

Original Article
Oncology



Demographics of dogs and cats with oral tumors presenting to teaching hospitals: 1996–2017

Megan Cray ¹, Laura E. Selmic ^{1*}, Audrey Ruple ²

¹Department of Veterinary Clinical Medicine, University of Illinois Urbana-Champaign, Urbana, IL, USA

²Department of Public Health, Purdue University, West Lafayette, IN, USA



Received: Mar 18, 2020

Revised: Apr 18, 2020

Accepted: Aug 3, 2020

*Corresponding author:

Laura E. Selmic

Department of Veterinary Clinical Sciences,
The Ohio State University, 601 Vernon L Tharp
St, Columbus, OH 43210, USA.
E-mail: selmic.1@osu.edu

© 2020 The Korean Society of Veterinary
Science

This is an Open Access article distributed
under the terms of the Creative Commons
Attribution Non-Commercial License ([https://
creativecommons.org/licenses/by-nc/4.0](https://creativecommons.org/licenses/by-nc/4.0))
which permits unrestricted non-commercial
use, distribution, and reproduction in any
medium, provided the original work is properly
cited.

ORCID iDs

Megan Cray 

<https://orcid.org/0000-0002-8350-1059>

Laura E. Selmic 

<https://orcid.org/0000-0001-6695-6273>

Audrey Ruple 

<https://orcid.org/0000-0002-5223-0217>

Conflict of Interest

The authors declare no conflicts of interest.

Authors Contributions

Conceptualization: Selmic LE, Ruple A; Data
curation: Cray M, Selmic LE, Ruple A; Formal
analysis: Ruple A; Investigation: Cray M, Selmic
LE, Ruple A; Methodology: Cray M, Selmic
LE, Ruple A; Project administration: Cray M,
Selmic LE, Ruple A; Resources: Selmic LE;

ABSTRACT

Background: Oral neoplasia has been reported to account for 6–7% of all canine cancer and 3% of all feline cancers. To the authors' knowledge the last epidemiologic analysis of general oral cancer in dogs and cats was published in 1976.

Objectives: The goal of this study was to report contemporary demographic information regarding oral tumors in dogs and cats.

Methods: Information was collected from cats or dogs diagnosed with oral neoplasia from the Veterinary Medical Data Base. Medical records representing cases that presented to one of 26 veterinary teaching hospitals from January 1, 1996 through December 31, 2017 were included.

Results: A total of 1,810 dogs and 443 cats were identified. A total of 962 cases (53.6%) of canine oral tumors were classified as malignant and 455 cases as benign (25.4%). The majority of feline oral tumors were classified as malignant (257 cases, 58.1%) and only a few benign (11 cases, 2.5%). The incidence of oral tumors was calculated to be 4.9 per 1,000 dogs (0.5%) and 4.9 per 1,000 cats (0.5%).

Conclusions: This incidence of oral tumors is considerably higher than previously reported in both dogs and cats. These results provide valuable information for generation of hypotheses for future investigations of breed-based and pathology-based oral neoplastic studies.

Keywords: Mouth neoplasms; database; incidence; dogs; cats

INTRODUCTION

Oral neoplasia is reported to account for 6–7% of all canine cancers and 3% of all feline cancers [1]. The incidence of oral tumors has been reported to be 70.4 cases per 100,000 dogs in the population [2]. In cats, oral malignancies affect 45.4 cats per 100,000 [2]. The most common oral malignancies in dogs are melanomas, squamous cell carcinomas, and fibrosarcomas [3]. In cats, 69% of malignant oral tumors are squamous cell carcinomas and 18% are fibrosarcomas [4]. Other oral tumor types that can be seen include osteosarcoma, acanthomatous ameloblastoma, and peripheral odontogenic fibromas [1]. Surgery is the first treatment of choice for most oral tumors as the goal is to achieve local control. However additional treatment modalities including chemotherapy, immunotherapy, and radiation

Supervision: Selmic LE, Ruple A; Validation:
Selmic LE, Ruple A; Writing - original draft:
Cray M; Writing - review & editing: Selmic LE,
Ruple A.

may be required when surgery is not possible or when treatment of microscopic metastatic disease is indicated [1].

The demographics of oral tumors in dogs and cats has been assessed in several studies to date; however many are decades old and may not represent the demographics of this disease in a contemporary population of dogs and cats [2,3,5,6]. To the authors' knowledge the last epidemiologic analysis of general oral cancer in dogs and cats was published in 1976 [2]. Updated contemporary information on oral tumors in dogs and cats is important to monitor disease trends, and estimate incidence of this disease in canine and feline populations given advances in diagnostic techniques available. The epidemiologic aspects of naturally occurring neoplasms provide valuable information for generation of hypotheses in future investigation of breed-based and pathology-based oral neoplastic studies. The objective of this study was to report contemporary demographic information regarding oral tumors in dogs and cats.

MATERIALS AND METHODS

Information was collected from cats or dogs diagnosed with oral neoplasia from the Veterinary Medical Data Base (VMDB; <http://vmdb.org>, the VMDB does not make any implicit opinion on the subject of the article or study). The VMDB stores abstracts of hospital records resulting in a compilation of all cases seen at participating university veterinary teaching hospitals (VTHs). Medical records representing cases that presented to one of 26 VTHs from January 1, 1996 through December 31, 2017 were abstracted from the database. Information obtained through database record evaluation included patient identification number, institution of admission, discharge date, sex, castration status, age, weight, diagnostic code, species, breed, and postal code. No additional information was provided from this database.

Case selection

Eligible cases were retrieved from a computer search of the VMDB for dogs and cats presented between January 1, 1996 and December 31, 2017. Dogs and cats were selected based upon diagnostic code which consisted of confirmed oral neoplasms. **Supplementary Table 1** lists the diagnostic codes accepted for inclusion in this study. A diagnosis of pharyngeal neoplasm was excluded for the purpose of this study. Medical records indicating initial diagnoses were included, thus individual animals were represented only once in the dataset.

Statistical analysis

Continuous data was assessed for normality using multiple methods including Shapiro–Wilk tests, skewness and kurtosis. The mean and standard deviation were used to describe normally distributed continuous data and the median and interquartile range (IQR) for continuous data that were non-normally distributed. Frequencies and percentages were used to describe any categorical data. The analyses were performed using commercially available software.

RESULTS

The VMDB contained medical records for 366,905 individual dogs and 91,326 individual cats seen at participating institutions between January 1, 1996 and December 31, 2017. Ten

Table 1. Sex demographics of the study population

Sex and neuter status	Canine	Feline
Female intact	5 (1.1)	59 (3.3)
Female neutered	188 (42.4)	816 (45.1)
Male intact	10 (2.3)	134 (7.4)
Male neutered	237 (53.5)	797 (44.1)
Unspecified	3 (0.01)	4 (0.002)

Values are presented as subjects (%).

universities contributed cases that met inclusion criteria for the purpose of this study. A total of 4,702 dogs and 717 cats diagnosed with oral tumors were identified through the VMDB search based on their diagnostic code.

Duplicate cases as a result of multiple visits were eliminated resulting in a total of 1,810 dogs and 443 cats identified as having an oral tumor. The incidence of oral tumors was calculated to be 4.9 cases per 1,000 dogs (0.5%) and 4.9 cases per 1,000 cats (0.5%). The median (IQR) age in dogs diagnosed with an oral tumor was 10.0 (4.4) years and the median (IQR) weight was 28.7 (22.5) kg. The median (IQR) age in cats diagnosed with an oral tumor was 12.8 (5.7) years and the median (IQR) weight was 4.4 (2.4) kg. **Table 1** demonstrates the sex demographics of the cases within this study.

In dogs, the majority of the oral tumors were classified as malignant (962 cases, 53.6%) followed by benign (455 cases, 25.4%) and unspecified or a histological diagnosis was not available (378 cases, 21.1%). In cats, the majority of oral tumors were also classified as malignant (257 cases, 58.1%) followed by unspecified (174 cases, 39.4%) and benign (11 cases, 2.5%). **Table 2** demonstrates the most common oral tumors locations in both dogs and cats. The most common specific location reported for oral tumors in dogs was the gingiva (438, 24.4%) followed by the lip (252, 14.1%). In cats, the most common specific location for oral tumors was the tongue (74, 16.7%) and the gingiva (53, 12.0%).

A total of 382 cats (86.0%) belonged to nonspecific breeds including American shorthair, domestic longhair, domestic shorthair, domestic medium hair, and mixed breed. However, there were 18 Persian cats (4.1%) and 18 Siamese cats (4.1%) in this population diagnosed with oral tumors (**Table 3**). A total of 469 dogs (26.0%) were reported as being of mixed breed. The most commonly reportedly purebred dogs with oral tumors included Labrador retrievers (234 cases, 13.0%), golden retrievers (201 cases, 11.1%), and boxers (58 cases, 3.2%) (**Table 4**).

Table 2. Frequency and percentage of locations for oral tumors in both dogs and cats

Site	Dogs	Cats
Oral Cavity	821 (45.8)	275 (62.2)
Gingiva	438 (24.4)	53 (12.0)
Lip	252 (14.1)	25 (5.7)
Tongue	159 (8.9)	74 (16.7)
Maxilla	68 (3.8)	8 (1.8)
Soft Palate	27 (1.5)	4 (0.9)
Mandible	27 (1.5)	3 (0.7)
Total	1,810	443

Values are presented as frequency (%).

Table 3. Frequency and percentage of reported feline breeds with oral tumors

Breed	Frequency (%)
Domestic shorthair	135 (30.5)
Mixed breed	111 (25.1)
American shorthair	71 (16.0)
Domestic longhair	55 (12.4)
Persian	18 (4.1)
Siamese	18 (4.1)
Domestic medium-hair	10 (2.3)
Maine coon	9 (2.0)
Abyssinian	2 (0.5)
Himalayan	2 (0.5)
Manx	2 (0.5)
Ragdoll	2 (0.5)
Scottish fold	2 (0.5)
Egyptian mau	1 (0.2)
Exotic shorthair	1 (0.2)
Norwegian forest	1 (0.2)
Russian blue	1 (0.2)
Tonkinese	1 (0.2)
Turkish van	1 (0.2)
Total	443

Table 4. Frequency and percentage of most commonly reported canine breeds with oral tumors

Breed	Frequency (%)
Mixed Breed	469 (26.0)
Labrador retriever	234 (13.0)
Golden retriever	201 (11.1)
German shepherd	41 (2.3)
Cocker spaniel	41 (2.3)
Rottweiler	32 (1.8)
Shih tzu	28 (1.6)
Miniature schnauzer	27 (1.5)
Border Collie	25 (1.4)
Other breeds	712 (39.3)
Total	1,810

DISCUSSION

This aim of this study was to report contemporary demographic information regarding oral tumors in dogs and cats. The incidence of oral tumors in this study was calculated to be 4.9 per 1,000 dogs (0.5%) and 4.9 per 1,000 cats (0.5%). This is considerably higher than previously reported incidence rates of oral tumors in dogs and cats. In one study, originating from University of Pennsylvania in 1964, the specific incidence rate for all types of oral cancer was 3.4 per 1,000 dogs [6]. Another study that used VMDB data and was published in 1976 calculated an oral-pharyngeal cancer occurrence rate of 1.3 per 1,000 dogs and 0.45 per 1,000 cats [2].

The authors of this study speculate that this apparent increase in incidence may be due to these tumors being diagnosed more frequently due to improvements in veterinary care such as routine oral care and regular preventive health examinations. In addition, animals may have longer lifespans than in past and therefore are more likely to develop cancer. Alternatively, there may be environmental factors such as the exposure to secondary tobacco smoke within the household or urban pollutants, which may be causing these tumors to occur more frequently in the companion animal population than in earlier studies. In

human medicine the overall incidence rate for oral and pharyngeal cancers combined is 10.4 per 100,000 population [7]. Trends in regards to oral cancer incidence in human males have differed between racial groups over time. For instance, the oral cancer incidence rate climbed from 16.8 to 20.7 per 100,000 persons per year among black men between 1973 to 1991, but declined slightly for white men from 17.5 to 15.3 per 100,000 during the same time period. Among women, however, incidence rates remained relatively constant at about 6.2 per 100,000 during the same time period [7]. Due to the variability in oral cancer incidence in the human population, it is difficult to directly correlate incidences in humans with our companion animal population.

The median age in dogs diagnosed with an oral tumor was 10.0 years and the median weight was 28.7 kg. This is similar to other studies where the average age for all dogs with oral and pharyngeal neoplasms was 9.8 years [6]. The mean age for dogs diagnosed with oral squamous cell carcinoma, fibrosarcoma, and melanoma were 8.4 years, 7.9 years, and 10.4 years, respectively [8]. In another study, an increase in age-specific rates of canine and feline oral tumors after 9 years of age was reported [9]. The median age in cats diagnosed with an oral tumor in our study was 12.8 years and the median weight was 4.4 kg. In cats diagnosed with oral squamous cell carcinoma, the average age was 12.5 years and those diagnosed with oral fibrosarcoma the average age was 10.3 years [10]. Therefore, our results are consistent with the reports that oral tumors arise more frequently in middle-aged and older animals.

In this study, there was an equal proportion of both male and female dogs and cats. Oral malignancies have been previously reported to occur with equal frequency in male and female cats [4]. One study determined the risk of male and female dogs for the 3 major oral-pharyngeal cancer sites did not reveal any statistically significant differences. However, there was significantly greater risk of occurrence of fibrosarcomas and melanomas in male dogs [2]. Another study demonstrated male dogs have a higher prevalence for oral melanomas (79.7%) and tonsillar carcinomas (74.0%) [6]. Unfortunately given the paucity of information contained within the medical records within the VMDB, tumor specific demographics could not be evaluated in this study.

Oral tumors have previously been reported to account for approximately 3–12% of all feline tumors [8-12]. In addition, a 10-year survey of feline oral neoplasia concluded that 89% of all oral tumors were malignant [10]. In this study, many of the feline oral tumors were also classified as malignant (257 cases, 58.1%). Very few cases of oral tumors were diagnosed as benign (11 cases, 2.5%). In dogs, tumors of the oral cavity have been reported to represent 5–7% of all tumors diagnosed [13]. In one study from 1968, benign oral tumors accounted for 3.4% of all canine neoplasms within one population [3]. In another more recent study of oral tumors, 50 dogs (74.6%) had a malignant neoplasm and 10 dogs (14.9%) had a benign neoplasm [14]. In this study 962 cases (53.6%) of canine oral tumors were classified as malignant and 455 cases were classified as benign (25.4%). It is possible that as we are diagnosing more oral tumors in dogs we may be identifying more benign masses incidentally. Regardless, benign oral tumors in dogs may be more common than previously suspected.

The most common location for oral tumors in dogs was the gingiva (24.4% of cases) followed by the lip (14.1% of cases). These results are consistent with the previous studies. In one study the most common site of oral neoplasia in the dog was the gingiva (15.4 cases per 10,000 dogs seen) [6]. In another study the most frequent sites of oral-pharyngeal cancer were as follows: gingiva-alveoli (n=127), lip (n=43), tonsil (n=37), palate (n=35), tongue

(n=18), oropharynx (n=10), esophagus (n=6), and other (n=6) [2]. In the same study the most frequent sites of oral-pharyngeal cancer in the cat were the tongue (n=12), gingivae (n=8), lip (n=4), oropharynx (n=4), and other (n=1) [2]. The most common location for oral tumors within the feline population of this study was the tongue (16.7% of cases) and the gingiva (12.0%). Previous studies have also determined that squamous cell carcinoma is the most common oral neoplasm in cats (61.2% of cases) and the most common site for this tumor is the sublingual area [10]. Therefore, the results for oral tumor location in cats, like dogs, is consistent with previous literature.

The majority of the cats in this epidemiologic study were non-specific breeds (86.0% of cases). To the authors' knowledge no previous study has identified feline breeds predisposed to oral neoplasia. The most common dog breed in this study was mixed breeds (26.0% of cases). In one study the highest breed specific rate of oral and pharyngeal neoplasia occurred in cocker spaniels (80.2 per 10,000) [6]. In another study German shorthair pointer, weimaraner, golden retriever, boxer, and cocker spaniel breeds had a significantly higher risk and dachshunds and beagles had a significantly lower risk for oral and pharyngeal cancer [2]. Finally, mixed breed dogs, cocker spaniels, poodles, and German shepherd dogs accounted for 60% of all oral and pharyngeal neoplasia cases in one population [5]. This study did not include animals with pharyngeal neoplasia. The most commonly reportedly breeds with oral tumors in our study included Labrador retrievers (234 cases, 13.0%), golden retrievers (201 cases, 11.1%), and boxers (58 cases, 3.2%). Additional studies are needed to determine if these canine breeds may be at an increased risk for oral neoplasia.

There are several limitations to consider when interpreting this retrospective epidemiologic study. Firstly, data was obtained from the VMDB in which information is contributed only from participating tertiary referral centers, which may result in decreased external validity. Ideally, specific tumor diagnoses would be investigated, however, this information was not often available in this medical record database. This study is strictly descriptive, as a control population was not used. Further studies must be conducted in order to investigate the effects of sex, age, and breed predisposition on the occurrence of oral neoplasia.

In conclusion, much of the data used to cite descriptive statistics in dogs and cats with oral neoplasia are decades old. This study reports contemporary demographic information regarding oral tumors in dogs and cats. These results provide valuable information for generation of hypotheses in future investigations of breed-based and pathology-based oral neoplastic studies.

SUPPLEMENTARY MATERIAL

Supplementary Table 1

Veterinary Medical Database diagnostic codes selected for inclusion of case population

[Click here to view](#)

REFERENCES

1. Liptak JM, Withrow S. Oral tumors. In: Withrow SJ, editor. *Small Animal Clinical Oncology*. St. Louis: Elsevier Saunders; 2013. pp. 381.

2. Dorn CR, Priester WA. Epidemiologic analysis of oral and pharyngeal cancer in dogs, cats, horses, and cattle. *J Am Vet Med Assoc.* 1976;169(11):1202-1206.
[PUBMED](#)
3. Dorn CR, Taylor DO, Schneider R, Hibbard HH, Klauber MR. Survey of animal neoplasms in Alameda and Contra Costa Counties, California. II. Cancer morbidity in dogs and cats from Alameda County. *J Natl Cancer Inst.* 1968;40(2):307-318.
[PUBMED](#)
4. Cotter SM. Oral pharyngeal neoplasms in the cat. *J Am Anim Hosp Assoc.* 1981;17(6):917-920.
5. Todoroff RJ, Brodey RS. Oral and pharyngeal neoplasia in the dog: a retrospective survey of 361 cases. *J Am Vet Med Assoc.* 1979;175(6):567-571.
[PUBMED](#)
6. Cohen D, Brodey RS, Chen SM. Epidemiologic aspects of oral and pharyngeal neoplasms of the dog. *Am J Vet Res.* 1964;25(109):1776-1779.
[PUBMED](#)
7. Ries LAG, Miller BA, Hankey BF, Kosary CL, Hurray A, Edwards BK. *Report No. NIH-94-2789. SEER Cancer Statistics Review, 1973-1991.* Bethesda: US Department of Health and Human Services, Public Health Service, National Cancer Institute; 1994.
8. Brodey RS. A clinical and pathological study of 130 neoplasms of the mouth and pharynx in the dog. *Am J Vet Res.* 1960;21:787-812.
9. Dorn CR. Epidemiology of canine and feline tumors. *J Am Anim Hosp Assoc.* 1976;12:307-312.
10. Stebbins KE, Morse CC, Goldschmidt MH. Feline oral neoplasia: a ten-year survey. *Vet Pathol.* 1989;26(2):121-128.
[PUBMED](#) | [CROSSREF](#)
11. Andrews LK. Tumors of the alimentary system. In: Holzworth J, editor. *Diseases of the Cat.* Philadelphia: WB Saunders; 1987. pp. 486-489.
12. Patnaik AK, Liu SK, Hurvitz AI, McClelland AJ. Nonhematopoietic neoplasms in cats. *J Natl Cancer Inst.* 1975;54(4):855-860.
[PUBMED](#)
13. Frew DG, Dobson JM. Radiological assessment of 50 cases of incisive or maxillary neoplasia in the dog. *J Small Anim Pract.* 1992;33(1):11-18.
[CROSSREF](#)
14. Bonfanti U, Bertazzolo W, Gracis M, Roccabianca P, Romanelli G, Palermo G, et al. Diagnostic value of cytological analysis of tumours and tumour-like lesions of the oral cavity in dogs and cats: a prospective study on 114 cases. *Vet J.* 2015;205(2):322-327.
[PUBMED](#) | [CROSSREF](#)