentage were terriers or mixed with other breeds. Among the pet dog breeds, we can mention Shih-Tzu, Spitz, Yorkshire terrier, English bulldog, Boxer, German shepherd, Great Dane, Pit Bull, etc. Meanwhile, big dogs like German shepherds were kept at home and considered pet dogs.

The guard dogs were sampled from the cities near Tabriz and its suburbs. The breed of guard dogs was mostly Iranian Mastiffs (Sarabi, Iraqi, and Afghani), which were very popular in Tabriz and its surroundings and kept at a low level regarding health issues.

The dogs were sampled from February 2019 to September 2021, and their age range was from one month to 13 years.

Dog Information Registration Table

Breed: Registration of dog breeds to relate the breed to flea infestation

Age: Recording the dog's age

Hair: Hair length types: long hair and short hair

Sex: The gender of the dog

Hygiene: The dog's health condition was rated in four states: poor, average, good, and excellent, and classified as numbers 1 to 4.

Contact: contact between dogs and other animals, including dogs and cats

Roaming: the dog can go outside of the home.

Home: Is the dog brought home or kept at home?

Anthelmintic therapy: whether the dog has taken anti-parasite medication and the status of parasite treatment.

Flea: presence of dogs and registration of fleas in two categories: *X. cheopis* and *P. irritans*

Flea Feces: Presence or absence of flea feces

Bathing: The state of washing and bathing the dog

Sampling Method

First, the dog was evaluated in terms of behavior, and fleas were identified carefully and patiently by brushing, removing hair, and looking at the skin. Fleas were taken by glue, and in cases where the number of fleas was high, the taken fleas were transferred to the test tube, and 70% alcohol was poured on it.

The animal's groin, armpit, head, neck, and back were the most common places where fleas were found. In cases of severe contamination, the groin and lower abdomen were the most convenient places to take samples.

Fixing and Preparing the Coke Slide

Fleas were dehydrated with ascending percentages of ethanol, from 50 to 100% absolute, for 10 to 20 minutes inside each percentage of alcohol.

Then, they were clarified with lactophenol and vented with Antilan glue or Canada balsam. First, glue is poured on the slide, then coke is placed over it, the slide is placed on it, and it is dried at laboratory temperature.

All fixation, slide preparation, and diagnosis stages were performed in the Department of Parasitology, Faculty of Veterinary Medicine, Islamic Azad University, Tabriz branch.

This study was conducted on 360 dogs in and around Tabriz to find the rate and type of human flea contamination in these dogs, which were divided into three categories: pets, guards, and stray dogs.

Results

Checking the Types of Breeds

This study was done on 360 dogs. The examined dogs were divided into three categories: stray dogs, guard dogs (guard and herd), and pet dogs, and the number of dogs in each group was as follows:

1. 140 stray dogs were collected and examined from different areas around Tabriz. These dogs were subjected to skin tests at different ages.
2. The number of sheep and guard dogs was 120, most from around Tabriz city and different areas such as Sarab, Azarshahr, Sufian, Ahar, etc. Most of the breeds of dogs have been purebred and mixed, which include German Shepherds, Great Danes, Dobermans, Pit Bulls, Rottweilers, Anatolian Karabash, Iraqi, and Sarabi (mastiff) dogs, or a mixture of the above breeds.
3. The number of domestic dogs was 100, which was used due to the random selection of domestic dogs and to ensure the method of random collection of samples. Pet dog breeds include a wide range of dogs, from tiny pets to dogs such as bulldogs, German shepherds, and boxers. But despite this, the number of existing dogs from the terrier breed and its mixed types with the Shih-Tzu breed and the Spitz has been very abundant.

Examination of Hair Type and Sex

In this study, most domestic breeds are long-haired dogs, and most guard dogs are short-haired, but among stray dogs, there are both types and among them, there are both long-haired and short-haired dogs.

Regarding the sex of dogs, sampling was done from two types: female and male. Still, due to the maintenance of male dogs as guard dogs, the number of male dogs in this category is higher, but in the category of pet dogs and stray dogs, the number of male and female dogs was almost equal.

Health Status and Maintenance of Dogs

Regarding the maintenance condition, it should be acknowledged that due to keeping them outside the house, most guard dogs are not in good condition, and only in a few cases has the maintenance of these dogs been relatively ideal. But in pet dogs, unlike guard dogs, in most cases, the level of maintenance of dogs is reasonable, and only in a few cases, and in dogs that were kept at home but in open environments or villas, the level of maintenance and hygiene is in good condition.

To determine the condition of keeping dogs, factors such as the condition of the hair coat, the presence of fecal matter or excrement attached to the anal area, the hygiene of the place of keeping, the time and number of bathing the animals, etc. were classified in a ranking from very poor to excellent. Their ratings were recorded for each dog. Only about the state of animal bathing, this case was divided into three categories: no bath, bath for two weeks or more, and weekly bath. Only in pet dogs were these cases fully considered by livestock owners, and unlike guard dogs, bathing in this category of animals was seriously considered.

Flea Infestation Status

Two cases were considered, according to the condition of the dogs, to check the rate of flea infestation in the studied animals. According to all the reliable articles and references, the absence of fleas on dogs and livestock despite flea feces should be considered because washing or using insecticides and anti-ectoparasite drugs can reduce contamination. However, the presence of flea feces on animals indicates the actual rate of flea infestation. Unfortunately, it is impossible to determine the type of fleas with flea feces, but the actual infestation rate is completely scientific and practical.

Regarding the dogs studied in this research, the mentioned cases were also considered, so that in guard dogs, the rate of actual contamination was 76.67% (92 dogs were contaminated with flea feces). Still, the rate of separation of different fleas from dogs' bodies was covered with 74 dogs, so the rate of flea infestation in this method (flea separation method) was 61.67%, which shows a difference of about 15%. However, regarding the rates of infection with different fleas in guard dogs according to the separation method, it was as follows:

The highest contamination rate in guard dogs is related to the *P. irritans* flea, which affects 35 collars (47%) of the dogs. Unfortunately, the contamination is severe, and that is at the human species, and it can be a zoonosis or can be transmitted to humans or animals (Figure 1).

Xenopsylla cheopis flea infection is in third place out of 12 dog collars, and 16.22% of dogs have shown infection with this flea. Unfortunately, this rodent flea infection is severe because it can cause a contagious disease, human plague, or *Yersinia pestis* (Figure 2).

The state of infection of pet dogs with various fleas is directly affected by their health status, bathing, and being outside the house, as well as taking the animals outside and contact with other animals, so that the infection with fleas is only in the dogs that are kept outside the house and were in contact with other animals or were allowed to go outside. The relationship between these cases and flea infestation in pets was kept only in the home, which is also significant ($P > 0.05$). The rate of flea infestation in pet dogs was 14 out of 100 dogs, which represents 14% contamination.

Xenopsylla cheopis flea contamination included 14.28% of all fleas, only found in two dogs. Although both dogs were kept in the villa, they were not in good health and had contact with stray dogs. Fortunately, all domestic



Figure 1. *Pulex irritans* Isolated From Dogs



Figure 2. *Xenopsylla cheopis* Isolated From Dogs

dogs have not been infected with human fleas.

Pollution Status in Stray Dogs

Unfortunately, the rate of contamination in stray dogs was 100%. The reason for this is the interaction of stray dogs with each other and contamination from the mothers of these dogs. The rate of real contamination based on the separation of fleas and flea excrement from the body of this group of dogs is equal, and in all stray dogs due to the lack of use of anti-parasitic substances or their bathing, the separation of flea excrement is equal to the rate of contamination (100%).

Pulex irritans contamination was confirmed in 7.15% of dogs and isolated from 10 dogs.

Four dogs have been isolated with *X. cheopis* contamination, which includes 2.85% flea contamination (Table 1).

Discussion

This study aimed to investigate the epidemiological investigation of human fleas and *Xenopsylla cheopis* as zoonotic fleas in different dog groups. During this period, there have been no comprehensive articles or practical works on the extent of prevalence and other types of flea species, either in the region or Iran. Therefore, due to the importance of the subject and the extreme extent of contamination, as well as the occurrence of common diseases and the transmission of these fleas to humans, which can even cause diseases transmitted by ticks and fleas, this research was conducted on different groups of dogs during two years in Tabriz and suburbs. According to the results of this research, unfortunately, flea infestation in dogs in the region is high, and in terms of health and epidemiology, treatment and prevention of these parasites should be done (10).

This study found that flea infestation in pet dogs is almost a global concern. However, the infestation rate is lower in some parts of the world and some regions. The pollution in pet dogs was 14%, which is lower than world rates. None of the pet dogs that were kept alone had flea infestations. In this group of dogs, the contamination rate was zero, indicating that contamination with fleas directly relates to the type of keeping.

This indicates that environmental pollution, especially in non-urban areas, is more common, which means severe pollution and a lower level of health for people and

Table 1. Prevalence of Fleas Isolated From Pet Dogs, Guard Dogs and Stray Dogs in Tabriz, Iran

| Dogs Categories | Number of Examined Dogs | The Number of Dogs Infected With Fleas (%) | Isolated Fleas (%) |
|-----------------------------|-------------------------|--|--|
| Pet dogs | 100 | 14 (14%) | <i>Xenopsylla cheopis</i> [2(14/28%)] |
| Guard dogs (guard and herd) | 120 | 74 (61/67%) | <i>Pulex irritans</i> [35(47%)] <i>Xenopsylla cheopis</i> [12(16/22%)] |
| Stray dogs | 140 | 140 (100%) | <i>Pulex irritans</i> [10(7/15%)] <i>Xenopsylla cheopis</i> [4 (2/85%)] |
| Total | 360 | 228 | 63 |

livestock in those areas (11,12).

The investigation of the guard dogs, which are mostly kept in the surrounding cities as herding and guard dogs (double-purpose), showed relatively severe contamination. The primary finding of this study is that the prevalence of *P. irritans* pollution is the highest among the dogs under investigation. Specifically, the pollution rates in dogs infected with *P. irritans* and *X. cheopis* species were 47% and 16%, respectively. These results highlight two fundamental aspects.

The first point is that human flea infection may be a reverse zoonosis, and it can be transmitted from humans to animals and vice versa. These parasites can spread as a result of human-animal interactions. It has been observed that the fleas of dogs and cats can also infect humans, and there are reports of human contamination by dog or cat fleas. However, we must consider the range of *P. irritans* infestations in different animals (13,14).

The second point is the presence of rodent fleas, which can transmit plague. Plague can be transmitted worldwide through rodent fleas, and environmental pollution can increase the risk of transmission and spread of the disease in humans. It has been determined that in Tanzania, rodent flea infestation in seven villages had a direct relationship with the incidence of plague and the recurrence of the disease from 1986 to 2004. Therefore, infestation with this type of fleas poses not only the risk of transmission of infection to people dealing with these fleas will have the ability to spread the plague in the region (15).

Unfortunately, rodent fleas have been isolated from two collars of pet dogs, mixed-breed terriers, and kept outside the house and in the garden. The aforementioned has caused the possibility of contamination of these dogs, which necessitates that the condition of keeping, health, information of owners and the place of keeping, and pollution of the environment have shown a direct and close relationship with the rate of contamination with dogs. In all the studies available in this area, a statistically significant difference has been observed among the kept dogs in terms of personal hygiene, the place of keeping, the level of hygiene of the environment, and the outside of the dogs ($P < 0.05$).

This study found that, despite the high number of male dogs compared to female dogs, there was no significant difference in flea infestation in both sexes, consistent with the research conducted in other countries. Also, in terms of age, no significant relationship was observed between different ages.

The same study did not show a significant difference of opinion regarding hair coverage, and no direct relationship was observed between hair length and flea infestation in the studied dogs. However, significant differences were observed between the pollution of pet dogs with guard and stray dogs in terms of the type of pollution, the rate of pollution, the state of animals

going out, the state of public health, and the state of maintenance ($P < 0.05$), which indicated that the type of keeping has a direct relationship with other animals and the amount of hygiene and outside on the animals has a direct relationship with the increase in the incidence of contamination in the studied dogs (16-18).

Even the study of the studied dogs showed that the intensity of contamination in stray and guard dogs significantly differs from that in pet dogs ($P < 0.05$).

So, the severity of pollution in guard dogs is mostly severe, and respectively mild and low pollution is observed in this category of dogs. In the case of mild and low pollution in pet dogs, the intensity of pollution in these animals has decreased due to frequent bathing, at least monthly. Therefore, according to the factors mentioned above and the results of this research, it can be seen that there is a close and direct relationship between flea infestation and the way dogs are kept healthy, and it should be done with comprehensive and coordinated measures and by raising the level of culture. Livestock owners should take necessary environmental and community health measures (19,20).

Ultimately, it is essential to recognize a prevalent flea infestation among the dogs in the region. The prevalence of these harmful skin parasites varies depending on the breed of dogs kept. Infestation with these parasites at different rates and with various symptoms is common. This causes economic damage due to the time and cost of treating animal diseases and leads to environmental pollution. Additionally, it increases the likelihood of disease transmission by these parasites, the potential for human infection, and the spread of diseases from dogs to humans, further contributing to environmental pollution. Therefore, it is recommended to address, manage, and eliminate the disease through meticulous planning, enhance the owners' cultural awareness, foster collaboration among diverse healthcare professionals such as veterinarians and human clinicians, and endeavor to eradicate this disease through comprehensive and recurrent examinations of cutaneous parasites, thereby averting the transmission of diverse diseases in both animals and humans.

Conclusion

It should be acknowledged that, unfortunately, flea infestation is expected in the region's dogs, depending on the type of dogs kept. Infestation with these insidious skin parasites with varying rates and symptoms is common, which, in addition to the economic damage of spending time and money on medicine for disease in animals, causes environmental pollution, increases the likelihood of disease transmission by these parasites, and increases the possibility of human infection and disease transmission from them to humans, as well as environmental pollution.

Authors' Contribution**Conceptualization:** Ali Shabestari Asl.**Data curation:** Yagoob Garedaghi, Pouya Motameni.**Formal analysis:** Yagoob Garedaghi.**Funding acquisition:** Yagoob Garedaghi, Pouya Motameni.**Investigation:** Ali Shabestari Asl, Yagoob Garedaghi, Pouya Motameni.**Methodology:** Ali Shabestari Asl, Yagoob Garedaghi.**Project administration:** Ali Shabestari Asl, Yagoob Garedaghi.**Resources:** Ali Shabestari Asl.**Software:** Pouya Motameni.**Supervision:** Ali Shabestari Asl.**Validation:** Ali Shabestari Asl, Yagoob Garedaghi.**Visualization:** Yagoob Garedaghi.**Writing—original draft:** Ali Shabestari Asl.**Writing—review & editing:** Yagoob Garedaghi.**Competing Interests**

The authors declare no competing interests.

Ethical Approval

Not applicable.

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