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**Survey of endoparasitic infections of dogs in a region
of Norway**

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Abbreviations

Syn: Synonyms

Spp: Species

PO: Per os

PC: Percutan

1. Introduction

In Norway the prevalence of endoparasitic infection in the dog population has been estimated to be relatively low due to the cold weather, the low number of stray dogs that cease the infection pressure and the good health status of the local dogs. In 2009-2012 a nationwide parasitological study was carried out on dogs in the country, with examining the faecal samples sent from veterinary clinics to the Norwegian Veterinary Institute for diagnostics reasons. The prevalence of endoparasitic infection of 1276 dogs was 20,8%. Except this, no other similar studies have been carried out in Norway (Dalaker et al., 2014).

On the basis of the climatic similarities in the Nordic countries one can assume that the prevalence of endoparasites in adult dogs is quite similar in these countries. In Finland the prevalence of gastrointestinal helminths was 5.9% (Pullola et al., 2006), in Sweden this data was 7.9% (Victorsson, 2014) and in Denmark it was 22.1% in hunting dogs (Al-Sabi et al., 2013).

In 2011, Norway increased the surveillance of *E. multilocularis* after the detection of this zoonotic parasite species in a red fox in Sweden (Wahlström et al., 2015). To prevent the introduction of this tapeworm to the Norwegian fauna, treatment of dogs with anticestode drug must be administered 24-120 hours prior to entering Norway (Mattilsynet, n.d.). Therefore, a high number of treatments are performed in the areas close to the Swedish border with Droncit® (praziquantel) and Milbemax® (milbemycin oxime and praziquantel) (Arnemo et al., 2008)

The risk of the introduction of pathogens has increased in Norway after the import regulations of EU changed the 1.1.2012. With this change the mandatory checks of rabies antibody titres was lifted which made it easier to import stray dogs from Eastern European countries. In 2012, The Norwegian Veterinary Institute made an import risk assessment of dogs imported from Eastern Europe. The impact of *E. multilocularis* on animal and human health was classified as “major” and probability of importation as “moderate” in this report (Høgåsen et al., 2012).

To investigate the prevalence of endoparasites in the border areas, faecal samples were collected from clinically healthy dogs in Trysil kommune (Figure 1), which is a small municipal in eastern Norway located by the Swedish border. The goal of this study was to see whether the endoparasitic infections of the local dogs has been influenced by the high treatment pressure. The other aim of the study was to get up-to-date information about the occurrence of endoparasitic infection in the local dogs related to their age, feeding, keeping, gender as well as their anthelmintic treatments.



Figure 1: The marked area (red) is indicating where Trysil kommune is located in Norway

2. Literature review

2.1. The most important endoparasite species of dogs

2.1.1. Protozoa

Giardia duodenalis

Giardia duodenalis (syn. *Giardia intestinalis* and *Giardia lamblia*) is a one-celled parasite and consist of eight (A-H) different genetic groups (assemblages) (Ryan and Cacciò, 2013). The genetic groups A and B can infect both humans and animals and is therefore regarded as zoonotic. In canine the genetic groups A-D has been distinguished, where the last two (C and D) are found to be specific for both canine and feline. The life cycle consists of two main stages – a cyst stage and a trophozoite stage. *Giardia* is transmitted directly between the animals or PO through water contaminated with faeces or sewage. After the PO ingestion with feed, water or by direct contact with faeces containing cysts, a trophozoite is released from the cyst in the upper part of the small intestine. In the intestines, the trophozoites use a vertical adhesive disk to attach to the epithelial cells of the duodenal and jejunal mucosa (Gjerde, 2011). The parasites multiply asexually by binary fission and the encystation of the trophozoites is led by the exposure to biliary salts (Geurden et al., 2010). Cysts are passed to the large intestine and excreted with the faeces. Also trophozoites may be excreted, e.g. due to diarrhoea (Gjerde, 2011). The life cycle may be completed within 72 hours as the cyst has an immediate infectious form after excretion (Geurden et al., 2010). *G. duodenalis* infection is usually asymptomatic, but symptoms like chronic diarrhoea, weight loss and dull coat may be seen. Decreased digestion and absorption of nutrients, especially fats, can result in steatorrhea (Gjerde, 2011).

In Norway the prevalence of *G. duodenalis* has been found to be 0-11,4% in the age group 1-12 months old dogs (Bangen et al., 2010).

***Isospora* spp.**

Isospora is referred to as the coccidia of carnivores and is a one-celled organism. The *Isospora* spp. (syn. *Cystoisospora*) of dogs and cats have two main ways of transmission, with sporulated oocysts or with a paratenic host. The parasite habits the small intestine, large intestine and partly other organs, the first part of the development takes place in the small intestine and the last part in the colon. *Isospora* infection may cause severe clinical signs in

animals with immune deficiencies, but usually only subclinical infection is seen in dogs (Gjerde, 2011).

In Norway the prevalence of *Isospora* infection of dogs is sporadic, but no comprehensive survey has been carried out (Bangen et al., 2010).

***Cryptosporidium* spp.**

Cryptosporidium is a one-celled parasite and the main specie in dogs is *C. canis*. The parasite can also infect cats and humans, and is therefore regarded as a zoonotic parasite. This protozoan habits the ileum and partly the colon. The dog is infected PO with infective sporulated oocytes which develop in the microvillar border of the small intestine (Companion Animal Parasite Council, 2012). This infection is usually subclinical in dogs, but it may cause diarrhoea (Gjerde, 2011).

In Norway the prevalence of this parasite is not really known (Bangen et al. 2010). In a study done by Hamnes et al. (2007) they found that the prevalence was between 5.1% and 22.5% in large dog breeds, less than 6 months of age. The Norwegian winter environment may play a role in the prevalence of both *Cryptosporidium* and *Giardia*, since the *Cryptosporidium* oocyst and *Giardia* cyst may not persist in the terrestrial winter environment. When these parasites are detected the oocyst/cysts will have been excreted after the winter season (Robertson and Gjerde, 2004).

2.1.2. Helminths

Toxocara canis

T. canis has a complex life cycle that varies between ages and the way of transmission. In young dogs that ingest infective eggs, the larvae penetrate the intestinal mucosa after the hatching (Peregrine, 2014). By the vena portae they enter the lung and moult from L3 to L4 and further to L5. From here they migrate up the respiratory tract and re-enter the duodenum by the oesophagus, entero-pneumo-enteric migration. In the small intestine the L5 will become sexual mature. A portion of the larvae will enter the bloodstream and enter different organs. This is the somatic migration (Gjerde, 2011).

Puppies may get infected by a lactogenic or an intrauterine way (Peregrine, 2014). In case of an intrauterine way of transmission, the dormant larvae are re-activated in the bitch by the hormonal changes caused by the pregnancy. The L3 migrates to the placenta and enters the foetal liver. Soon after birth the parasites will wander to the lungs of the puppies and moults to L4 and from this stage they will be coughed up and passed to the small intestine. In the lactogenic way of transmission, the puppies will get infected with milk containing infective L3. This infection can happen after re-activation of the dormant larvae, or by a new infection of the bitch right before or after the birth (Gjerde, 2011).

In older dogs the quantity of L3 entering the somatic migration is higher. After the hatching, the larva migrates to e.g. the liver, lungs, muscles, connective tissue, kidneys, where their development is arrested (Peregrine, 2014). In these organs the parasite will be encapsulated, hypobiotic larva. At the age of 3-10 weeks, the migration of the parasite changes from enteric-pneumo-enteric to somatic and in 5 months old female dogs and 8 months old male dogs there is more or less no larvae entering the enteric-pneumo-enteric migration (Gjerde, 2011).

The parasite may use a life cycle including non-specific paratenic hosts, like humans. Therefore, this parasite is regarded as a zoonotic one. In the case of a paratenic infection, the L3 has a somatic migration. When a canine is ingesting a paratenic host, the free L3 will then enter the enteric-pneumo-enteric or somatic migration. Humans may get infected through water, feed and soil contaminated with faeces containing eggs from foxes and dogs (Gjerde, 2011). Usually the infection is asymptomatic, but clinical signs such as loss of body condition and poor growth in young dogs may be seen. Eosinophilic pneumonia caused by migrating larvae, diarrhoea (Peregrine, 2014) and a potbelly (Companion Animal Parasite Council, 2016a) in infected animals may also be seen. In humans the infections are asymptomatic, but in case of visceral larva migrans, fever, hepatomegaly and persistent eosinophilia may occur. Also the Ocular larva migrans can be seen if the larva settle in the retina and impair vision (Peregrine, 2014).

T. canis is the most common endoparasitic infection of Norwegian dogs (Bangen et al., 2010).

Toxoscaris leonina

This parasite species can be found in the small intestine of Canidae and Felidae, where the female parasite lay unembryonated eggs. The infection happens after PO ingestion of infective eggs containing L3. These eggs will hatch in the small intestine and the larva will penetrate the intestinal wall. The L3 will stay in this site for about 14 days before they moult to L4-L5. The parasite will stay in the mucosa and in the lumen of the intestines and therefore no visceral migration will take place. Facultative intermediate hosts may participate in the life cycle, like chicken, mice and rabbit. In these animals the infection occurs after ingestion of infective eggs and the egg will hatch to L3 in the small intestine. The parasite migrates directly from the intestine to the abdominal cavity and inhabit different organs of the intermediate host (Gjerde, 2011). The clinical signs are usually very mild or asymptomatic. (Bangen et al., 2010).

The *T. leonina* infection of dogs is not very common in Norway and infected animals are usually treated with anthelmintic drugs.

Ancylostoma caninum

Ancylostoma caninum is a parasitic infection of dogs, foxes and other Canidae (Gjerde, 2011). Adult worms can be found in the small intestine, where they will lay eggs that are passed out with faeces. In the environment the eggs will larvate, hatch and moult into L3 (Companion Animal Parasite Council, 2016b). The final host may get infected PO from free-living larvae, a paratenic host or by consuming milk from lactating bitches or by PC infection. In the PC infection the larvae will wander to the lungs by the bloodstream. From here they will either wander to the small intestine or to muscles and fatty tissue by somatic wandering. During pregnancy the hypobiotic larvae will be reactivated and they will wander to the udder. The larvae may also be activated in dogs with decreased immunity, which may be an important factor in the imported dogs (Gjerde, 2011). In the PO infection the larvae will pass to the small intestine and a small portion will wander to the lungs and back again to the small intestine by the tracheal route. The paratenic host will be infected PC and the final host will be infected after the consumption of these. Clinical signs of the puppies may be pale mucous membrane, diarrhoea, dehydration, thirst and no weight gain (Companion Animal Parasite Council, 2016b). The severity of the anaemia of these animals depends of the number and size of the worms. In heavy infections the animals may die (Gjerde, 2011).

The prevalence of the *A. caninum* is relatively low in Norway, and the infection is more common in foxes (Bangen et al., 2010).

Uncinaria stenocephala

This nematode species can be found in the small intestine of cats, dogs and foxes (Companion Animal Parasite Council, 2016b). Adult hookworms lay eggs which are passed out with the faeces. In the environment the L1 will hatch and moult to an infective L3 before it wanders out of the faeces. The infection happens primarily in two main ways: PO infection and PC infection. After the PO infection, the parasite will pass to the small intestine and develop into adults. A portion may also penetrate the intestinal wall and be carried to the lung by the bloodstream. From here they will follow the respiratory tract to oesophagus were they are swallowed. The larvae from the PC infection will wander to the lungs and from there go to the small intestine with the tracheal route. Only a small portion of the PC L3 will manage to complete this wandering (Gjerde, 2011). In the PC infection dermatitis with erythema, papules, inflammation, thickened skin with alopecia can be seen. The dermatitis is located in the regions that are in contact with the soil, like the paws, elbows, thighs and the ventral portion of the abdomen. In the PO infection moderate anaemia, hypoalbuminaemia, diarrhoea and decreased feed intake is mainly seen (Gjerde, 2011).

This parasitic infection is very common in red foxes in Norway. In the dog population it can most often be seen in hunting dogs (Gjerde, 2011). The reason for the different prevalence of *A. caninum* and *U. stenocephala* in red foxes is most likely caused by the different temperature tolerance of the parasite. The eggs and larvae of *A. caninum* will be killed by freezing, and will not develop at temperatures below 15°C. *U. stenocephala* tolerates colder temperatures (Kennedy, 2001).

Trichuris vulpis

Trichuris vulpis has a direct life cycle and can be found in caecum and colon of dogs, cats and foxes (Gjerde, 2011). Unembryonated eggs are passed out with faeces and the eggs need humid environment to embryonate (Companion Animal Parasite Council, 2016c). The infective eggs contain L1, and after PO ingestion they hatch and free larvae will be released in the last part of the small intestine. The larvae will penetrate the mucosa and glands and

will moult and mature. In some cases, melena or catarrhal - haemorrhagic typhlitis and colitis can be detected. The blood loss may be so severe that anaemia and hypoalbuminaemia can be diagnosed, together with reduced feed intake, decreased body weight and death (Gjerde, 2011).

This nematode infection is not common in Norwegian dogs (Bangen et al., 2010) and it is often either subclinical or asymptomatic (Companion Animal Parasite Council, 2016c).

Oslerus osleri

Oslerus osleri (syn. *Filaroides osleri*) is a lungworm species which infects dogs and foxes. The parasite has a direct life cycle and after PO infection with saliva, vomitus or faeces the parasite is passed to the small intestine. From here they enter the lymph and blood vessels (Gjerde, 2011) and the adult worms can be found embedded in fibrinous nodules in the tracheal mucosa in the bronchi and bifurcation (Companion Animal Parasite Council, 2007). Adult females lay eggs containing L1 and these may hatch already in the trachea. The infective L1 is passed with the faeces or with the saliva and infect other dogs. Therefore, the parasite may be transmitted to the puppies when the bitch nurses them. Emaciation, collapse, weight loss and respiratory distress may be observed in severe affected dogs (Conboy, 2007). Also subclinical infection may happen, as well as secondary bacterial infections (Gjerde, 2011).

In Norway the prevalence of this *O. osleri* is sporadic and the clinical sign is a chronic dry cough (Bangen et al., 2010) that is triggered by physical activity and also by cold air.

Crenosoma vulpis

This nematode species can infect foxes, but also dogs and cats (Gjerde, 2011). This parasite has an indirect life cycle which includes an intermediate host like terrestrial snails and slug gastropods (Companion Animal Parasite Council, 2007). The adult females are ovoviviparous and can be found in the bronchi where they lay eggs. These eggs enter the small intestine by the tracheal route and they may also hatch already in the respiratory tract. The L1 is passed with the faeces and infects the intermediate host. In the snails, the L1 will develop into an infective L3 in about 3 weeks. The infection is acquired by the ingestion of molluscs like *Helix*, *Cepaea* and *Deroceras* spp.. After the infection of the final host the

larvae are entering the portal circulation and from the liver they are carried by the veins to the lung or they can enter the lungs by the lymph- and blood vessels. In the lung, they appear in the alveoli and will sexually mature (Gjerde, 2011). Clinical signs such as chronic bronchitis-bronchiolitis with cough and that occasionally end with gagging (Companion Animal Parasite Council, 2007), sneezing and increased respiratory rate can be seen. In foxes also the fur quality will be influenced (Gjerde, 2011). The infection of *C. vulpis* may be misdiagnosed as an allergic respiratory disease due to the positive response to corticosteroids in these dogs (Conboy, 2009).

The infection of *C. vulpis* is sporadic in dogs and cats in Norway and is more prevalent in red foxes (Bangen et al., 2010). This do not cause any severe impact on the fur foxes, since the contact with the intermediate host is limited (Gjerde, 2011).

Capillaria aerophila

Capillaria aerophila (syn. *Eucoleus aerophilus*) causes an infection in foxes, dogs and cats, but may also cause infection in other animals like hedgehogs and badgers (Gjerde, 2001). The parasite has a direct life cycle and the animals are infected through the consumption of feed or water contaminated with larvated eggs containing L1 (Kuehn, 2013). After the PO ingestion of the egg, they are passed to the small intestine where they hatch. The larvae penetrate the intestinal mucosa and are entering the lungs by the lymph- and bloodstream (Companion Animal Parasite Council, 2007). Adult *C. aerophila* inhabits the epithelium in trachea, bronchi and bronchioles and they lay eggs after mating. These eggs are coughed up, swallowed and released into the environment by the faeces (Kuehn, 2013). Even though the life cycle is direct, the animals may also become infected by paratenic hosts like earthworms (Cesare et al., 2012). The infection may be symptomless, but clinical signs as coughing, sneezing, mucopurulent nasal discharge (Gjerde, 2011), dyspnoea, anorexia may be seen (Companion Animal Parasite Council, 2007). In severe cases bronchitis, tracheitis may be seen, as well as secondary infections with bacteria (Gjerde, 2011).

In Norway *C. aerophila* infection of red foxes is quite common, but rare in dogs (Bangen et al., 2010).

Angiostrongylus vasorum

It can cause a parasitic infection in foxes, but it can also be detected in dogs and wolves. Dogs get infected after the ingestion of gastropods or their slime containing infective larvae, or from frogs acting as paratenic host. The larvae are passed to the intestines after the ingestion (Gjerde, 2011) and wander to the local lymph nodes (Companion Animal Parasite Council, 2007). They will further wander to the right ventricle and lung arteries where they develop into adult worms. Adult females will lay eggs that are carried away with the small blood vessels. The eggs will hatch and the larva wanders to the lung tissue and into the airspace (Companion Animal Parasite Council, 2007). From here the larva will provoke coughing and they will be swallowed and passed out with the faeces. The clinical signs of the infection may vary from asymptomatic to mild and to severe. In the mild cases a cough may be noticed, while in the more severe cases cough, dyspnoea, epistaxis, hind limb lameness, heart failure and collapse can be detected (Gjerde, 2011).

This parasite has been detected in both Sweden and Denmark, and in March 2016 it was detected for the first time in a fox in Ski, Norway (Mattilsynet, 2016).

2.1.3. Cestoda

In Norway the following tapeworm species has been detected; *Taenia* spp, *Echinococcus multilocularis*, *Echinococcus granulosus*, *Dipylidium caninum*, *Mesocestoides* and *Diphyllobothrium latum* (Gjerde, 2011).

***Taenia* spp. and *Echinococcus* spp.**

Taenia species are large tapeworms consisting of several segments, while *Echinococcus* is the smaller version consisting of just a few segments. Both *Taenia* and *Echinococcus* spp. have final hosts like dog, fox, cat and other carnivores. The intermediate hosts are herbivores and the stenoxenicity depends on species. In the final host infective eggs are passed with faeces and will be ingested by the intermediate host. In the intermediate host the 6-hooked oncosphere will travel with the blood to the liver, lung or other organs and tissues where they will develop to metacestodes. *Echinococcus* spp. develop to hydatid and the *Taenia* spp. will develop to cysticercus, strobilocercus or coenurus. The final host get infected with metacestodes after consuming the intermediate host. The clinical signs of a tapeworm

infection in the final host are usually asymptomatic or mild, while it can be severe and cause death in the intermediate host (Gjerde, 2011).

In Norway *Echinococcus multilocularis* is present in Svalbard, but has not been detected on the mainland. *Echinococcus granulosus* could earlier be detected in 10% of the reindeers in Finland, Northern Norway, but today this is no longer the case. The cause of this may be the change of herding dogs into snowmobile. This parasite has not been detected in wolves or other cervids (Andersen, 2008). Both dog and cat fleas are rare in Norway therefore *Dipylidium caninum* is not common. Also prevalence of the *Mesocestoides* infection of dogs and cats and the infection of *Diphyllobotrium latum* is low (Gjerde, 2011).

3. Materials and methods

3.1 Study population

The study population used in this survey consists of dogs located in Trysil kommune, Norway.

3.2 Procedure of faecal sampling

The faecal samples were collected at Trysil Dyreklinikk AS between 21st of July to 25th of August 2015. Dog owners booking appointments at the clinic for simple procedures, like vaccination, were asked to bring faecal samples from their dogs. At the time of receiving the faecal samples they were marked with the name of the dog and the samples were given a number in chronological order for the statistical analysis. None of the dogs in this study population showed any clinical signs of a parasitic infection, like diarrhoea and respiratory clinical signs. Also dog breeders and the owners of the different sled kennels in Trysil kommune were asked to bring samples from their dogs. At the time of collection of the samples, the owners were given a questionnaire (Appendix 1). In this questionnaire the owners filled out the information concerning the dogs. In the questionnaire the owners needed to fill in information about the dog breed, age and the gender. The way of keeping of the dog was also a part of the questionnaire, where the owner had to specify if the dog was kept indoor/outdoor and if it was kept together with other animals. In the cases where the dogs were kept together with other animals, the species had to be indicated. Indoor keeping refers to the dogs that live indoor together with the humans, and where the dog is walked both with and off-leash outside every day. The outdoor keeping refers to the dogs which are kept in outdoor kennels or in sled dog kennels. The use and purpose of the dogs had to be indicated. In this part of the questionnaire the owners should specify if the dog was kept as a pet, hunting dog, sled dog or for other purposes. In the questionnaire also the place of birth or the origin of the dogs should be answered, as well as information regarding the traveling history, domestic and abroad. If they answered that they had been traveling with the dogs, they had to specify when and where they had been travelling with the dog. In the last part of the questionnaire the owner had to give information about the feeding and deworming. Regarding the feeding of the dogs, the type of feed should be indicated: pet food, leftovers, offals etc. In the question about the deworming the owner should specify when the last deworming took place and also what kind of deworming they used. The name and phone numbers of the owners was also asked, where the phone numbers were filled into

the journal system of the clinic (Sanimalis). After the faecal analysis the owners were informed about the findings in the cases where the samples were positive. Only one faecal sample was collected from each dog.

3.3 Faecal examination for parasitic infection

The faecal samples were investigated as soon as possible. If no faecal analysis was possible the day of the collection, the samples were put in a fridge with a temperature of 4°C and investigated the next day. Three different investigatory methods were used for the analysis of the faecal samples: sucrose flotation, Baermann method and IFAT.

3 g faeces were mixed with 57 ml tap water in a 60 ml syringe for 30 seconds. After this the mixture was filtered through a strainer and transferred into 10 ml test tubes. The test tubes were centrifuged for 3 min at 3000 rpm. The sediment of these tubes were used for both the sucrose flotation method and for IFAT.

3.3.1 Sucrose flotation

2 drops of saturated sugar solution (specific weight 1,3) were put on a microscope slide and thereafter 1 drop of the sediment was added to the slide. The drops were mixed and systematically investigated under the microscope with first 4x, and thereafter a higher magnification. Eggs and oocytes were detected with this method and the result was either positive or negative for the given parasitic infection.

3.3.2. Baermann method

5 g faecal sample was put in a gauze which was placed into a sieve. The sieve was put into a funnel and lukewarm water was added until it covered the faeces. A rubber tubing with a clamp in the end was attached to the stem of the funnel. After 12-24 hours the water in the rubber tubing was transferred into a 10 ml test tube. This tube was centrifuged for 3 min at 300 rpm. The sediment was checked in the microscope.

When water is added to the faecal sample the larvae cannot swim against the gravity and will be concentrated in the rubber tubing. Therefore, L1 larvae can be detected with this method. The detected larvae were differentiated on the basis of morphological differences.

3.3.3. IFAT

A smear with the sediment was made on a microscope slide. When the smear had air-dried 1 drop of methanol was used for fixation. After this fixation, the samples were sent to NMBU where 10-20 µl MAB (monoclonal antibodies) working solution was added to the smear. The microscope slides were put in a wet-chamber at 37 °C for 30 min and thereafter the slide was rinsed with 1 drop of distilled water to remove excess colour solution. The slides were investigated with a Leica fluorescence microscope with a filter that captures the wavelength of FITC (fluorescein isothiocyanate). The cysts of *Giardia* and oocysts of *Cryptosporidium spp.* was detected with this method, and the result was given as positive and negative.

3.4 Statistical analysis

The data collected in the questionnaire for each dog was analysed and used for the statistical analysis.

The frequencies of parasitic infections were analysed alone and in the respect of age, gender, keeping (indoor (alone), indoor (with other animals) and outdoor), feeding (pet food, pet food and scraps, pet food and slaughtered by-products) and use of the dogs examined. To see the distribution and frequencies of any parasitic infection in the study population, they were divided into 6 different groups: 0-3 months, 4-6 months, 7-12 months, 1-5 years, 6-10 years and 10+ years, and also 0-1 years and 1+ years of age.

The dogs they were divided into five different groups: breeding, competition, hunting, pet and sled dog. Fisher's test was used The significant level is < 5% ($p = < 0,05$).

4. Results

4.1 Parasitic infection of the dogs

Of the 113 faecal samples collected, 39 (34,5%) were positive. *Giardia duodenalis* infection was the most common, it occurred in 13 (11,5%) samples and *Isospora* spp. occurs in four (3,5%) of the samples examined with IFAT. No dogs were found to be infected with *Cryptosporidium* spp. with the detection with IFAT. Six (5,3%) dogs were positive for *Crenosoma vulpis*, while no infection caused by *Capillaria aerophila*, *Oslerus osleri* or *Angiostrongylus vasorum* was detected with the Baermann method. Tapeworms were found in 12 (10,6%) faecal samples, eight (7,1%) had the eggs of *Toxocara canis*. The eggs of *Uncinaria stenocephala* and *Ancylostoma caninum* occurred in six (5,3%) and two (1,8%) samples, respectively. Doubled infection by *Toxascaris leonina* and *Trichuris vulpis* was detected in one (0,9%) sample (Figure 2).

In 11 (28,2%) of the 39 dogs more than one parasite species caused the infection (Figure 3). Ten (25,6%) dogs were infected with two different parasites. Four parasites (*Giardia duodenalis*, *Isospora* spp., *T. canis* and *U. stenocephala*) occurred in a dog. All of the 11 dogs with more than one parasitic infection were kept together with other animals and only one of these dogs had received an antiparasitic treatment in 2015. Six (54,5%) out of 11 infected animals were used as sled dogs, four (27,2%) were breeding dogs and two (18,1%) pets.

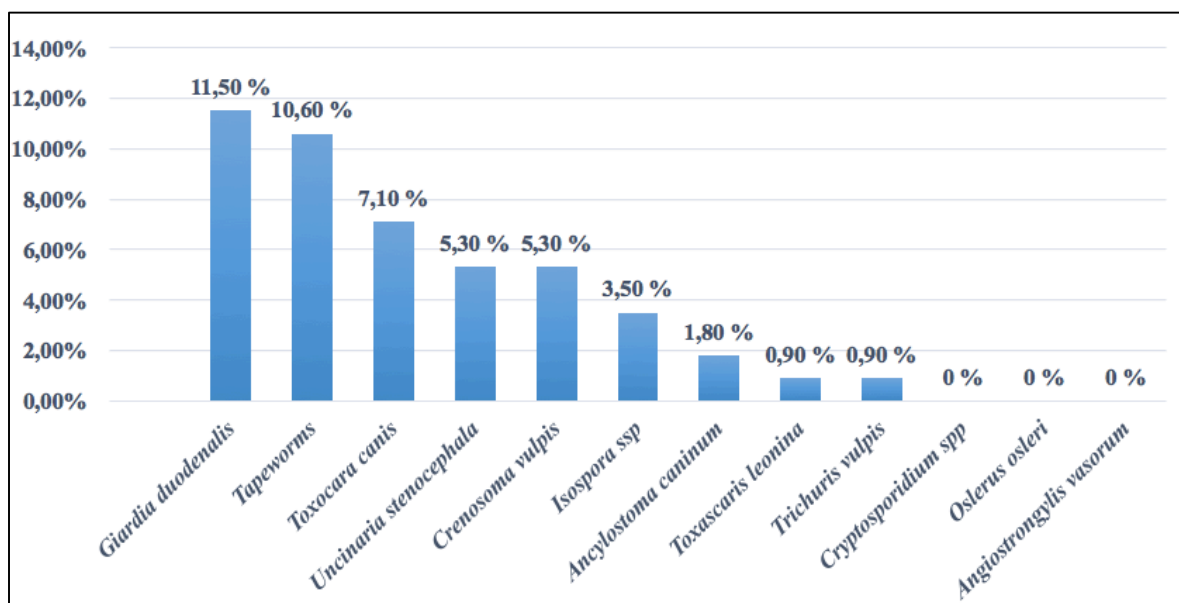


Figure 2: The distribution of each parasitic infection rate.

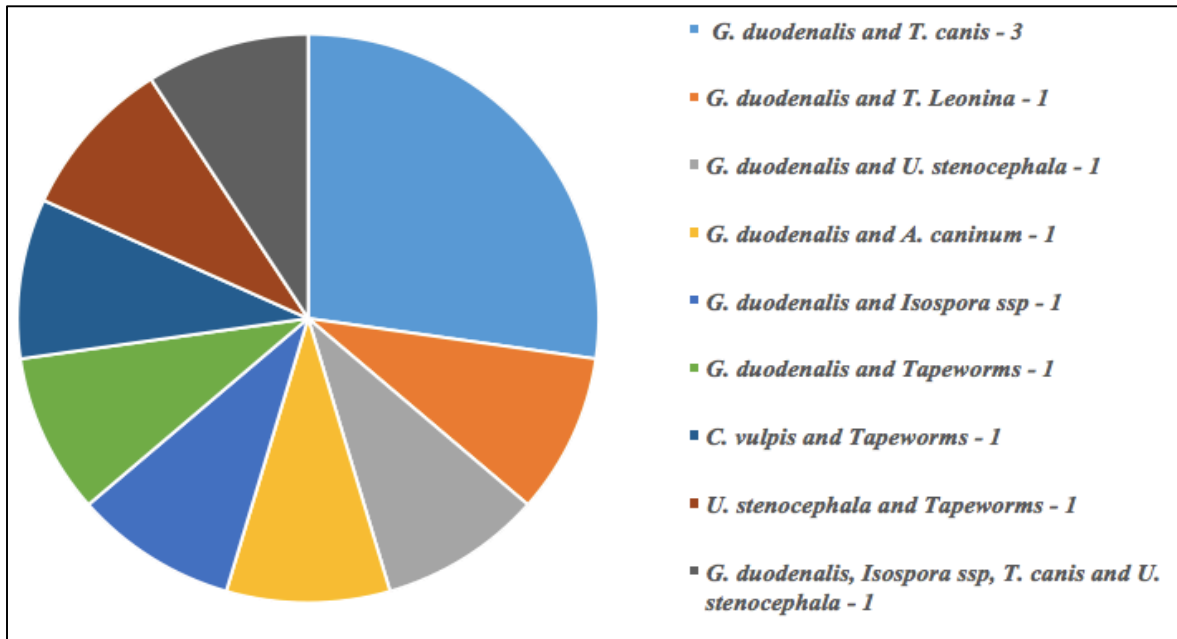


Figure 3: The distribution of multi infection of dogs.

4.2 Parasitic infection related to the age of dogs

Significantly ($p=0,0066$) more young dogs were infected than older ones (Figure 4). There was a significant difference between the two age groups in the infection rate when they were divided into 0-1 years of age and 1+ years of age. More young dogs were infected ($p=0,0035$, $n=28, 83$; infection rate = 28,6%, 6,0% respectively). The percentage of infected dogs in the different age group is presented in Figure 5.

The number of young dogs infected with *G. duodenalis* differed significantly ($p=0,0036$) from the number of older ones. Percentage of *G. duodenalis* infection was 37,5% ($n=8$), 50% ($n=8$), 8,3% ($n=12$) and 8,3% ($n=60$) in the age group 0-3 months, 4-6 months, 7-12 months and 1-5 years of age, respectively. There was a significant difference ($p=0,0488$) between *Giardia* infection rate between the two age groups of 0-1 years and 1+ years ($p=0,0035$, $n=28, 83$; infection rate = 28,6%, 6,0% respectively).

There was no significant difference ($p=0,0990$) between the groups of dogs infected with *Isospora* spp. Percentage of *Isospora* spp. infection was 12,5% ($n=8$), 16,7% ($n=12$) and 1,7% ($n=60$) in the age group of 0-3 months, 7-12 months and 1-5 years, respectively. There

was a significant difference ($p=0,0488$) between *Isospora* infection rate between the two age groups of 0-1 years and 1+ years ($n=28, 83$; infection rate= $10,7\%$, $1,2\%$, respectively).

Significantly ($p= 0,0002$) more young dogs were infected with *T. canis* than older ones. Percentage of *T. canis* infection was $62,5\%$ ($n=8$), $8,3\%$ ($n=12$), $1,7\%$ ($n=60$) and $5,9\%$ ($n=17$) in the age group 0-3 months, 7-12 months, 1-5 years and 6-10 years, respectively. There was a significant difference ($p=0,0031$) between *T. canis* infection between the two age groups of 0-1 years and 1+ years ($n=28, 83$; infection rate= $21,4\%$, $1,8\%$, respectively).

There was no significant difference between the age groups in *C. vulpis* infection ($p= 0,4999$). Percentage of *C. vulpis* infection was $8,3\%$ ($n=60$) and $16,7\%$ ($n=6$) in the age group 1-5 years and 10+ years, respectively. There was no significant difference between age groups when they were divided into two age groups ($p= 0,3342$, $n= 28, 83$; infection rate = $0,0\%$, $7,2\%$ respectively)

The number of young dogs infected *T. leonina* infection was not significant ($p= 0,1982$). Percentage of *T. leonina* infection was $12,5\%$ ($n=8$) in the age group 4-6 months. There was no significant difference between age groups when they were divided into two age groups ($p= 0,2523$, $n= 28, 83$; infection rate = $3,6\%$, $0,0\%$ respectively).

There was no significant difference between the age groups in *U. stenocephala* infection ($p= 0,5214$). Percentage of *U. stenocephala* infection was $8,3\%$ ($n=12$) and $3,3\%$ ($n=60$) in the age group 7-12 years and 1-5 years of age, respectively. There was no significant difference between age groups when they were divided into two age groups ($p= 1,0000$, $n= 28, 83$; infection rate = $3,6\%$, $4,8\%$ respectively).

There was no significant difference between the age groups in *A. caninum* infection ($p=0,4251$). Percentage of *A. caninum* infection was $12,5\%$ ($n=8$) and $1,7\%$ ($n=60$) in the age group 4-6 months and 1-5 years of age, respectively. There was no significant difference between age groups when they were divided into two age groups ($p= 0,4426$, $n= 28, 83$; infection rate = $3,6\%$, $1,2\%$ respectively).

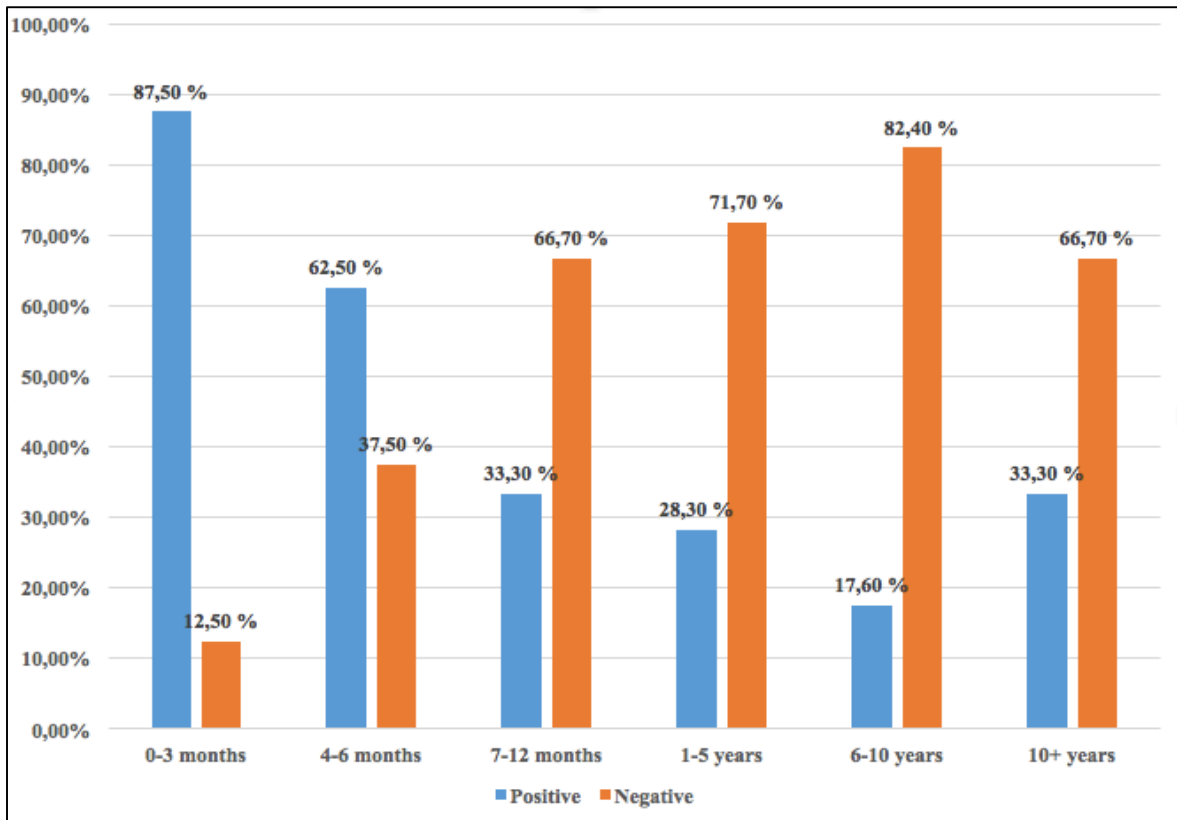


Figure 4: The percentage of parasitic infections in different age groups.

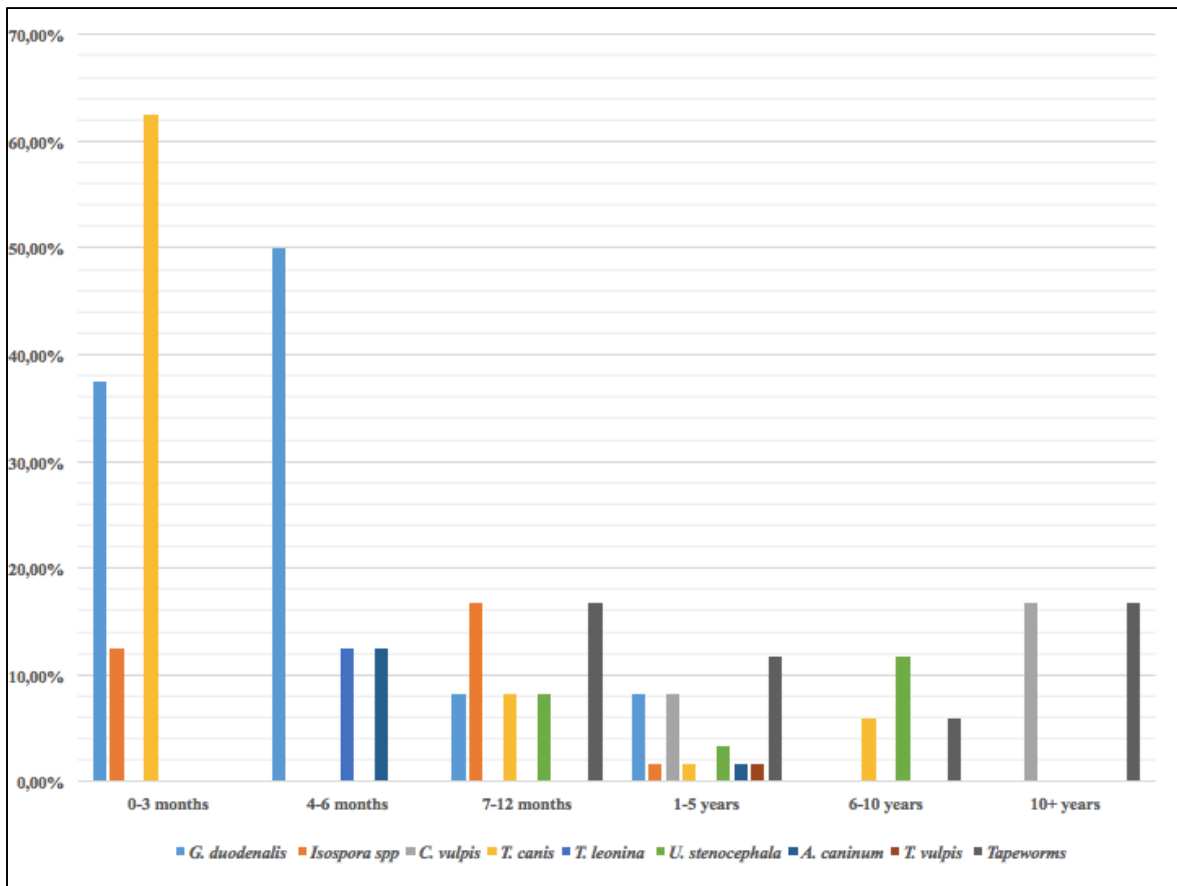


Figure 5: Percentage of each parasitic infection in different age groups

The number of young dogs infected *T. vulpis* was not significant ($p=1,0000$). Percentage of *T. vulpis* infection was 1,7% ($n=60$) in the age 1-5 years of age, respectively. There was no significant difference between age groups when they were divided into two age groups ($p=1,0000$, $n=28, 83$; infection rate = 0,0%, 1,2% respectively)

There was no significant difference between the age groups in tapeworm infection ($p=7301$). Percentage of tapeworm infection was 16,7% ($n=12$) and 11,7% ($n=60$), 5,9% ($n=17$) and 16,7% ($n=6$) in the age group 7-12 months, 1-5 years of age, 6-10 years of age and 10+ years respectively. There was no significant difference between age groups when they were divided into two age groups ($p=0,7270$, $n=28, 83$; infection rate = 7,1%, 10,8% respectively)

4.3. Parasitic infection related to gender

There was no significant difference between the number of infected female and male dogs ($p=1,0000$). 53 females (34,0%) and 60 males (35%) were infected.

Concerning each parasite species there was no significant difference between female and male dogs (*G. duodenalis*: $p=0,1380$; *C. vulpis*: $p=0,0970$; *T. canis*: $p=0,2790$; *T. leonina*: $p=0,4690$; *U. stenocephala*: $p=0,4168$; Tapeworm: $p=0,3728$; *A. caninum*, *T. vulpis* and *Isospora* spp.: $p=1,0000$).

4.4. Parasitic infection related to feeding of dogs

More dogs ($n=84, 41,7%$) fed with only pet food were infected than those ones supplemented with scraps ($n=13, 7,7%$) and processed slaughtered by-products ($n=14, 14,3%$). There was a significant difference ($p=0,0145$) between these groups

According to each parasite species there was no significant difference between the feeding with only pet food, supplemented with scraps and processed slaughtered by-products (*G. duodenalis*: $p=0,4770$; *C. vulpis*: $p=0,8091$; *T. canis*: $p=0,5555$; *T. leonina*: $p=1,000$; Tapeworm: $p=0,1432$; *A. caninum*: $p=0,2364$ and *Isospora* spp, *U. stenocephala* and *T. vulpis*: $p=1,0000$).

Percentage of *G. duodenalis* infection was 14,3 % (n=84) and 7,1% (n=14) in the groups fed with only pet food and supplemented with slaughtered by-products, respectively. The percentage of *Isospora* spp infection was 3,6% (n=84) in the groups fed with only pet food. *C. vulpis* infection had a percentage of 7,1 % (n=84) in the group fed with only pet food. Percentage of *T. canis* infection was 9,5% (n=84) in the group fed with only pet food. The percentage of *T. leonina* infection was 1,2% (n=84) in the group fed with only pet food. Percentage of *U. stenocephala* infection was 6,0% (n=84) and 7,1% (n=14) in the groups fed with only pet food and supplemented with processed slaughtered by-products, respectively. *A. caninum* infection had a percentage of 1,2% (n=84) and 7,7 % (n=13) in the groups fed with only pet food and supplemented with scraps, respectively. Percentage of dogs infected with *T. vulpis* was 1,2% (n=84) in the group fed with only pet food. Percentage of tapeworm infection was 14,3% (n=84) in the group fed with only pet food.

4.5. Parasitic infection related to keeping

More dogs kept outdoor were infected than dogs kept indoor. There was significant difference ($p=0,0010$) between the data of the two groups. The numbers of infected dogs kept indoor alone or with other animals differed from each other, but this difference was not provable. 11 dogs kept indoor alone were infected, meanwhile 47 and 55 ones kept indoor and outdoor with other animals were positive for any infection, respectively (Figure 6).

There was significant difference between the groups in tapeworm infection ($p= 0,0083$). 0,0% (n=11) positive samples were found for dogs kept indoor alone, 2,1% (n=47) positive for dogs kept indoor with other animals and 20,0% (n=55) positive samples for dog kept outside.

According to the other parasite species there was no significant difference between the groups out, indoor with other animals and indoor alone (*G. duodenalis*: $p=0,4223$; *Isospora* spp: $p=0,5592$; *C. vulpis*: $p=0,2828$; *T. canis*: $p=0,7622$; *U. stenocephala*: $p=0,2828$; *A. caninum*: 0,3568 and *T. vulpis* and *T. leonina*: $p=1,0000$).

Percentage of *G. duodenalis* infection was 14,9 % (n=47) and 10,9% (n=55) in the groups kept indoor with other animals and outdoor, respectively. The percentage of *Isospora* spp infection was 6,4% (n=47) and 1,8% (n=55) in the groups kept indoor with other animals

and outdoor, respectively. Percentage of *C. vulpis* infection was 2,1% (n=47) and 9,1% (n=55) in the groups kept indoor with other animals and outdoor, respectively. *T. canis* infection had a percentage of 6,4% (n=47) and 9,1% (n=55) in the groups kept indoor with other animals and outdoor, respectively. Percentage of *T. leonina* infection was 1,8% (n=55) in the group kept outdoor. The percentage of *U. stenocephala* infection was 2,1% (n=46) and 9,1% (n=55) in the groups kept indoor with other animals and outdoor, respectively. Percentage of *A. caninum* infection was 4,3% (n=47) in the group kept indoor with other animals. Percentage of dogs infected with *T. vulpis* was 1,8% (n=55) in the group kept outdoor.

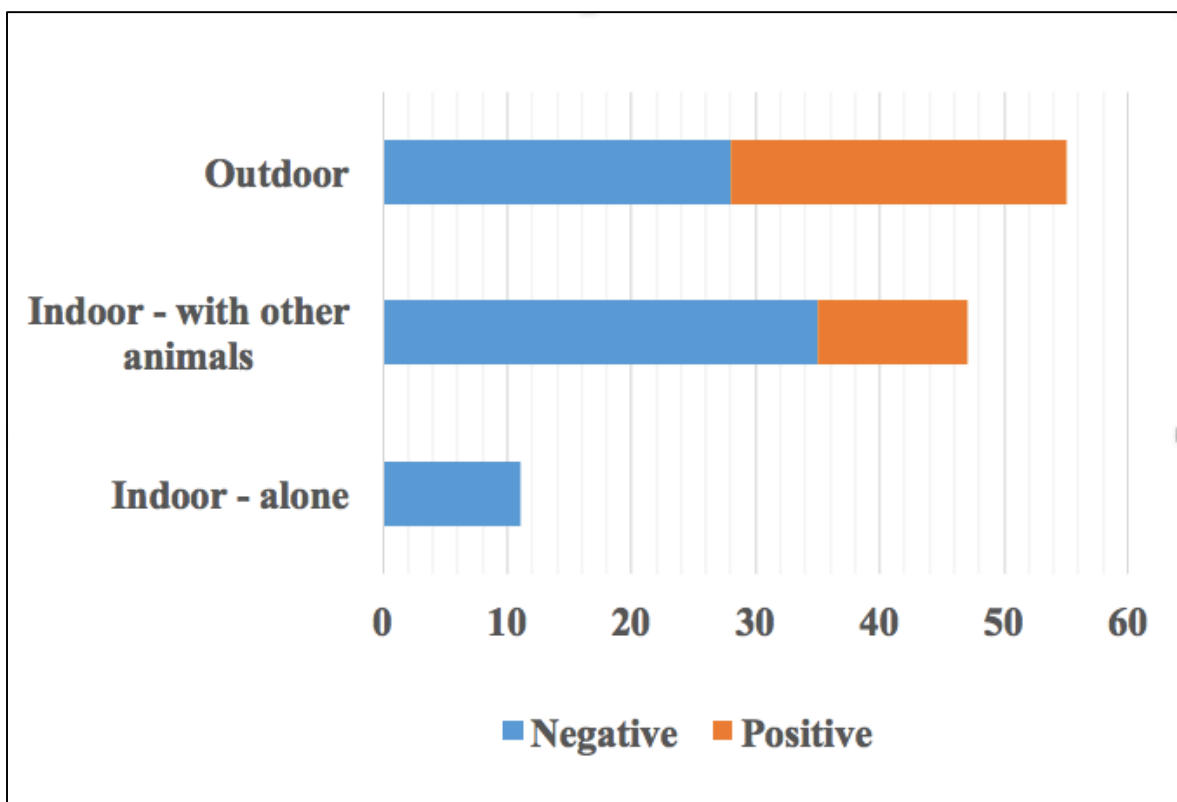


Figure 6: Number of infected dogs kept alone or with other dogs indoor or outdoor

4.6. Parasitic infection related to use

Significantly ($p=0,0003$) more sled dogs ($n=45$; 57.8%) were infected than other ones (9 (33.3%), 7 (14.3%) 15 (13,3%) and 36 (16,7%) of breeding, competition, hunting and pet dogs, respectively (Figure 7).

There was significant difference between the groups in tapeworm infection ($p= 0,0026$). 11,1% ($n=9$) and 24,4% ($n=45$) positive samples were found for breeding dogs and sled dogs, 0,0% ($n=7$, 15, 36) positive samples for competition dogs, hunting dogs and pet dogs.

Concerning the other parasite species there was no significant difference between the groups breeding, competition, hunting, pet dogs and sled dogs (*G. duodenalis*: $p=2663$; *Isospora* spp: 0,2292; *C. vulpis*: $p=0,4692$; *T. canis*: $p=0,5380$; *U. stenocephala*: $p=0,3996$; *A. caninum*: $p=4715$ and *T. leonina* and *T. vulpis*: $p=1,0000$)

Percentage of *G. duodenalis* infection was 33,3 % ($n=9$), 6,7% ($n=15$), 8,3% ($n=36$) and 13,3% ($n=45$) in the groups breeding, hunting, pet dog and sled dog, respectively. *Isospora* spp infection had a percentage of 11,1% ($n=9$), 6,7% ($n=15$) and 2,2% ($n=45$) in the groups breeding, hunting and sled dog, respectively. Percentage of *C. vulpis* infection was 2,8% ($n=36$) and 11,1% ($n=45$) in the groups pet dog and sled dog, respectively. The percentage of *T. canis* infection was 11,1% ($n=9$), 6,7% ($n=15$), 2,8% ($n=36$) and 11,1% ($n=45$) in the groups breeding, hunting, pet dog and sled dog, respectively. Percentage of *T. leonina* infection was 2,2% ($n=45$) in the group sled dog. The percentage of *U. stenocephala* infection was 14,3% ($n=7$), 2,8% ($n=36$) and 8,9% ($n=45$) in the groups competition, pet dog and sled dog, respectively. *A. caninum* infection had a percentage of 5,6% ($n=36$) in the group pet dog. Percentage of dogs infected with *T. vulpis* was 2,2% ($n=45$) in the group sled dogs.

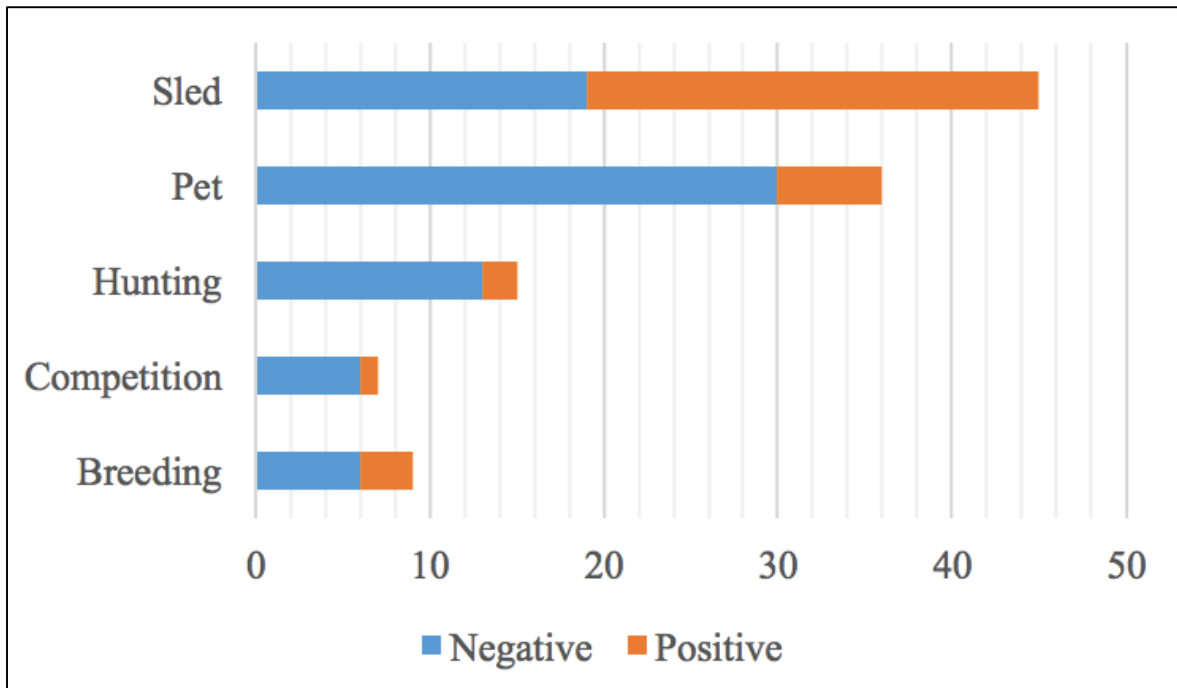


Figure 7: Number of infected dogs according to use

4.7 Parasitic infection related to antiparasitic treatment

Ten of 39 infected dogs were treated with an antiparasitic drug in the year of the sampling. Two of these dogs were treated with Milbemax® (milbemycin oxime and praziquantel) within 12 days before sampling. The faecal samples of both dogs contained *Taenia* type eggs. Five animals were treated 2-3 months before their sampling. Two of them treated with Milbemax® were positive for *G. duodenalis*. The other three dogs which were treated with pyrantel pamoate were also positive for *G. duodenalis*. One dog treated with pyrantel pamoate about 4 months before the sampling was infected with *A. caninum*. A dog which was treated Milbemax® 6 months before the sampling was infected with *G. duodenalis*, *Isospora* spp., *T. canis* and *U. stenocephala*. The dog treated 8 months before the sampling with Milbemax® were positive for *Isospora* spp.

5. Discussion

In this survey the prevalence of the endoparasitic infection of dogs in Trysil kommune in Norway was 34,5%. Although the faecal samples of only 113 local dogs were examined the data of this study is quite high compared to the other surveys carried out in Scandinavia during the last 10 years. In a nationwide Norwegian survey carried out between 2009 and 2012 20.8% of 1276 dogs with clinical signs of a parasitic disease were found be infected (Dalaker et al., 2014). In Sweden where 303 dogs were examined the prevalence of their infections caused by endoparasites was 7,9% (Victorsson, 2014). Al-Sabi et al. (2013) reported that 22,1% of 359 hunting dogs were infected in their studies carried out in Denmark in 2007. In the present survey none of the dogs showed any clinical signs. The reason for the higher prevalence value without any clinical signs may be that the majority of the faecal samples in this survey was collected from kennels where the infection pressure is higher compared to the dogs checked in the survey carried out in Norway by Dalaker et al. (2014). Another reason for the higher prevalence of parasitic infection in 113 dogs is that the three most common parasites in this study were *G. duodenalis*, tapeworms and *T. canis* which usually cause frequently asymptomatic infections.

In the Swedish survey carried out by Victorsson (2014) faecal samples were collected from adult dogs, while in the present survey from puppies, older young as well as adult dogs. A significant difference was found between the infected dogs which were younger or older than 1 year of age. In the Danish study only hunting dogs took part in the study and the prevalence of *Giardia* infection was not examined (Al-Sabi et al., 2007). The higher infection rate in this study is also related to giardiasis detected in almost 1/3 of the infected dogs.

Hamnes et al. (2007) carried out a study in Norway on *Cryptosporidium* and *Giardia* infection of dogs younger than 1-year-old. The prevalence of cryptosporidiosis and giardiasis ranged between 5.1 and 22.5% and 6.9 and 11.4%, respectively. They concluded that both prozoan infection are common in Norwegian dogs, and that *Cryptosporidium* is being more prevalent than *Giardia*. The present survey cannot support the conclusion of Hamnes et al. (2007) since *Giardia* was the most common parasitic infection, and *Cryptosporidium* was not detected. The reason for this difference may be that Hamnes et al. (2007) carried out a longitudinal study on dogs only younger than 1-year-old and several

faecal samples from each dog were examined. However, only one faecal sample was collected from each dog with different age in this survey. The infection caused by these parasites may also be influenced by immune status before weaning and geographical location too and not only by age of the animals (Hamnes et al., 2007).

11 (28,2%) of 39 infected dogs had more than one parasite species. In the study of Ortuño et al. (2014) 27.8% of the dogs were positive for a parasitic co-infection. In Romania where a study on giardiasis of dogs was carried out in 2008-2009 71.2% of the animals were co-infected with other intestinal parasites (Mircean et al., 2012). In that study besides *Giardia* *T. canis* was the most common (14/52), followed by *I. ohioensis* (12/52). Batchelor et al. (2008) reported that 56 (8,5%) of dogs were infected with more than one parasite including *Giardia*. In comparison 9 of the 11 co-infected dogs in the present survey was infected with *Giardia*. The most common co-infection was *Giardia* and *T. canis*. Batchelor et al. (2008) found that 380 dogs were infected with *Giardia* and 42 of these animals were also infected with *I. canis*, 7 with *T. canis* and 2 with *Cryptosporidium*.

The prevalence of *C. vulpis* was stated to be sporadic in Norwegian dogs, while common in red foxes (Bangen et al., 2010). In the present survey the prevalence of *C. vulpis* was 5,3%, which is a bit lower compared to the survey carried out in Norway in 2009-2012 when the infection rate was 7,6% (Dalaker et al., 2014). Davidson et al. (2006) found that the Norwegian population was one of the most commonly infected with *C. vulpis* among the European foxes. Nationwide they also found a prevalence of *C. vulpis* 105 (58%) out of 181 red foxes, while 55/102 (54%) foxes were parasitized. Considering that the intermediate hosts of *C. vulpis* are snails, the infection pressure is influenced by the weather. Temperature, moisture and water availability are the main factors of the development and survival of the gastropods and insect vectors (Traversa et al, 2010)

The Norwegian medicines agency states that the prevalence of *Isospora* in dogs are sporadic, but that it can be a problem in some kennels (Bangen et al., 2010). In the present survey a prevalence of 3,4% was found in 113 dogs for *Isospora* spp. that is higher than 2.3% reported by Dalaker et al. (2014). In their study a seasonal change of *Cystoisospora* infection was found in dogs, its prevalence was the highest from August to December. This may explain why the prevalence of *Isospora* in the present survey (3,5%, n=113) exceeds the findings of Dalaker et al. (2014) (2,3%, n=1276), since the faecal samples in the present survey were

collected in July and August, while Dalaker et al. had a year-round collection of the samples. In German study Barutzki and Schaper (2011) found 5,6% prevalence of dogs infected with *Isospora* spp.

In the present survey twice as many *T.canis* infected dogs (7.1%) were found than Dalaker et al. (2014) reported (3.1%). The prevalence was 6,1% in Germany (Barutzki and Schaper, 2011) and 12,4% in Denmark in 2007 (Al-Sabi, 2013). Gjerde (2011) stated that *T. canis* was the most common endoparasite species in dogs in Norway, especially in young dogs. In the present survey *Giardia* was the most common parasite, and not *T. canis*. The same tendency can be seen in other studies as well. Dalaker et al. (2014) reported 14,2% for *Giardia* and 3.1% for *T. canis*. Victorsson (2014) found 2,6% and 2,3% for these species, Claerebout et al. (2009) detected *Giardia* in 9,3% of household dogs and in 43,9% in kennel dogs, the prevalence of *T. canis* was 4,4% in household dogs and 26,3% in kennel dogs. Barutzki and Schaper (2011) observed *Giardia* and *T. canis* in 18,5% and 6,1% of dogs, respectively.

The prevalence of hookworms in the present survey was 5,3% for *U. stenocephala* and 1,8% for *A. caninum*, and this is higher compared with the data reported by Dalaker et al. (2014) who got 0,7% for *U. stenocephala* and 0,1% for *A. caninum*. The prevalence of *U. stenocephala* was also higher if it is compared with Finish data (2,6%) (Pullola et al., 2006). The prevalence of *U. stenocephala* of dogs was 7,3% (Al-Sabi et al., 2013), in Germany was 2,2% (Barutzki and Schaper, 2011).

The prevalence of *T. vulpis* infection of 113 dogs studied was 0,9%. *T. vulpis* is not common in Norway, but it can occur in both dogs and foxes in Norway (Gjerde, 2011). Compared to the prevalence obtained in the Scandinavian countries this percentage is a bit higher, but lower compared to German data. The prevalence of *T. vulpis* was 0.2% in Norway (Dalaker et al., 2014) and Finland (Pullola et al., 2006), 0.3% in Sweden (Victorsson, 2014). In Germany 1.2% of dogs shed the eggs of *T. vulpis* (Barutzki and Schaper, 2011).

The prevalence of tapeworm infection was 10.6% in the present survey which is much higher compared to previous Norwegian and other European studies. In Norway the prevalence was 0.1% (Dalaker et al., 2014). Concerning the occurrence of the most dangerous tapeworm species in Norway a surveillance of *E. multilocularis* started in red foxes and it was

intensified in 2011 when this species was diagnosed in Sweden for the first time. In this surveillance program four wolves and 523 foxes has been investigated and all of them were negative. They also investigated slaughtered pigs, small ruminants and cattle, which all were negative, also for *E. granulosus* (Høgåsen et al., 2012).

In Denmark the prevalence of tapeworm infection in dogs was 1.7% (Al-Sabi et al., 2013). From Germany 0,4% (Barutzki and Schaper, 2011) was reported. Claerebout et al. (2009) found that 0,2% household dogs in Belgium were infected with tapeworms. In the present survey higher prevalence of tapeworm infection was found in sled dogs. It can be explained with some factors. The infection pressure in the sled kennels is much higher compared to dogs kept indoor alone. Also the occurrence of intermediate hosts like small rodents is higher in this type of keeping. Some dog owners may also give offals to their dogs after hunting game animals. Two of the dogs in this study were positive for a tapeworm infection even though they were treated with Milbemax® (milbemycin oxime + praziquantel) 12 days before the sampling. This may raise the question if the parasite is starting to get resistant against the parasitic treatment. In this case several factors play a role in these positive findings. The treatments were not performed by a veterinarian, and both of the dogs belong to the same owner. Therefore, it may be that the treatment was not done correctly or that the owner gave the wrong date of treatment. Still the possibility of a starting resistance cannot be excluded, since no studies on anthelmintic resistance against tapeworms in dogs has been carried out in Norway.

A significant higher prevalence of parasitic infections caused by *G. duodenalis*, *Isospora* spp. and *T. canis* was found in dogs younger than 1-year-old. Dalaker et al. (2014) reported the same tendency, like Batchelor et al. (2008) and Barutzki and Schaper (2011). A reason for a higher prevalence of endoparasitic infection in young dogs could be that the immune system of young animals does not generate a long term immunity (Gates and Nolan, 2009). In older the dogs the prevalence is reduced due to that the primary infection which leads to an acquired immunity. In young dogs, external factors as stress of weaning, transportation and re-homing could predispose to an infection and therefore be a reason for a higher prevalence (Becker et al., 2012).

In the present survey a significant difference occurred between the infection of dogs fed with pet food and dogs fed with processed slaughtered by-products and scraps. Even though food of dogs plays an important role in the transmission of some parasite, other reason like keeping, age season, treatment and immune status should be kept in mind. Also a majority of the infected dogs were kept outdoor or together with animals, therefore they could come easily in contact with an infective source, like contaminated water or intermediate hosts like game. The reason for the high parasitic prevalence in dogs kept outdoor in the survey may be that the majority of these dogs were sled dogs. The keeping systems used in these kennels allow the dogs to come in contact with small vertebrate animals, in direct contact with the other dogs in the kennel, as well with contact with faeces from the other dogs. The size of the kennel plays a role in the parasite prevalence and that dogs housed in high density in restricted area and in a kennel increased the transmission. This will result in a rapid and permanent contamination of kennel soil and surface (Bajer et al., 2011). The owner of one of the game collection station told that he gave and sold the offals to some of the sled kennels in Trysil kommune. One can therefore assume that several of the owners and then especially the sled kennel owners feed their dogs with slaughter from e.g. elk in the hunting season.

No significant difference could be seen in the parasitic infection of male and female dogs. Visco et al. (1977), Coggins (1998), Cosme et al. (2015), Alvarado-Esquivel et al. (2015) and Hamnes et al. (2007) found similar tendencies in their studies. Gonadectomy has been associated with lower prevalence of parasitic infections in both genders (Kirkpatrick, 1988). This can also be seen in the study of Coggins (1998) and Visco et al. (1998). This was not investigated in this study.

Bajer et al. (2010) investigated parasitic infections in sled dogs in Poland, and they found a very high (68%) prevalence. This data is very high compared to those ones obtained in Nordic countries, in Sweden it was 7.9% (Victorsson, 2014), in Danish hunting dogs was 21.3% (Al-Sabi, 2013) and in kennel dogs in Finland the prevalence was 16,7% (Pullola et al., 2006). Bajer et al. (2011) raised two main questions regarding this finding; that the environmental contamination potential of sled dogs must be extremely high and that this level of parasitic infection must have a detrimental effect on the achievements of the dogs.

In the present survey a significant difference could be seen in the use of the dogs, with the highest prevalence in sled dogs.

In Norway the dogs do not receive a prophylactic anthelmintic treatment on regular basis. The recommendations state that the dogs should not get an anthelmintic treatment unless the infection is diagnosed on the basis of the clinical signs or confirmation with laboratory diagnostics. The routinely treatments are therefore not recommended, except for pregnant/lactating bitches and puppies. They should be treated routinely against roundworms (Bangen et al., 2010). Therefore, the two main reasons for treating the dogs with anthelmintic drugs are due to clinical signs and for traveling abroad.

6. Limitations

In this survey a few limitations occurred. The frame of the thesis and the collection of the faecal samples were lined on the voluntary delivery of faecal samples by the owners. The owners were given the result of the parasitic investigation of the faecal samples, and therefore a few owners participated in this survey for the free parasitic investigation of their dog. This may be a risk for the selection basis, since these owners usually are updated and treat their dogs are treated with antiparasitic drugs on regularly basis or if they see clinical signs of a parasitic infection. The owners also collected the faecal samples and not the veterinarian. Due to this it is not known if the faecal samples are collected from the right dogs (e.g. in the sled kennels) and that it was stored correctly. Only one faecal sample was collected from each dog and not three, which is recommended. That means that the average parasitic prevalence may be higher. Another factor which is important is that most likely some owners did not give the correct information, e.g. in the case of feeding. As mentioned above the game collection centre sell and gives away offals to the sled kennels in Trysil kommune. Therefore, it can be believed that some owners in this study feed their dogs with offals arriving from game animals they prepared after the hunting season or offals from the game collection centres.

7. Conclusion

The prevalence of the parasites in the present survey is higher compared to Dalaker et al. (2014). Although a low number of dogs were investigated for an endoparasite infection in one of the municipalities in Norway, the results extend the knowledge about the parasitic infection of dogs. Especially important data was obtained about tapeworm infection in this area. Further studies are needed to answer whether the dogs should receive a prophylactic anthelmintic treatment or if the current national rule should be changed.

8. Summary

Title: Survey of endoparasitic infections of dogs in a region of Norway
Author: Pernille Eline Langaanes
Supervisor: Prof. Dr. Farkas Róbert

To investigate the endoparasite infections of dogs in the area of Trysil Kommune, Norway, faecal samples were collected once from 113 dogs and investigated at Trysil Dyreklinikk AS and Parasitological laboratory at Norwegian University of Life Science (NMBU) in 2015. All of the faecal samples were investigated with IFAT, Baermann method and sucrose flotation. Thirty-nine out of 113 faecal samples (34.5%) were positive for a parasitic infection. Thirteen (11.5%) of the dogs were infected with *G. duodenalis* using IFAT. The following prevalence of the other parasite infection was found: *C. vulpis* (6, 5.3%), tapeworms (12, 10.6%), *T. canis* (8, 7.1%), *U. stenocephala* (6, 5.3%), *A. caninum* (2, 1.8%) and *T. leonina* (1, 0.9%) and *T. vulpis* (1, 0.9%). No dogs were infected with *Cryptosporidium* spp., *O. osleri*, *C. aerophila* or *A. vasorum*.

The infection rate was significantly higher in dogs younger than 1-year-old compared to older ones. There was no significant difference between the number of infected female and male dogs. Amongst dogs kept outdoor, significantly more animals infected. In the analysis of the usage of the dogs sled dogs were more often infected than pet and hunting dogs.

9. Bibliography

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11. Appendices

Appendix 1: Questionnaire



Endoparasites in dogs

Name of the owner:

Name of the dog:

Breed:

Ager:

Sex:

Female:

Male:

Keeping (indoor/outdoor, kept alone/together with other animals?):

Use (pet, hunting, sled dog etc.):

Where is the dog originally from? (where in Norway/which country and if so, when was it imported to Norway?):

Has the dog ever been traveling? When and where? (both Norway and abroad):

Feeding of the dog (pet food, slaughter, leftovers etc.):

With what and when was the last antiparasitic treatment?

For the veterinarian

How many samples:

Time and place of the sample:

Result:

- *Giardia duodenalis*
- *Cystoisospora spp*
- *Cryptosporidium spp*

- *Oslerus osleri*
- *Crenosoma vulpis*
- *Capillaria aerophila*
- *Toxocara canis*
- *Toxascaris leonina*
- *Uncinaria stenocephala*
- *Ancylostoma caninum*
- *Trichuris vulpis*
- *Angiostrongylus vasorum*

- *Taenia spp*
- *Echinococcus*