Medical differences between stray and owner surrendered dogs in Dutch animal shelters

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Abstract

Many Dutch animal shelters suffer from financial problems. They often receive a compensation for the care of stray animals by the local governments, but this seems to be not enough. This study investigated whether there is a difference in health condition and age between owner surrendered dogs and stray dogs to provide insight in which group of animals causes the highest financial burden on animals shelters. Information about origin (stray dog or owner surrendered dog), age and physical examination at the moment of intake was collected for 1462 dogs housed in three Dutch animals shelters in the period from January 2010 to June 2013. Number of disorders and affected organ systems in both groups were analyzed.
Results show that stray dogs have significantly higher number of disorders compared with owner surrendered dogs at the moment of intake. Dental and dermatologic disorders were the most common. For both groups of disorders stray dogs were most affected. No difference in age was found between stray dogs and owner surrendered dogs.

Samenvatting

Vele Nederlandse asielen kampen met financiële problemen. Veel asielen worden door locale overheden betaald voor de opvang van zwerfdieren. Echter, deze vergoeding blijkt vaak niet genoeg te zijn. Deze studie onderzoekt of er een verschil in gezondheid en een verschil in leeftijd is tussen afstandshonden en zwerfhonden om inzicht te krijgen in welke groep dieren de grootste financiële belasting voor het asiel vormt. Van 1462 honden uit drie Nederlandse asielen zijn gegevens over afkomst (zwerf of afstand), leeftijd en klinisch onderzoek bij binnenkomst verzameld. Dit zijn honden die van Januari 2010 tot en met Juni 2013 in het asiel zijn opgenomen. Het aantal aandoeningen dat een hond had bij binnenkomst en de betrokken orgaansystemen zijn geanalyseerd.
Uit de resultaten van dit onderzoek blijkt dat zwerfhonden significant meer aandoeningen hebben dan afstandshonden op het moment van binnenkomst. Gebitsproblemen en huidproblemen kwamen het meest voor. Bij beide categorieën was de prevalentie het hoogst bij zwerfhonden. Er is geen verschil in leeftijd gevonden tussen afstandshonden en zwerfhonden.

1. Introduction

Dogs are an essential part of Dutch society. In the Netherlands there are about 1,5 million dogs. In 2010 21% of Dutch households owned a dog.[1] Unfortunately, not every dog is assured of a lifelong home. The 115 Dutch animal shelters[1] take care of the dogs that cannot stay with their owners. Around 25 000 dogs are taken in by animal shelters yearly.[2] These dogs are owner surrendered dogs, stray dogs and confiscated dogs. Owner surrendered dogs are dogs who have been relinquished to the shelter by their owner, who pays an intake fee. The price of this fee varies between the shelters. A stray dog is a dog unaccompanied by a responsible person in a public area.[3] This might include dogs who are lost or dogs who are abandoned by their owners. In the Netherlands there is no permanent stray dog population like in other countries.[4] The majority of Dutch stray dogs does not live as stray for a long time. Most of them are taken in by a shelter within a few days. Every municipality is legally obliged to take care of these dogs for 14 days before rehoming them.[5] The costs of caring for the animals during this fortnight are (partially) paid by local governments, while the task is delegated to local animal shelters. In this period the dog is not legally the property of the shelter and the owner may come and take the dog home. After this period the shelter is the legitimate owner by Dutch law and they will try to rehome the dog. 75% of the stray dogs return to their owner yearly. These dogs excluded, in 2011 48% of all dogs in a shelter were owner surrendered and 26% were stray dogs. The remaining dogs in the shelter were confiscated for various reasons, or were born in the shelter or came from another shelter.[1,2]

1.1 Financial problems animal shelters

The major sources of income for animal shelters are the contribution of the local government , the subsidy of local humane organizations (mostly the Dutch Society for the Prevention of Cruelty to Animals (SPCA))and private donations. The remainder sources are the intake fees and the income from adopted animals. The costs for confiscated animals are paid by the agency of Ministry of Economic Affairs or claimed from the former owner.[6]
Often the annual income received this way is insufficient to cover the costs. Nearly all shelters suffer from an annual budget deficit and several shelters are at risk of bankruptcy.[7,8,9] In the Dutch media the SPCA states that the government funding of shelters is of inappropriate level.[10] There is no legal obligation about the level of government funding and therefore this varies strongly between municipalities. The SPCA states that the care of stray animals in the Netherlands cost around 9 million euro yearly, whereas only 5 million euro is paid by the local governments.[10] A tight budget asks for an optimization of resources. Differences in costs of care between stray animals and owner surrendered animals will provide insight in which group of animals causes the highest financial burden on animals shelters. This information can be used to analyze the current financial problems in animal shelters and to find the solutions how to solve it. Because there are no Dutch studies available concerning the differences between stray animals and owner surrendered animals, the Royal Dutch Society for the protection of dogs (RSPD) asked to investigate possible differences between these two groups of dogs. A recent study initiated by the same humane organization looked into the differences of behavior between the two groups and found no significant difference

between them. [11] The current study will investigate whether there is a difference in health condition between owner surrendered dogs and stray dogs.

1.2 Health condition

1.2.1 Policy of shelters concerning the intake of diseased animals

A decreased health condition of shelter dogs has a negative impact on a shelter. Not only costs required for the treatment can increase, also a longer stay in the shelter negatively influences a shelter. Lister et al[12] found that puppies with clinical signs of disease at intake had a longer stay in the shelter.[12] Shelters try to reduce the intake of dogs with a disease . A shelter is permitted to refuse animals with disease when they are surrendered by their owners. [13] Therefore, the dog is examined by a veterinarian before relinquishment. In case the veterinarian finds abnormalities the shelter makes an assessment whether this will be a problem in rehoming the dog. If the health problems can be cured the owner is charged to pay for the required medical treatment before the shelter accepts the dog. If the problems cannot be cured it depends on the severity of the disease and the required costs whether a shelter decides to accept a dog. The policy around the relinquishment of diseased or injured animals is different in every shelter and depends on their financial resources and their experiences with rehoming possibilities in their area. The extra cost of surrendering a diseased or injured dog and the possible refusal of the dog might encourage some owners to abandon their dog instead of surrendering him. The assumption is that dogs in need of medical care are more likely to be abandoned than to be surrendered. Furthermore, since a shelter is allowed to refuse an owner surrendered dog with a disease, it is expected that the group of these dogs is a selection of relatively healthy dogs, whereas the group of stray dogs might also include the (severely) diseased dogs. The result of this could be that a higher number of stray dogs will be in need of medical care and therefore cause a higher financial burden on the shelter than dogs that are owner surrendered.

1.2.2. Increased cost

In American studies it is described that a small percentage of dogs are relinquished for their decreased health condition.[14,15] Also in a study among Dutch pet owners on a public welfare program the cost of the veterinary care was reported as a reason of relinquishment.[16] Patronek et al[17] found that lack of veterinary care is a strong risk factor for relinquishment. Visiting a veterinarian regularly (> 2 times per year) seemed to be connected to reduced relinquishment. Lack of veterinary care might be caused by limited financial possibilities of the owner. Sixty percent of the respondents of the study among Dutch pet owners on a public welfare program had omitted a visit to the veterinarian at some time by lack of financial resources. The respondents declared they wanted to see a veterinarian but simply could not afford it.[16]

Research by TNS NIPO in 2008 showed that a dog or cat owner in the Netherlands spends yearly 62,2 euro for veterinary care.[18] These costs may increase considerably in case of severe trauma or diseases. 14% of Dutch cat and dog owners are willing to pay what is necessary to save their dog, without a maximum. 20% of the owners say the amount they are willing to pay depends on the quality of life their animal will have and on their own finances.[18] In case an owner cannot afford the medical care he might relinquish the dog to a shelter. However, it is never proven whether or not diseased dogs in general are in more risk of relinquishment. Dutch media describe an increase of diseased animals relinquished to shelters in the past years of economic recession.[19,20] The SPCA supports this, stating that owners wait longer before seeking veterinarian help since the start of the

economic recession. When owners finally visit a veterinarian and receive the bill they often decide not to continue the treatment but surrender their animals to a shelter or abandon them instead. This causes an increase of diseased animals in shelters since the start of the economic recession. [21,22] However, these statements have scientifically never been proven in Dutch shelters and are contradicted by an American study of Weng et al.[23] This study determined that the proportion of owners reporting the illness of their animals as the reason for relinquishment did not differ before and after the start of the recession.

1.3. Difference in age

Since the health condition of an animal depends on the age amongst others, this factor is included in the current study. Shelters charge a higher intake fee for older dogs for their expected longer stay in the shelter and more medical care. In case the prevalence of older dogs will be higher in the group of stray dogs this will influence the results of difference in health condition between stray dogs and owner surrendered dogs.

1.4. Aim of this study

In summary, the aim of this study is to find whether there is a difference in health condition and age between stray dogs and owner surrendered dogs in Dutch animal shelters. Study on differences in these factors between stray animals and owner surrendered animals will provide insight in which group of animals causes the highest financial burden on animals shelters. This study is carried out to test the following hypotheses:

Health state
H_0 = There is no significant difference in health state between stray dogs and owner surrendered dogs in Dutch animal shelters.
H_1= There is a significant difference in health state between stray dogs and relinquished dogs in an animal shelter.

Age
H_0= There is no significant difference in age between stray dogs and relinquished dogs in an animal shelter
H_1= There is a significant difference in age between stray dogs and relinquished dogs in an animal shelter.

2. Materials and Methods

This study is a retrospective cohort study. Data recorded by three Dutch shelters between January 2010 and June 2013 were collected. The dogs, shelters, veterinarians, DIPO files and health categories are described in the paragraphs below.

2.1 Dogs

Dogs included:
- *Stray dogs:* Dogs brought to the shelter without someone paying the intake fee.
- *Owner surrendered dogs:* Dogs surrendered by their owners who paid the intake fee.
- Adopted dogs that returned to the shelter after a year were included in the study. In this period the new owner had the opportunity to give the dog (medical) care and training. We presume that the possible influences of the care by the new owner will be visible after this year of ownership.

Dogs excluded:
- Dogs that returned to their owners within 14 days.
- Dogs of which it was not clearly recorded whether they were returned to their owners or not.
- Confiscated dogs
- Dogs born in the shelter
- Dogs from another shelter
- Adopted dogs that returned to the shelter within a year after adoption.
- Adopted dogs that returned to the shelter after one year, but already included in the research data at their first moment of entering the shelter.
- Dogs entering the senior care in one of the shelters, because by them the prevalence of older dogs in the research group would not be representative for the shelter population of the whole country.
- Dogs with inaccurate description of physical examination or illegible handwriting
- Dogs showing aggressive behavior which made a physical examination impossible.

In all shelters the owner surrendered dogs were examined by the veterinarian before relinquishment. Therefore, dogs could only be relinquished at days the veterinarian worked in the shelter. The veterinarian decided whether the dog should be accepted. If the dog was in need of medical care this was achieved at the cost of the previous owner. If the dogs have not had their yearly vaccination this was also achieved at the cost of the previous owners.
Stray dogs were kept in quarantine for 14 days. They were examined, vaccinated, dewormed and deflead within 5 days. The age of each stray dog was estimated by the veterinarian.

2.2 Shelters

This study was conducted in three Dutch animal shelters. For the anonymity of the shelters they will be described as shelter A, B and C.
The average yearly intake in shelter A is about 550 dogs in the period from 2010 to 2013. The intake of stray dogs is about 250 dogs yearly, whereas the yearly intake of owner surrendered dogs is about 150 dogs. The remaining dogs taken in by this shelter are confiscated or born in the shelter. The percentage of stray dogs that return to their owners is about 55%. Shelter A is officially recognized by the Dutch SPCA.
The average yearly intake in shelter B is about 400 dogs in the period from 2010 to 2013. The intake of stray dogs is about 240 dogs yearly, whereas the yearly intake of owner surrendered dogs is about

70 dogs. The remaining dogs taken in by this shelter are confiscated or born in the shelter. The percentage of stray dogs that return to their owners is about 80%. Shelter B also accommodates a senior dog care, managed by the RSPD. The senior dogs do not participate in this study. Shelter B is officially recognized by the Dutch SPCA.
The average yearly intake of dogs in shelter C is about 580 dogs in the period from 2010 to 2013. The intake of stray dogs is about 400 dogs yearly, whereas the yearly intake of owner surrendered dogs is about 80 dogs. The remaining dogs taken in by this shelter are confiscated or born in the shelter. The percentage of stray dog that return to their owner could not be calculated, since no actual numbers of these dogs were available. Shelter C is part of a learn and work company that offers jobs for people who have, for several reasons, limited possibilities to find a job on the regular labor market. Shelter C is not connected to the Dutch SPCA.

2.3 Veterinarians

Shelter A has its own veterinarian who works fulltime in the shelter. Another part-time veterinarian cooperates during busy periods and substitutes the first veterinarian at his days off. There is a veterinarian assistant available, who also works as animal caretaker in the shelter. First line surgery is performed in the operating room in the shelter. The shelter is equipped with a Radiographic Equipment. Radiographs are made on medical indication and of all dogs with high risk of hip disorders, include all large breeds.
In shelter B a veterinarian of a nearby veterinary practice works for three days a week in the shelter. All surgery on dogs is performed in this veterinary practice. The shelter employs a veterinarian assistant who works in the shelter for four days a week.
Shelter C also has a veterinarian of a nearby veterinary practice, who works for two days a week in the shelter. All surgery is done in the veterinary practice. The shelter employs a veterinarian assistant who works fulltime in the shelter.

2.4 DIPO files

All shelters have been keeping records of their animals in the computer system DIPO. In the DIPO files information about the origin (stray dog or owner surrendered dog) and date of intake is noted, as well as information about the dogs signalment: age, breed, sex, spay/neuter status and health state of the dog. Files of individual animals are kept for at least five years.
In this study, the DIPO files of dogs taken in between January 2010 and June 2013 were reviewed and analyzed. Of every dog the origin (stray dog/ owner surrendered), date of intake, date of birth and findings of physical examination at moment of intake was collected. Medical data recorded after the initial intake was not used since this could include diseases acquired in the shelter.

In shelter B and shelter C the findings of the physical examinations and the achieved medical care of all dogs were recorded digitally with DIPO. In shelter A this information was first registered manually by the veterinarian or veterinarian assistant and afterwards recorded in DIPO by counter assistants. In the other shelters the recording of findings was done by the veterinarian or by the veterinarian assistant. For each shelter this was the same veterinarian and veterinarian assistant during the complete research period. In shelter B and C another veterinarian of their practice substituted them on their days off. In shelter A the veterinarians were substituted by known veterinarians from an employment agency.

In shelter B description of surgery or X-rays done in the veterinary practice was in short recorded in the DIPO files. In shelter C details of the surgery or X-rays done in the veterinary practice was described in the computer system of the practice and copied in the DIPO files.

2.5 Categories of health condition

Based on their medical records all dogs were classified in different categories of health condition. In this study two types of classification were used and described in the paragraphs below: number of disorders and organ systems involved. The definitions for each category in both classification systems were edited for the aim of this study.

2.5.1 Number of disorders

One classification is based on the number of disorders a dog suffers from. It is assumed that with increasing number of disorders the health condition of the dog deteriorates.
Category 0: dogs with no sign of disease, injury, congenital or genetic abnormality that decreases the health of the dog at this moment or will decrease it in the future.
Category 1: dogs with (a) sign(s) of disease, injury, congenital or genetic abnormality with one primary cause that decreases the health condition of the dog at this moment or will decrease it in the future. For example a dog which coughs and has nasal discharge is placed in category 1 under the assumption that both signs are caused by one problem in the upper airway.
Category 2: dogs with signs of diseases, injury, congenital or genetic abnormalities with two primary causes that decreases the health condition of the dog at this moment or will decrease it in the future. For example a dog with a heart murmur and an orthopedic problem is placed in category 2 under the assumption these problems are signs of two different disorders.
The categories with increasing number of diseases are similarly defined.

In some dogs several clinical signs may have had one primary cause but since this was not demonstrated they counted as two disorders. For example, otitis externa and dermatitis are likely to be caused by a food allergy or atopic dermatitis, but without further diagnostic this could not be proven and therefore these signs were counted as two disorders. If diagnostic procedure was not completed only symptoms were included in the study instead of the disease itself. All problems with teeth or parodontium were together counted as one disorder.

2.5.2 Organ systems

The other type of classification is based on the organ systems:

-Healthy
Dogs with no signs of disease(s), injury, congenital or genetic abnormalities that decreases the health condition at this moment or will decrease it in the future.
- Circulatory and respiratory disorders
Dogs with signs of disease(s), injury, congenital or genetic abnormalities of the circulatory or respiratory system that decreases the health condition at this moment or will decrease it in the future.
- Dental disorders
Dogs with signs of disease(s), injury, congenital or genetic abnormalities of the teeth, parodontium or

mucus membranes of the mouth that decreases the health condition at this moment or will decrease it in the future.

- *Dermatologic disorders*

Dogs with signs of disease(s), injury, congenital or genetic abnormalities of the skin that decreases the health condition at this moment or will decrease it in the future. Otitis externa is also classified in this category.

- *Gastro-intestinal disorders*

Dogs with signs of disease(s), injury, congenital or genetic abnormalities of the intestinal tract that decreases the health condition at this moment or will decrease it in the future.

- *Ocular disorders*

Dogs with signs of disease(s), injury, congenital or genetic abnormalities of one or both eye(s) that decreases the health condition at this moment or will decrease it in the future.

- *Orthopedic disorders*

Dogs with signs of disease(s), injury, congenital or genetic abnormalities of bones, muscles, tendons or joints that decreases the health condition at this moment or will decrease it in the future.

- *Remainder problems*

Dogs with signs of disease(s), injury, congenital or genetic abnormalities that decreases the health condition at this moment or will decrease it in the future but is not classified in the other categories.

2.5.3 Not included disorders

Some disorders were not included because the recordings of these disorders were not clear. For example, when a dog had fleas this was not recorded in all shelters since all dogs were usually deflead after their first physical examination. Furthermore, stray dogs were examined a few days after their arrival and could also be infected with fleas during their time in the shelter. Therefore fleas were not counted as a disorder.

Other disorders were not counted as disorder because it was assumed they did not have a direct influence in the dog's health status. These findings include cryptorchidism, rostral cross bites and dental malocclusions. Also cataract was not counted as a disorder since no differentiation could be made between real cataract and the normal aging process nucleus sclerosis.

2.6 Data collection and analyses

Data of each dog (DIPO number, shelter, origin, date of birth, date of intake and findings at first clinical examination) were entered in Microsoft Office Excel 2007. Subsequently, of each dog the affected organ system(s) and the number of disorders were noted. Age at moment of intake was calculated by Excel using date of birth and date of intake.

Data was analyzed with IBM SPSS statistics 20. Since age was not normal distributed in both groups it was analyzed with the Kolmogorov-Smirnov test and the Mann-Whitney test. Association between origin and number of disorders was analyzed with the Poisson log linear model. In this model the independent variable were origin, shelter and age. The dependent variable was number of disorders. It was also tested whether there was an interaction between the influences of origin and age and between origin and shelter.

The logistic regression model was used for testing the association between origin and affected organ systems. In this model the independent variables were origin, shelter and age. The test was performed for each category, which was the dependent variable. Again it was also tested whether

there was an interaction between the influences of origin and age and between origin and shelter. For all tests the level of significance was set at $p<0,05$.

3. Results

Data were collected from a total of 1462 dogs, consisting of 721 stray dogs and 741 owner surrendered dogs.
In shelter A data from 511 dogs was collected, consisting of 270 owner surrendered dogs and 241 stray dogs. In shelter B data from 393 dogs was collected, 244 owner surrendered dogs and 149 stray dogs. In shelter C data from 558 dogs was collected, 227 owner surrendered and 331 stray dogs.

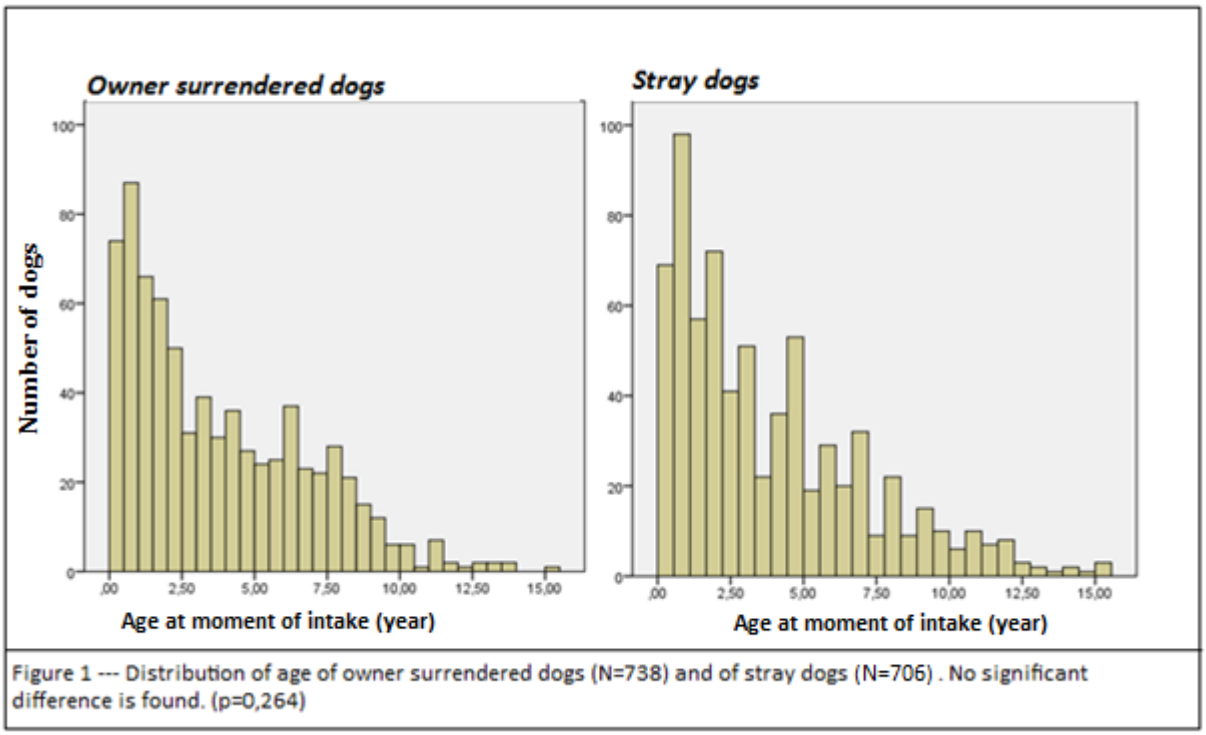

Figure 1 --- Distribution of age of owner surrendered dogs (N=738) and of stray dogs (N=706) . No significant difference is found. (p=0,264)

3.1 Age

The age at moment of intake was noted for 1444 dogs. For 15 stray dogs and 3 owner surrendered dogs no date of birth was noted in the DIPO file and therefore the age at moment of intake could not be calculated.
The distribution of age for owner surrendered dogs and for stray dogs is showed in figure 1. In both groups the highest peak is seen before the age of 2,5 years. Mean age of owner surrendered dogs was 3,75 years (S.D.= 3,038). Mean age of stray dogs was 3,91 years (S.D.= 3,241). The distribution of age of stray dogs does not significantly differ from the distribution of age of owner surrendered dogs (Kolmogorov-Smirnov=1,005; p=0,264). The same goes for the difference in median of age between both groups (Mann-Whitney= -0,751; p=0,453).

3.2 Number of disorders

42,9% of stray dogs and 61,0% of owner surrendered dogs did not had any disorder. Figure 2 shows the percentage of owner surrendered and stray dogs per number of disorder. The number of disorders in stray dogs significantly differed from the number of disorders in owner surrendered dogs. Of dogs in the same shelter and of the same age, a stray dog had 1,57 times more disorders

than an owner surrendered dog. The shelter a dog was brought to did also significantly influences the number of disorders. Dogs taken in by shelter A have 0,47 times less disorders than dogs taken in by shelter C. Dogs taken in by shelter B have 0,48 times less disorders than dogs in shelter C. Dogs in shelter B and shelter A did not significantly differ in number of disorders.
Interaction between origin (stray or owner surrendered) and shelter was not significant which means the effect the shelter has on the number of disorders is the same on stray dogs as compared to owner surrender dogs.
When age increases one year, the number of disorders increases with a factor 1,15. Interaction between age and origin was not significant. Log ratios and p-values are shown in the appendix, table 1.

3.3. Organ systems

List of most common disorders in each category is shown in table 1. The list of circulatory and respiratory disorders and the list of dental disorders were the actual disorders found in the dogs. The other lists are the disorders most presented in that category.

Dental and dermatologic disorders were the most common disorders in both groups. In all categories stray dogs were the most affected dogs. The percentages are shown in figure 3. Percentage for each category and significant associations are described in the paragraphs below. For all categories no interaction was found between the influences of origin and age. Difference in prevalence of disorders between shelters is shown in figure 4.

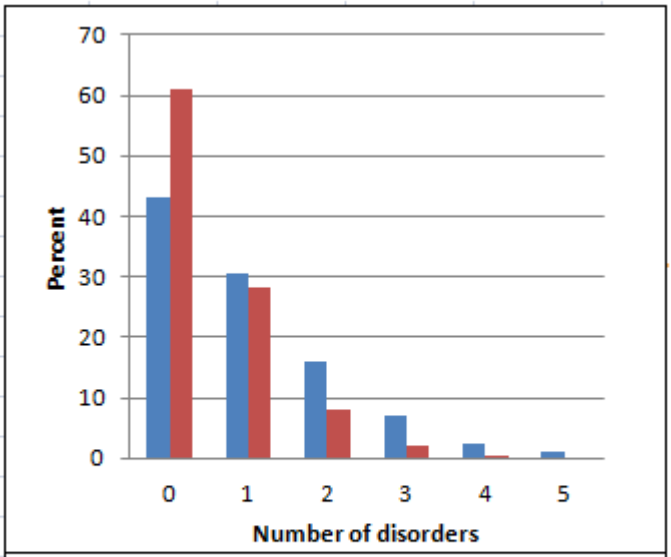

Figure 2 --- Difference in number of disorders between stray dogs and owner surrendered dogs in percentage.

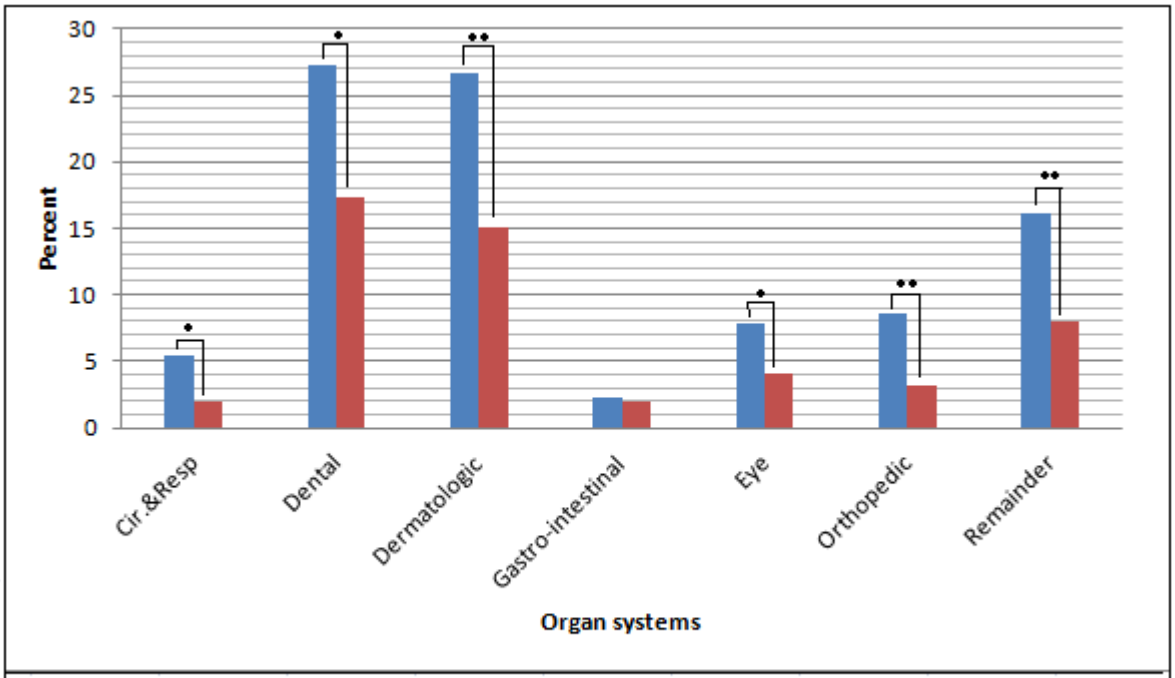

Figure 3 --- Prevalence of disorders classified in organ systems in stray dogs ■ and owner surrendered dogs. ■ Significant association between origin (stray or owner surrendered) and category is marked with: • • = p<0,01 and • = p<0,05.

Circulatory and Respiratory disorders:	- Abnormal heart sounds (35) - Coughing and/or nasal discharge(18) - Dyspneu/ stridor (3) - Heart failure (1) - Arrhythmia (1) - Mass in thorax (1)
Dental disorders:	- Calculus (varying from calculus on a few elements to gingivitis, pardontitis and required extractions)(320) - Persistent primary tooth (10) - Epiludes (5) - A mass in the jaw (1)
Dermatologic disorders:	- Otitis externa (111) - Wounds (33) - Ear mites (31) - Dermatitis or pyoderma (26) - Undefined dermatologic problems (21)
Gastro-intestinal disorders:	- Diarrhea and/or vomiting (8) - Mass/tumor close to the anus (5) - Anal sac disorders (4) - Peri-anal hernia (4) - Intestinal parasites (3)
Ocular disorders:	- Conjunctivitis/keratitis (38) - Entropion (12) - Cherry eye(s) (6) - Tumors on the eyelids (5) - Blindness (4) - Ectropion (4)

Orthopedic disorders:	- Patella luxation (16) - Arthrosis in one or more joints (16) - Trauma/fracture (11) - Hip dysplasia (8) - Lameness without further diagnostics (8)
Remainder disorders:	- Underweight (58) - Obesitas (50) - Neurologic signs (epilepsy/ataxia/circling) (12) - Tumors of mammary glands (11) - Umbilical hernia (11)

Table 1 --- List of most common disorders in each category of organ system. In brackets number of affected dogs.

Circulatory and respiratory disorders

Prevalence of circulatory or respiratory disorders is 5,5% in stray dogs and 2,0% in owner surrendered dogs. Whether a dog is a stray dog or an owner surrendered dog significantly influences whether or not a dog has a circulatory or respiratory disorder. The odds for a stray dog having a circulatory or respiratory disorder is a factor 2,23 higher compared to the odds for an owner surrendered dog. The shelter by which the dog was taken in does not significantly influences whether or not it has a circulatory or respiratory disorder. Furthermore, the interaction between origin and shelter is not significant, which means the effect the shelter has on whether or not a dog has a circulatory or respiratory disorder is the same on stray dogs as compared to owner surrendered dogs.

The age of the dog at the moment of intake significantly influences whether or not a dog has a circulatory or respiratory disorder. When age increases one year, the odds of suffering from a circulatory or respiratory disorder increases with a factor 1,30.

Log odds ratios and p-value's of all variables are shown in the appendix, table 2.

Dental disorders

The prevalence of dental disorders is 26,9% in stray dogs and 17,3% in owner surrendered dogs. The odds of having a dental disorder is a factor 1,65 higher for stray dogs compared to owner surrendered dogs. The shelter in which a dog is taken in significantly influences whether or not a dog has a dental disorder. The odds of having a dental disorders is a factor 0,19 lower for dogs in shelter A compared to dogs in shelter C and a factor 0,22 lower for dogs in shelter B compared to dogs in shelter C. The odds of having a dental disorders did not significantly differ for dogs in shelter B compared with dogs in shelter A. The interaction between origin and shelter is not significant, which means the effect the shelter has on whether or not a dog has a dental disorder is the same on stray dogs as compared to owner surrendered dogs.

When age increases one year, the odds of having a dental disorder increases with a factor 1,50. The log odds ratios and p-values are shown in the appendix, table 3.

Dermatologic disorders

The prevalence of dermatologic disorders is 26,8% in stray dogs and 15,1% in owner surrendered dogs. The odds of a stray dog with a dermatologic disorder is a factor 1,84 higher compared to an owner surrendered dog. The shelter in which a dog is taken in significantly influences whether or not a dog has a dermatologic disorder. The odds of having a dermatologic disorder is a factor 0,33 lower for dogs in shelter A compared to dogs in shelter C and a factor 0,41 lower for dogs in shelter B

compared to dogs in shelter C. The odds for having a dermatologic disorders did not significantly differ for dogs in shelter B compared to dogs in shelter A. Interaction between origin and shelter is not significant, which means the effect the shelter has on whether or not a dog has a dermatologic disorder is the same on stray dogs as compared to owner surrendered dogs.
Age significantly influences whether or not a dog suffers from a dermatologic disorder. When age increases one year, the odds of suffering from a dermatologic disorder increases with a factor 1,09. Log odds ratios and p-values are shown in the appendix, table 4.

Gastro-intestinal disorders
Prevalence of gastro-intestinal disorders is 2,2% in stray dogs and 1,9% in owner surrendered dogs. The origin of a dog was not significantly associated with whether or not a dog had a gastro-intestinal disorder, neither was the shelter. Interaction between shelter and origin was not significant, which means the effect the shelter has on whether or not a dog has a gastro-intestinal disorder is the same on stray dogs as compared to owner surrendered dogs.
Age was significantly associated with whether or not a dog had a gastro-intestinal disorder. When age increases one year, the odds of having a gastro-intestinal disorder increases with a factor 1, 13. Log odds ratios and p-values are shown in the appendix, table 5.

Ocular disorders
Prevalence of ocular disorders was 7,9% in stray dogs and 4,0% in owner surrendered dogs. The odds of having an ocular disorder is a factor 1,85 higher for a stray dog compared to an owner surrendered dog. The shelter also significantly influences whether or not a dog has an ocular disorder. The odds of having an ocular disorder did not significantly differ for dogs in shelter A compared to shelter C, but it is a factor 0,36 lower for dogs in shelter B compared to dogs in shelter C. Dogs in shelter B did not significantly differ from dogs in shelter A. Interaction between origin and shelter was not significant, which means the effect the shelter has on whether or not a dog has an ocular disorder is the same on stray dogs as compared to owner surrendered dogs.
When age increases one year, the odds for having an ocular disorder increases with a factor 1,09
Log odds ratios and p-values are shown in the appendix, table 6.

Orthopedic disorders
Prevalence of orthopedic disorders was 8,6% in stray dogs and 3,1% in owner surrendered dogs. The odds of having an orthopedic disorders is a factor 2,53 higher for a stray dog compared to an owner surrendered dog. The shelter significantly influences whether or not a dog has an orthopedic disorder. The odds of having an orthopedic disorders is not significantly different for dogs in shelter A compared to dogs in shelter C, but it is a factor 0,509 lower for dogs in shelter B compared to dogs in shelter C. The odds of having an orthopedic disorders is not significantly different for dogs in shelter B compared to dogs in shelter A. Interaction between shelter and origin was not significant, which means the effect the shelter has on whether or not a dog has an orthopedic disorder is the same on stray dogs as compared to owner surrendered dogs.
When age increases one year, the odds for having an orthopedic disorder increases with a factor 1,12. Log odds ratios and p-values are shown in the appendix, table 7.

Remaining disorders
Prevalence of remaining disorders was 16,1% in stray dogs and 8,0% in owner surrendered dogs. The

odds of having a remaining disorder is a factor 1,79 higher for stray dogs compared with owner surrendered dogs. The shelter in which a dog is taken in significantly influences whether or not a dog has a remaining disorder. The odds of having a remaining disorder is a factor 0,42 lower for dogs in shelter A compared to dogs in shelter C and a factor 0,43 lower for dogs in shelter B compared with dogs in shelter C. The odds of having a remaining disorder did not significantly differ for dogs in shelter B and dogs in shelter A. Interaction between origin and shelter is not significant, which means the effect the shelter has on whether or not a dog has a remaining disorder is the same on stray dogs as compared to owner surrendered dogs.

When age increases one year, the odds of having a remaining disorders increases with a factor 1,21. Log odds ratios and p-values are shown in the appendix, table 8.

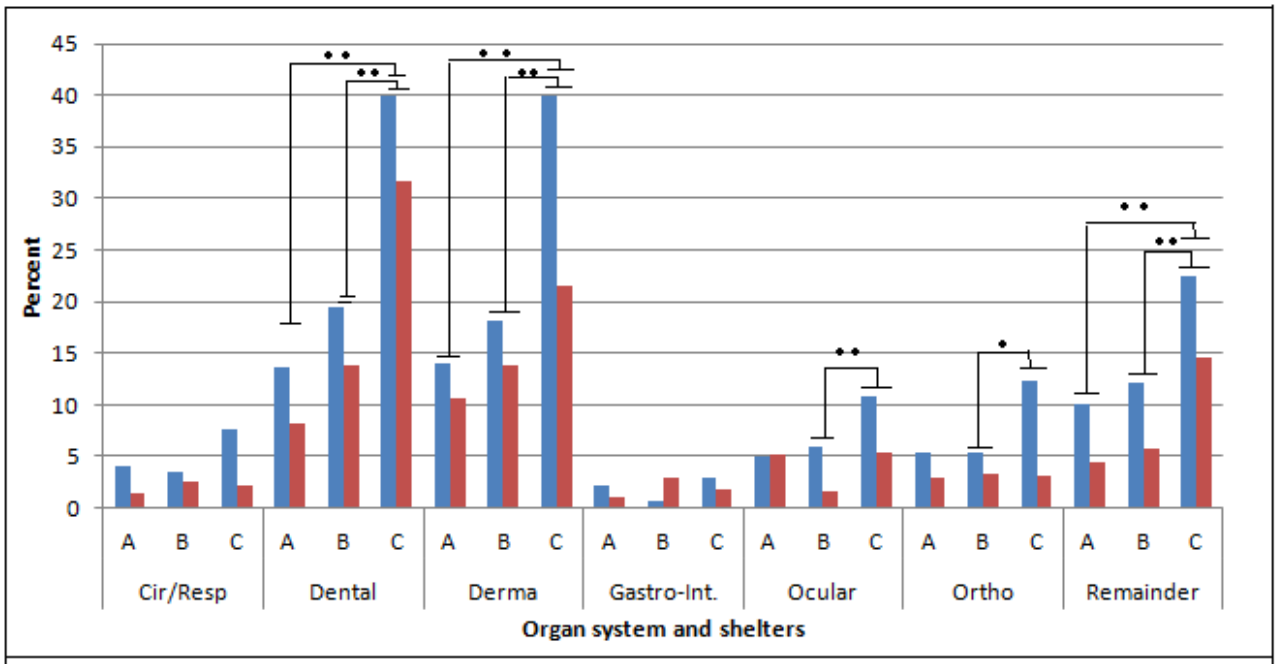

Figure 4 --- Percent of stray and owner surrendered dogs in shelter A, B and C suffering from a disorders from different organ systems. Significant association between shelter and whether or not a dog has a disorder is marked with •• = p<0,01 and • = p<0,05

3.4 Euthanasia

2,3% of all dogs was euthanized for medical reasons or their disorder caused death. List of top 3 reasons for euthanasia and disorders causing death is shown in table 2. Significant association between origin and whether or not the dog died or was euthanized is found. 4,2% of stray dogs and 0,4% of owner surrendered dogs died or were euthanized. The odds of dying or being euthanized is a factor 6,28 higher for stray dogs compared with owner surrendered dogs. The shelter did not significantly influenced whether or not a dog died or was euthanized. Interaction between shelter and origin was not significant, which means the effect the shelter has on whether or not a dog died is the same on stray dogs as compared to owner surrendered dogs.

Age is significantly related to dying or being euthanized. When age increases one year, the odds of dying or being euthanized increases with a factor 1,38.

Log odds ratios and p-values are shown in the appendix, table 11.

Reasons for euthanasia or dying:	**-** Tumor (13) - Orthopedic disorders (9) - Neurologic disorders (8)

Table 2 --- List of top 3 reasons for euthanasia or disorders that caused death. In brackets number of affected dogs.

4. Discussion

In this study the difference in health condition of stray dogs and owner surrendered dogs is investigated as well as the difference in age between these two groups. The health condition is classified in number of disorders and in categories of involved organ systems. In both classification systems a difference is found between stray dogs and owner surrendered dogs.

4.1 Stray dogs in a poorer health condition

The presumption of a higher prevalence of dogs with a disease among stray dogs compared with owner surrendered dogs is confirmed by this study. Stray dogs suffer from more disorders than owner surrendered dogs. This difference can be caused by the following:

- Rejection by the veterinarian at intake of dogs with clinical symptoms surrendered by their owners, while all stray dogs (including the diseased) are taken in by the shelter;
- A real difference in the physical condition of stray dogs compared with owner surrendered dogs before the selection at intake by the veterinarian.

It is not clear how often a shelter refused an owner surrendered dog with a disease. In the participating shelters there is no registration concerning this issue. Staff of the shelters claim that it does not occur regularly in their shelter. When we consider the most common disorders found in this study it seems likely that owner surrendered dogs in most cases are accepted by the shelter while suffering from these disorders. From contact with shelters staff it seems that a dental disorder is not considered to be a severe disorder for which a dog would be refused. The same goes for the most occurring dermatologic disorders (otitis externa and skin wounds) and remaining disorders (obesitas and underweight). Nevertheless, some of these disorders might be a reason of abandoning a dog instead of surrendering it since the owner has to pay the required treatment before the dog can be relinquished. Most common orthopedic disorders (patella luxation and arthrosis) and circulatory disorders (heart murmur) may be a reason of not accepting an owner surrendered dog by a shelter. However, these are speculations which are not addressed in this study. This study used only the physical characteristics of shelter dogs after they were admitted by the shelter. This means that no conclusion can be drawn about the reasons which generate these differences between stray dogs and owner surrendered dogs.

4.2. Former owners

When studying medical condition of two groups of shelter dogs it would be interesting to know something about their former owners. However, since the majority of previous owners of abandoned dogs cannot be traced and studied we are only able to study the characteristics of owners who surrender their dogs to a shelter. Several American and English studies have determined these characteristics and the reasons for relinquishments.[14,15,17,24,25,26] Both Scarlett et al[25] and Diesel et al[26] found behavioral problems of the dog as a main reason of relinquishment. Other reasons of relinquishment were: the dog in need of more attention than could be given, human housing issues[25,26],personal problems of the owner and allergies.[25] Patronek et al[17] found that factors with the

highest risk of relinquishment were owners not participating in dog obedience classes, owners that did not give their dogs enough veterinary care, owning an intact dog (not spayed/neutered), incorrect care expectation and dogs regularly urinating at inappropriate places. New et al[24] found that people relinquishing their dogs were more likely to be men and younger than 50 years old. Relinquished dogs were mostly owned for a short period of time and dogs acquired at little or no cost were in more risk of relinquishment.[14,15,17,24] as well as dogs obtained without planning.[26] Owners relinquishing dogs had less knowledge of pet care and behavior than other owners.[24]
Some of these risk factors suggest that owners relinquishing their dog are less concerned about the care and welfare of their dog than owners who do not surrender their dogs to shelters. However, a study of DiGiacomo et al[27] showed that most relinquishment cases are a lot more complex than stated by other studies. They found that the majority of owners involved in the study struggled with the decision to give up their dogs and tried other possible solutions before surrendering their dogs to the shelter. [27]
Since these studies did not deal with previous owners of stray dogs, we can only guess at their reasons for not retrieving their stray dog from the shelter. The difference in surrendering a dog to a shelter or abandoning it might be induced by financial resources and/or(un)willingness to invest in the welfare of the pet.

4.3. Prevalence of disorders

57,1% of stray dogs and 39,0% of owner surrendered dogs had one or more disorders. This disease prevalence is higher than that determined by a study in the United States and Australia among dogs living in households.[28] They found a disease prevalence of 16%. This difference might be caused by the fact that this prevalence was estimated on the basis of the reporting of the owners. These owners may not have reported small disorders like a little dental calculus, whereas in the current study all disorders were reported. Compared with a study at private veterinary practices in the United States the disease prevalence in the current study was very low.[29] They found a prevalence of 93%. This difference is simply explainable by the fact that they only studied dogs at the veterinary practice. They also found dental and dermatologic disorders were most common. This is in accordance with the results of the current study.

Most common disorders found in the present study are compared with results in other studies and described in the paragraphs below, as well as possible causes and consequences for the difference between stray and owner surrendered dogs.

4.3.1 Dental disorders

The prevalence of dental disorders found by the present study (26,9% of stray dogs and 17,3% of owner surrendered dogs) is comparable with a study among North-American pet dogs.[30] The prevalence of calculus or gingivitis among these dogs was 20%. The higher prevalence of dental disorders in stray dogs found in the current study is supported by a study in Japan in 1989,[31] where the prevalence of dental disorders in stray dogs and pet dogs were studied. They found that the prevalence of dental calculus and periodontal disease was higher in stray dogs than in pet dogs. However, this was only significant at younger age. Actually, at older age (>5 years) they found a higher prevalence of calculus among pet dogs compared with stray dogs. In the current study no interaction was found between age and origin, which means that the difference in frequency of

dental disorders between stray dogs and owner surrendered dogs applies to all ages. The differences between the Japanese study and the present study might be a consequence of different dog populations. Stray dogs in the current study differ from stray dogs in Japan since stray dogs in the Netherlands are not likely to be on the streets as a stray for a long period of time, whereas stray dogs in Japan might have lived as a stray during their whole life. Pet dogs in the Japanese study cannot be compared with owner surrendered dogs in the current study since they are still living in a household, with other customs in caring for a dog by Japanese dog owners and knowledge about efficient prevention of dental disorders is increased since 1989.

The reasons for a higher prevalence of dental disorders in stray dogs compared with owner surrendered dogs are speculative, since no information is available about the history of stray dogs. Furthermore, it is not known whether this is a difference in the two dog populations itself or created by the shelter who refuses owner surrendered dogs with dental disorders.
From contact with shelter staffs it seems that dental disorders are not a common reason of refusal by the participating shelters, but shelters charge a higher intake fee for dogs in need of dental treatment. This might instigate owners who cannot afford this to abandon their dogs. Another reason could be the (lack of) dental care by the former owner of a stray dog. Daily tooth brushing and offering dental treats are very effective in reducing the risk of dental calculus, gingivitis and peridontitis.[32] Because of the higher prevalence of dental disorders in stray dogs it is possible that former owners of stray dogs provide less of this care compared with owners who surrender their dogs, but this goes beyond the scope of this study.
Whereas only speculations can be made about the causes of higher prevalence of dental disorders in stray dogs, the consequence of this finding is clear. Results of this study suggest stray dogs are more often in need of dental treatment, which means they cause high financial costs for a shelter. Costs for dental treatment vary widely between veterinarians and depend on weight of the dog, whether or not extractions are required and number of tooth with dental calculus. A simple dental treatment may cost around 200 euro.[33]

4.3.2. Dermatologic disorders

The prevalence of dermatologic disorders in the current study is 26,8% for stray dogs and 15,1% for owner surrendered dogs. It is difficult to compare these prevalence's with those found in other studies since different definitions of dermatologic disorders are used. In dogs examined at private veterinary practices in the United States prevalence's were determined for otitis externa, dermatitis, atopic/allergic dermatitis, pyoderma, animal bite, hot spots and pruritis.[29] All together the prevalence of these disorders was 32.7%. Otitis externa was the most common disorder among the dermatologic disorders, which is similar in the present study. Freeman et al[28] found a prevalence of 8% of dermatologic disorders in dogs living in households in the United States and Australia but they did not include otitis externa in the group of dermatologic disorders. They found a prevalence of 8% of deafness and other otic diseases. In the current study the prevalence of otitis externa in all dogs (both stray and owner surrendered) is 7,5%, which is comparable with other studies where prevalence vary between 6,3% in dogs admitted to an animal hospital in Japan[34] to 7,5% in dogs admitted to a small animal clinic in New Zealand[35].
The cause for the higher prevalence of dermatologic disorders in stray dogs may differ for each specific disorder. An owner surrendered dog with a severe atopic dermatitis may be refused by the shelter since this disease requires livelong treatment and therefore will decreases the changes for

adoption for that dog. However, from contact with shelter staffs it seems that the most common disorders in this category (otitis externa and skin wounds) are not likely to be a reason for refusing a dog. Several factors are associated in the development of otitis externa and could be involved in the cause of the difference in prevalence between stray and owner surrendered dogs. Especially breed is an important factor. The cocker spaniel is determined to be the breed with the highest prevalence of otitis externa among dogs in Japan[34], New Zealand[35] and Greece.[36] Recent study by the RSPA in Dutch shelters showed that in both stray dogs and owner surrendered dogs this breed is not very common.[11] They studied the prevalence of different breeds in the same three shelters as the participating shelters in the current study. Difference in breed prevalence between stray dogs and owner surrendered dogs is only seen for the American Staffordshire Terrier and sight hounds, with a higher prevalence in the group of stray dogs and for the Beagle and Labrador Retriever with a higher prevalence in the group of owner surrendered dogs.[11] A study of Tarpataki et al[37] describes the American Staffordshire Terrier as a breed with high risk of food allergies, which can be a primary cause of otitis externa[36] and several other dermatologic signs. A study of Nødtvedt et al[38] describes the American Staffordshire Terrier as one of the top 10 list of breeds with high prevalence of atopic dermatitis, which might also be a primary cause of otitis externa.[36] Therefore it is conceivable that the higher prevalence of American Stafford Shire dogs among stray dogs[11] causes a higher prevalence of dermatologic disorders among these dogs compared with owner surrendered dogs.
The other most common disorders among the dermatologic disorders were skin wounds. The higher prevalence among stray dogs may be explained by the difference in history. Stray dogs may be injured during the period they were strays.
High prevalence of skin wounds among stray dogs are not likely to cause a financial burden to the shelter since most wounds did not require treatment. However, since otitis externa is a difficult disorder to control[39] stray dogs do cause a high financial burden on shelters in this respect.

4.3.3. Remaining disorders

Prevalence of remaining disorders in the current study was 16,1% in stray dogs and 8,0% in owner surrendered dogs. Since definition of this category is not similar with other studies it cannot be compared. However, prevalence of some of the most common disorders in this category, underweight, obesity and ocular disorders, are determined by other studies. Prevalence of a low body condition score (BSC) in dogs varies between different studies. In dogs examined in veterinary practices in Australia a prevalence of 4,2%[40] was found. In pet dogs in Australia and the United States a prevalence of 5,6% was found[28] and in five primary veterinary practices in the United Kingdom a prevalence of 5,3%.[41] Totton et al[42] describes a low BCS as the most common problem among stray dogs in India. They found a prevalence of 70%, which can be explained by the fact that these stray dogs live under very different circumstances than Dutch stray dogs do. As most strays dogs only stray for a few days, a low BCS in Dutch stray dogs most likely started during their time with their formers owners. Although underweight can be a result of many diseases, for the current study underweight with no other disease described is assumed to be a result of inappropriate feeding, since most medical records of the affected dogs described a weight gain after a period of appropriate feeding in the shelter. The level of weight gain and the number of dogs that gained weight was not analyzed. Prevalence of overweight and obesity varies from 32,3% to 59,3% in dogs in the United States, Australia and New Zealand.[28,40,41] Ricci et al[43] found that 60% of dogs housed in an Italian shelter for an average of 14 months were overweight or obese. This might be related to limited movement and unbalanced diets in the shelter and is not comparable with the current study. Prevalence of obesity

in the current study for all dogs (both stray and owner surrendered) is 3,4%, which is much lower compared with other studies. Reasons for this can be divers. The BCS is not registered in the medical files of each individual dog. It is plausible that only prominent obesity is reported and therefore (slightly) overweight is likely to be underestimated.

It is assumed that most common remaining disorders described before will not be a reason for refusal by a shelter. Higher prevalence of underweight and obesity in stray dogs would be more likely to be a result of inappropriate feeding and restriction of movement during their time with their former owners. The higher prevalence of obese or underweight in stray dogs might not have substantial medical consequences for the animal shelter, but can influence the length of stay in a shelter for emaciated and very obese dogs.
Other disorders classified in this category, like neurologic problems, might be a reason of refusal by the shelter. Since the type of disorders classified in this category varies widely nothing can be stated about the cause of differences between owners surrendered dogs and stray dogs.
Dogs with neurologic disorders and tumors of the mammary glands will be in need of medical treatment en therefore cause high costs for the shelter.

4.4. Euthanasia

4,2% of stray dogs and 0,4% of owner surrendered dogs died due to their disorder(s) or were euthanized. These euthanasia percentages both are considerably lower than percentages found in the United States, which is related to the overpopulation of dogs in the United States. Notaro et al[44] found a euthanasia percentage of 26,5% in dogs brought in the shelter by citizens, a percentage of 54,3% in dogs brought in by animal control officers and a percentage of 31,6% in owner surrendered dogs.[44] Even though the percentages are much higher compared with the percentages in the current study, the lower percentage in owner surrendered dogs compared with dogs brought in by animal control officers agree with the current study. However, dogs brought in by animal control officers include besides stray dogs also confiscated dogs. Stray dogs brought in by citizens did not differ from owner surrendered dogs in percentage of euthanasia.[44]
Difference in euthanasia percentage between stray dogs and owner surrendered dogs in the present study indicates that more stray dogs suffer from severe and untreatable problems. It is plausible this is caused by the intake procedure for owner surrendered dogs. Dogs with severe problems that may cause death sometime soon are not likely to be accepted by a shelter. Proportion of these dogs might therefore be higher in stray dogs.

4.5. Age

There is no difference in age between stray dogs and owner surrendered dogs found in the current study. This is in agreement with the previous study by the RSPD.[11] In both groups the majority of dogs where younger than 2,5 years and relinquishment or becoming a stray dog decreases with increasing age. This is in agreement with the results of study of New et al[24] who found that the risk of relinquishment seemed to decrease with increasing age.[24] Relinquished dogs were significant younger than dogs in pet owning households. Most relinquished dogs were less than 2 years old. This could be related to the impulse purchase of a puppy and regretting the purchase afterwards, when it matures . In the present study age is found to be an important factor that influences health condition

of the dog. Since age did not differ between stray dogs and owner surrendered dogs this influence was similar for both groups.

4.6 Differences between shelters

This study shows that the prevalence of disorders differ between the three participating shelters in both stray and owner surrendered dogs. The number of the total disorders and the prevalence of disorders of almost all organ systems was higher in shelter C. Shelter A and B however were very comparable.
For all organ systems the interaction between origin (stray or owner surrendered) and shelter was not significant, which means the effect the shelter has on the medical state of a dog is the same on stray dogs as compared to owner surrendered dogs. In other words, the difference between shelters for owner surrendered dogs also applies to stray dogs. The difference between shelters for owner surrendered dogs is explained by the fact that the shelters have a different intake policy. One shelter might accept owner surrendered dogs with a disease whereas another shelter might not accept it. However, difference between stray dogs in different shelters is not expected, since shelters are obliged to accept all stray dogs. The reason for this can be divers. Difference in service area might cause a difference in health of stray dog population. As described before owners may omit visiting a veterinarian when they have limited financial resources and eventually relinquish their dog with a disease since they cannot afford medical care. Since higher prevalence of disorders is found in shelter C this could be an indication that this municipality includes more people with limited financial resources. However, Central bureau of Statistics determined percentage of people in the welfare system per municipality and found this percentage is lower in the service area of shelter C compared with the service area of shelter A.[45] Furthermore, shelter B and shelter C are shelters in proximity of each other and with similar number of citizens, whereas shelter A serves a lot more citizens and is located in another province. [46]
The influence of the veterinarians might cause a significant difference in health condition between stray dogs in the three shelters. The veterinarian in shelter C might examine the dogs in more detail and therefore might find more abnormalities. Also, this veterinarian may report more (small) abnormalities whereas the other veterinarians might not report them.
Although the current, nor other studies, can explain the actual reasons of this difference of health condition between dogs in the three shelters, the differences in the veterinary procedure at intake in each shelter might be the most reasonable cause. The medical scores of hundreds of dogs in a shelter are registered by one (or two) veterinarian(s). A systematical small difference in reporting will eventually result in a significant difference when the number of participating dogs increases. The veterinarian in shelter A reports all his findings manually, only abnormalities were reported with short description and no further details about diagnostics, severity and treatment. In shelter B findings were reported digitally and with more details. Reports made in shelter C were most detailed. They reported the complete clinical examination, including normality's and small abnormalities. It is likely this resulted in a higher prevalence of disorders in shelter C.

4.7 Limitations of this study

There are a number of limitations to the present study. Several are inherent to retrospective studies.

The reliability of results of this study is dependent of the reliability of findings and reports made by the veterinarians and staff of the shelters. The veterinarians involved are experienced and their clinical ability is sufficient for the current study. However, the medical registration differed between the shelters. Prevalence of disorders could be underestimated because not all disorders may be reported. Furthermore, the veterinarians did not anticipate the use of their reports in this study on beforehand. Therefore they may have considered some findings unimportant to report at that moment, whereas it might be important for this study.

Another limiting factor is that diagnostic procedure was not completed in all cases. In these cases symptoms were included in the study instead of the disease itself. For example, heart murmurs were rarely followed by further diagnostic examination for financial reasons. Therefore no differentiation could be made between heart murmurs caused by a severe heart disease and an innocent murmur.

In general, differentiation in severity of diseases was a difficult aspect of this study. This problem was dealt with by using the classification in number of disorders. But with this classification both a tumor and some dental calculus were counted as one disorder and no differentiation was made in severity. However, in general it is assumed that the higher the number of disorders the poorer the health condition of the dog. With dental disorders this classification in number of disorders could not be used. All different dental disorders were together counted as one, since dental disorders were not described in detail in the medical files. For some dogs only the term 'dental treatment" was noted and it could not be traced whether there was gingivitis, paradontitis or persistent primary tooth. This has the consequence that no differentiation could be made in severity of dental disorders. Since it is showed in this study that dental disorders are a common problem in shelter dogs and significantly more in stray dogs than in owner surrendered dogs it would be interesting to further study these disorders in shelter animals and differentiate in severity and costs of treatment.

Limitations of the current study were similar for both groups. As a consequence difference between the two groups is not suspected to be strongly influenced by this limitations.

5. Conclusion and further research

The present study shows that stray dogs in an animal shelter are in poorer health state compared with owner surrendered dogs. It is unknown how this will influences the costs for medical care and the costs of increased length of stay for the two dog populations, as the euthanasia rate for stray dogs is higher for strays than for owner surrendered dogs.

Further research is needed to analyze the differences found between strays and owner surrendered dogs. Are these two dog populations really different or are these differences created by the medical procedure of the shelter veterinarian at intake? Prospective research could be conducted for more reliable results. In this research standardized procedures of clinical examination, diagnostics and reporting of findings can be used to increase reliability of the data. Furthermore, more shelters participating in the study could result in a more reliable representation of shelter dog population in the whole country.
Further research could also be carried out to determine differences in specific conditions. For example, difference in body condition score could be investigated. Furthermore, differences in prevalence and severity of specific dental and dermatologic disorders could be investigated.

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Appendix

1. Number of disorders

Number of Disorders		
Main Effects	**Log Ratio**	**P-Value**
Stray (~Owner surrendered)	0,448	0,000
Shelter A (~Shelter C)	-0,753	0,000
Shelter B (~Shelter C)	-0,728	0,000
Shelter B (~Shelter A)	0,024	0,802
Age	0,140	0,000

Table 1 --- Log odds ratios and P-values of Poisson log linear model of number of disorders.
~= Compared to

2. Circulatory and respiratory disorders

Circulatory and/or respiratory disorders		
Main effects	**Log odds ratio**	**P-value**
Stray (~Owner surrendered)	0,804	0,014
Shelter A (~shelter C)	-0,351	0,325
Shelter B (~shelter C)	-0,437	0,253
Shelter B (~shelter A)	-0,086	0,840
Age	0,260	0,000

Table 2 --- Log odds ratios and P-values of logistic regression of circulatory or respiratory disorders.
~= compared to

3. Dental disorders

Dental disorders		
Main effects	**Log odds ratio**	**P-value**
Stray (~Owner surrendered)	0,498	0,001
Shelter A (~shelter C)	-1,638	0,000
Shelter B (~shelter C)	-1,499	0,000
Shelter B (~shelter A)	0,139	0,544
Age	0,407	0,000

Table 3 --- Log odds ratios and p-values of logistic regression of dental disorders.
~= compared to

4. Dermatologic disorders

Dermatologic disorders		
Main effects	**Log odds ratio**	**P-value**
Stray (~Owner surrendered)	0,609	0,000
Shelter A (~shelter C)	-1,103	0,000
Shelter B (~shelter C)	-0,892	0,000
Shelter B (~shelter A)	0,211	0,289
Age	0,083	0,000

Table 4 --- Log odds ratios and p-values of logistic regression of dermatologic disorders.
~= compared to

5. Gastro-intestinal disorders

Gastro-intestinal disorders		
Main effects	**Log odds ratio**	**P-value**
Stray (~Owner surrendered)	0,054	0,889
Shelter A (~shelter C)	-0,294	0,523
Shelter B (~shelter C)	-0,152	0,744
Shelter B (~shelter A)	0,142	0,781
Age	0,123	0,019

Table 6 --- Log odds ratios and p-values of logistic regression of gastro- intestinal disorders.
~= compared to

6. **Ocular disorders**

Ocular disorders		
Main effects	**Log odds ratio**	**P-value**
Stray (~Owner surrendered)	0,617	0,011
Shelter A (~shelter C)	-0,381	0,140
Shelter B (~shelter C)	-1,034	0,003
Shelter B (~shelter A)	-0,653	0,078
Age	0,088	0,008

Table 6 --- Log odds ratios and p-values of logistic regression of ocular disorders.
~= compared to

7. Orthopedic disorders

Orthopedic disorders		
Main effects	**Log odds ratio**	**P-value**
Stray (~Owner surrendered)	0,928	0,000
Shelter A (~shelter C)	-0,499	0,073
Shelter B (~shelter C)	-0,676	0,035
Shelter B (~shelter A)	-0,177	0,621
Age	0,116	0,000

Table 7 --- Log odds ratios and p-values of logistic regression of orthopedic disorders.

~= compared to

8. Remaining disorders

Remaining disorders		
Main effects	**Log odds ratio**	**P-value**
Stray (~Owner surrendered)	0,583	0,001
Shelter A (~shelter C)	-0,869	0,000
Shelter B (~shelter C)	-0,854	0,000
Shelter B (~shelter A)	0,015	0,953
Age	0,193	0,000

Table 8 --- Log odds ratios and p-values of logistic regression of remaining disorders.
~= compared to

9. Euthanasia

Euthanasia/dying		
Main effects	**Log odds ratio**	**P-value**
Stray (~Owner surrendered)	1,838	0,004
Shelter A (~shelter C)	-0,482	0,377
Shelter B (~shelter C)	-0,330	0,551
Shelter B (~shelter A)	0,152	0,817
Age	0,320	0,000

Table 9 --- Log odds ratios and p-values of logistic regression of euthanasia/dying.
~= compared to