

EPIDEMIOLOGICAL STUDIES OF SPONTANEOUS CANINE MAMMARY TUMORS IN BULGARIA

Ivelina Grozeva

Department of General and Clinical Pathology, Faculty of Veterinary Medicine, Trakia University, Stara Zagora, Bulgaria

Corresponding author: Assist. Prof. Ivelina Grozeva

E-mail address: ivelina.grozeva@trakia-uni.bg

Present address: Department of General and Clinical Pathology, Faculty of Veterinary Medicine, Trakia University, Student Campus, 6000 StaraZagora, Bulgaria Phone: +359/877/333885

ORCID: 0009-0006-9033-6334

Abstract

The epidemiological study was performed on 264 spontaneous mammary tumors from dogs admitted for examination and treatment at the University Veterinary Hospital, Trakia University - Stara Zagora, as well as from private veterinary clinics throughout Bulgaria. The studies were conducted over a four-year period (2022–2025). The neoplastic formations were processed using classical histological techniques and classified according to the histological classification for canine mammary tumors published by Goldschmidt *et al.* [8]. Two hundred and six (78.03%) of the neoplasms were of epithelial origin, fifty-five (20.83%) were of mixed origin, and three (1.14%) were of mesenchymal origin. Malignant tumors dominated with 64.77% (171/264), while benign tumors were 35.23% (93/264). Macroscopically, mammary tumors were single or multiple nodular masses ranging in size from 0.3 to 15 cm in diameter. The mean age of affected dogs was 9.6 years, ranging from 3 to 17 years. The most commonly affected breed was the Yorkshire Terrier. Mammary tumors were most common in Southern Bulgaria. The results of the conducted study support the conclusion that mammary tumors in dogs represent a serious problem in veterinary oncology. Their development is a dynamic process that requires timely monitoring and identification of risk groups of dogs.

Keywords: *mammary tumors in bitches, epidemiological studies*

Introduction

Mammary tumors are a serious problem in veterinary oncology. They are among the most common neoplasms in unspayed female dogs [3, 11, 12, 14, 19]. In dogs ovariohysterectomized before the first estrous cycle, the risk of developing mammary neoplasia is reduced by 99.5%, 92% and 74% if they are castrated before the second and third estrus, respectively [17]. The average age of affected animals is between 8 and 11 years [20] and dogs under 2 years of age are rarely affected [1]. Mammary tumors can occur in dogs of any breed, but certain breeds such as miniature and “toy” breeds are overrepresented in epidemiological studies [20]. In the study by Itoh *et al.* [9], 59.4% of the studied dogs were small breeds such as Maltese, Yorkshire Terrier, Shih Tzu, and others. According to data from an epidemiological study by Salas *et al.* [16], which included 1917 dogs, it was found that 48.4% of mammary tumors occur in small breed dogs, 29.1% in medium-sized breeds and 22.3% in large breeds. According to literature data, the breeds most commonly affected are Pomeranian, Maltese, Yorkshire Terrier, Spitz, Cocker Spaniel, Dachshund, Poodle, German Shepherd [9, 10, 11, 25].

Mammary gland tumors are most common in female dogs. However, there are rare cases in male dogs. The incidence in male dogs is estimated in the literature to be low: 0.5–2.7%, usually < 1%, depending on the country of study and the tested group of dogs [22]. The most common form in approximately 93% of cats and 67% of dogs of all cases of mammary neoplasms is nodular. It is characterized by the presence of one or several tumor nodules. Diffuse tumor process occurs relatively less frequently [24]. Neoplastic formations can range in size from a few millimeters to over several centimeters, with the majority of them located in the caudal mammary glands [16]. Tumors larger than 5 cm are more likely to be malignant and affected animals have a shorter survival rate [3].

Science & Research

The aim of this study was to track the prevalence of mammary tumors in dogs in Bulgaria. After 2014, there is not enough information in our country regarding the prevalence, gender, breed, and age sensitivity of this type of neoplasms among the canine population.

Materials and methods

We conducted the research on biopsy materials from mammary gland tumors in dogs admitted for examination and treatment at the University Veterinary Hospital, Trakia University - Stara Zagora, as well as from private veterinary clinics throughout Bulgaria. The studies were conducted over a period of four years (2022 - 2025). We studied a total of two hundred and sixty-four spontaneous mammary tumors. Pathohistological studies were performed at the Department of General and Clinical Pathology, Faculty of Veterinary Medicine, Trakia University - Stara Zagora. We processed the neoplastic formations using the classical histological technique [5, 6]. The sections were stained with hematoxylin-eosin. The neoplasms were classified according to the histological classification for mammary tumors in dogs published by Goldschmidt *et al.* [8].

Results

The study included 264 neoplastic formations of the mammary gland. Macroscopically, the mammary tumors were single or multiple nodular masses ranging in size from 0.3 to 15 cm in diameter. Benign formations were mostly circumscribed, dense with a round-oval shape. In malignant neoplasms, the shape was more often irregular. They were of dense consistency, often multinodular and with an ulcerated surface. Areas of hemorrhage and necrosis are observed on the cut surface. In mixed tumors, there were areas of very hard consistency, containing cartilage and/or bone tissue.

Pathohistologically, five types of benign and eleven types of malignant tumors were diagnosed. Two hundred and six (78.03%) of the neoplasms were of epithelial origin, fifty-five (20.83%) - mixed and three (1.14%) of mesenchymal origin (Fig. 1.). Malignant tumors dominated with 64.77% (171/264), while benign tumors were 35.23% (93/264). The most common were tubulopapillary carcinoma 22.73% (60/264), solid carcinoma 11.74% (31/264), tubular carcinoma 7.95% (21/264), complex carcinoma 6.82% (18/264), mixed benign tumor 14.39% (38/264) and fibroadenoma 8.71% (23/264).

Prevalence of tumors depending on age

The average age of the affected dogs was 9.6 years, ranging from 3 to 17 years. The largest number of tumors was found in animals aged 8-10 years, respectively 36 (13.64%) dogs aged 8 years, 31 (11.74%) dogs aged 9 years and 30 (11.36%) dogs aged 10 years. The lowest prevalence was in dogs in the 15-17 year age group, totaling 1.14%. The mean age of dogs that developed benign tumors was 7.5 years, while that of those with malignant tumors was higher- 9.2 years. The age was unknown in 6 of the studied animals. Fig. 2. presents the overall age distribution.

Prevalence of tumors depending on breed

The study included 38 dog breeds. The most commonly affected breed (Fig. 3.) was Yorkshire Terrier - 41 dogs (15.53%), followed by Crossbreeds - 39 dogs (14.77%) and Pinscher - 26 dogs (9.85%). Other commonly affected breeds were Cocker Spaniel (4.92%), Jack Russell Terrier (3.79%), Pomeranian (3.79%), German Shepherd (3.79%), Siberian Husky (3.4%), French Bulldog (3.4%), Cane Corso (3.4%), German Spitz (2.65%), Chihuahua (2.27%), and others. Single cases were observed in Boxer, Caucasian Shepherd, Papillon, Basset Hound, Akita Inu.

Prevalence of tumors by gender and reproductive status

The majority of the studied animals that developed neoplastic mammary gland formations were female - 262 dogs (99.24%) and only 2 of the cases were observed in male dogs (0.76%). The lesions observed in the male dogs were squamous cell carcinoma of the mammary gland in a Labrador and a

Yorkshire Terrier diagnosed with precarcinomatous changes in the mammary gland (ductal ectasia, epitheliosis and papillomatosis).

Of all the animals in the study, 23 were castrated, with 17 of the diagnosed tumors were malignant and 6 were benign.

Spread of tumors depending on anatomical localization and size of the formations

In 10.61% of the studied animals, the thoracic mammary glands were affected, in 34.1% of the cases - the abdominal glandular lobes, in 51.89% of the dogs - the inguinal glands, and in 3.4% the anatomical localization of the tumors was unknown. Single nodular neoplastic formations were found in 59.47% of the dogs, and multiple tumor formations in 40.53%, of which in 11 (4.17%) cases they covered all gland complexes. Depending on the size of the tumors, 136 tumors with sizes up to 3 cm were found, 95 tumors with sizes from 3 to 5 cm and 33 tumors with sizes over 5 cm, with the largest of them reaching 15 cm (Fig. 4.).

Distribution of tumors depending on habitat

The study included animals from 27 cities across Bulgaria. The largest number of dogs were from central regional cities such as Plovdiv (16.67%), Sofia (13.26%), Stara Zagora (12.12%), Burgas (7.95%), Varna (6.44%), Veliko Tarnovo (6.06%), Ruse (4.17%), Yambol (4.55%). Single cases were found in animals from Galabovo, Svilengrad, Shumen, Provadia, Primorsko. Mammary gland tumors were most common in Southern Bulgaria, and least common in the Central and Northeastern parts of the country.

Discussion

The results of our study show the increasingly frequent occurrence of spontaneous mammary tumors in dogs in Bulgaria. A large proportion of the diagnosed neoplastic formations were malignant, with their ratio to benign ones being 64.77%:35.23%. The data obtained are very similar to those from the study by Dinev *et al.* [4], in which the prevalence of mammary neoplasia was 62.9% for malignant and 37.1% for benign neoplasms, respectively. Epithelial tumors are the most common, followed by mixed and mesenchymal tumors. Tubulopapillary and solid carcinoma were most frequently diagnosed among malignant tumors, and among benign tumors - mixed benign tumors and fibroadenomas, which is consistent with the results of studies by other authors in our country [18, 23].

There is a wide age range in which mammary tumors occur in bitches [16]. Most neoplasms occur in middle-aged to older dogs, with a low incidence in young animals [2, 13], and dogs under 2 years of age rarely affected [1]. The average age of affected animals is between 8 and 11 years [20]. In our study, the age of the affected animals varied very widely (3-17 years). We found the largest number of tumors in animals in the age group from 8 to 10 years, respectively 36 dogs aged 8 years, 31 dogs aged 9 years and 30 dogs aged 10 years. The lowest prevalence was in dogs in the 15-17 year age group (1.14%). Our results are very similar to those of other epidemiological studies in the same direction [15, 16]. Our study shows that the average age of the affected dogs was 9.6 years (7.5 years in dogs with benign tumors, and 9.2 years in those with malignant tumors), which is in line with data from other studies conducted in Bulgaria and abroad [9, 20, 23].

According to literature data, the breeds most commonly affected are Pomeranian, Maltese, Yorkshire Terrier, Spitz, Cocker Spaniel, Dachshund, Poodle, German Shepherd [9, 10, 11, 25]. Our study shows that a large proportion of neoplasms were found in breeds such as Yorkshire Terrier (41/264), Pinscher (26/264), Cocker Spaniel (13/264), Pomeranian (10/264), Jack Russell Terrier (10/264), German Shepherd (10/264), German Spitz (7/264). According to other authors, more Crossbreeds suffer from tumor growths in the mammary glands [7, 21]. In the present study, there were thirty-nine Crossbreed dogs.

Very often in epidemiological studies related to the prevalence of mammary tumors in dogs, small breeds are overrepresented [9, 20]. According to research data from other authors working in

the same direction as Salas *et al.* [16], it was found that 48.4% of mammary tumors occur in dogs of these breeds. Our results also show an increase in the occurrence of this type of neoplasia in small dog breeds such as Yorkshire Terrier, Pinscher, Pomeranian, Jack Russell Terrier, Chihuahua, French Bulldog, Beagle.

The incidence of mammary gland involvement by tumor formations in male dogs has been estimated in the literature as low: 0.5–2.7%, usually < 1% [22]. The majority of animals studied by us that developed mammary gland neoplasms were female - 262 dogs (99.24 %) and only 2 of the cases were observed in male dogs (0.76 %). In them, the lesions were associated with precarcinomatous manifestations and squamous cell tumor. Mammary tumors are less common in the United States compared to European countries, where ovariohysterectomy is not routinely performed [19]. Of all the animals in our study, only twenty-three were castrated, which is consistent with this statement. This may be due to low awareness among owners about the benefits of castration.

The caudal lobes of the mammary glands are the most common location for the manifestation of tumor formations [16]. In our study, 51.89% of the dogs were affected by the inguinal glands, followed by the abdominal lobes in 34.1% of cases and 10.61% with localization in the thoracic mammary glands. The prevalence of mammary neoplasms in dogs favors nodular tumor lesions, while diffuse ones occur in a smaller number of them [24]. Single nodular neoplastic formations were found in 59.47% of dogs, and multiple tumor formations in 40.53%.

According to the study by Dinev *et al.* [4], about 70% of the dogs with mammary tumors were from the region of Southeastern Bulgaria. Our results are somewhat in contrast, as we found a prevalence of 17.05% of affected dogs in this region. The highest prevalence of tumors was in Central Southern Bulgaria and Southwestern Bulgaria (51.9%).

The results of the conducted study support the conclusion that mammary tumors in dogs represent a serious problem in veterinary oncology. Their development is a dynamic process that requires timely monitoring and identification of risk groups of dogs.

REFERENCES

1. Brodey R, Goldschmidt M, Roszel J. Canine mammary gland neoplasms. *J Am Anim Hosp Assoc* 1983; 19: 61-90.
2. Cassali GD, Lavallo GE, Ferreira E, Estrela-Lima A, De Nardi AB, Ghever C, Sobral RA, Amorim RL, Oliveira LO, Sueiro FA, Beserra HE, Bertagnolli AC, Gamba CO, Damasceno KA, Campos CB, Araujo MR, Campos LC, Monteiro LN, Nunes FC, Horta RS, Reis DC, Luvizotto MCR, Magalhães GM, Raposo JB, Ferreira AMR, Tanaka NM, Grandi F, Ubukata R, Batschinski K, Terra EM, Salvador RC, Jark PC, Delecrodi JE, Nascimento NA, Silva DN, Silva LP, Ferreira KC, Frehse MS, di Santis GW, Silva EO, Guim TN, Kerr B, Cintra PP, Silva FB, Leite JS, Mello MF, Ferreira MG, Fukumasu H, Salgado BS, Torres R. Consensus for the Diagnosis, Prognosis and Treatment of Canine Mammary Tumors – 2013. *Braz J Vet Pathol* 2014; 7 (2), 38 – 69.
3. Cassali GD, Jark PC, Gamba C, Damasceno KA, Estrela-Lima A, De Nardi AB, Ferreira E, Horta RS, Firmo BF, Sueiro FA, Rodrigues LC, Nakagaki CY. Consensus Regarding the Diagnosis, Prognosis and Treatment of Canine and Feline Mammary Tumors - 2019. *Braz J Vet Pathol* 2020; 13(3), 555 – 574.
4. Dinev I, Dimov D, Parvanov P, Georgiev P, Simeonova G. Incidence of canine neoplasms - a retrospective study. I. Mammary neoplasms in the bitch. *Bulgarian Journal of Veterinary Medicine* 2002; 5 (3), 195 - 204.
5. Djurov A, Aleksandrova E, Alexandrov M. Pathohistological research methods. Zemizdat, Sofia, 1989.
6. Dyakov L, Lozanov L, Angelov A, Stoykov D. Veterinary Pathohistology Practice Guide. Zemizdat, Sofia, 1989.
7. Edmunds G, Beck S, Kale KU, Spasic I, O'Neill D, Brodbelt D, Smalley MJ. Associations Between Dog Breed and Clinical Features of Mammary Epithelial Neoplasia in Bitches: an Epidemiological Study of Submissions to a Single Diagnostic Pathology Centre Between 2008-2021.

Science & Research

- J Mammary Gland Biol Neoplasia 2023; 28(1):6. doi: 10.1007/s10911-023-09531-3. PMID: 36961631; PMCID: PMC10039094.
8. Goldschmidt M, Peña L, Rasotto R, Zappulli V. Classification and Grading of Canine Mammary Tumors. *Veterinary Pathology* 2011; 48 (1) 117-131. DOI: 10.1177/0300985810393258.
 9. Itoh T, Uchida K, Ishikawa K, Kushima K, Kushima E, Tamada H, Moritake T, Nakao H, Shii H. Clinicopathological Survey of 101 Canine Mammary Gland Tumors: Differences between Small-Breed Dogs and Others. *Journal of Veterinary Medical Science* 2005; DOI: 10.1292/jvms.67.345.
 10. Kim HW, Lim HY, Shin JI, Seung BJ, Ju JH, Sur JH. Breed- and age-related differences in canine mammary tumors. *Can J Vet Res.* 2016; 80(2):146-55. PMID: 27127342; PMCID: PMC4836041.
 11. Moe L. Population-based incidence of mammary tumors in some dog breeds. *J Reprod Fertil Suppl.* 2001; (57): 439–443.
 12. Moon Ch, Kim D, Yun S, Lee H, Jeong S. Assessment of prognostic factors in dogs with mammary gland tumors: 60 cases (2014-2020). *Korean J Vet Res* 2022; 62 (1):e9 <https://doi.org/10.14405/kjvr.20210046>.
 13. Nosalova N, Huniadi M, Hornáková L', Valencáková A, Hornák S, Nagoos K, Vozar J, Cizkova D. Canine Mammary Tumors: Classification, Biomarkers, Traditional and Personalized Therapies. *Int. J. Mol. Sci.* 2024; 25, 2891. <https://doi.org/10.3390/ijms25052891>.
 14. Nunes FC, Campos CB, Teixeira SV, Bertagnolli AC, Lavalle GE, Cassali GD. Epidemiological, clinical and pathological evaluation of overall survival in canines with mammary neoplasms. *Arquivo Brasileiro de Medicina Veterinaria e Zootecnia* 2018; 70, 1714e1722.
 15. Pastor N, Caballé NC, Santella M, Ezquerro LJ, Tarazona R, Duran E. Epidemiological study of canine mammary tumors: age, breed, size and malignancy. *Austral J Vet Sci* 2018; 50, 143-147.
 16. Salas Y, Márquez A, Diaz D, Romero L. Epidemiological Study of Mammary Tumors in Female Dogs Diagnosed during the Period 2002- 2012: A Growing Animal Health Problem. *PLoS ONE* 2015; 10(5): e0127381. doi:10.1371/journal.pone.0127381.
 17. Schneider R, Dorn CR, Taylor D.O. Factors influencing canine mammary cancer development and postsurgical survival. *J Natl Cancer Inst* 1969; 43(6):1249–61.
 18. Simeonov R. A retrospective study of canine mammary gland tumours. *Science & Technologies* 2014; Volume IV, Number 5.
 19. Sorenmo K. Canine mammary gland tumors. *Vet Clin North Am Small Anim Pract.* 2003; 33 (3):573-96. doi: 10.1016/s0195-5616 (03)00020-2. PMID: 12852237.
 20. Sorenmo K, Rasotto R, Zappulli V, Goldschmidt M.H. Development, Anatomy, Histology, Lymphatic Drainage, Clinical Features, and Cell Differentiation Markers of Canine Mammary Gland Neoplasms. *Vet. Pathol* 2011;48, 85–97.
 21. Srisawat W, Pringproa K, Prachasilchai W, Thongthar A, Sthitmatee N. Epidemiology and classification for canine and feline mammary gland tumors: a histopathological survey of 437 mammary gland tumor biopsies performed in a secondary care hospital in Chiang Mai, Thailand from 2012 to 2019. *PeerJ* 2024; DOI 10.7717/peerj.17077.
 22. Tkaczyk-Wlizło A, Kowal K, Śmiech A, Ślaska B. Occurrence of mammary gland tumours in male dogs and its weak association with development of testicular tumours: a review. *Journal of Applied Genetics* 2024; 65:137–153, <https://doi.org/10.1007/s13353-023-00818-z>.
 23. Tzvetkov Y. Pathomorphological studies and some epizootological properties at the tumour in dog. PhD thesis, Central Laboratory of Biology and Game Diseases with Small Animal Clinics, Sofia, 1998.
 24. Yakunina MN. Mammary cancer in dogs and cats. *Vetpharma №2*, 2011; pp. 60-72.
 25. Zatloukal J, Lorenzová J, Tichy F, Necas A, Kecová H, Kohout P. Breed and age as risk factors for canine mammary tumours. *ACTA VET. BRNO* 2005; 74:103-109.

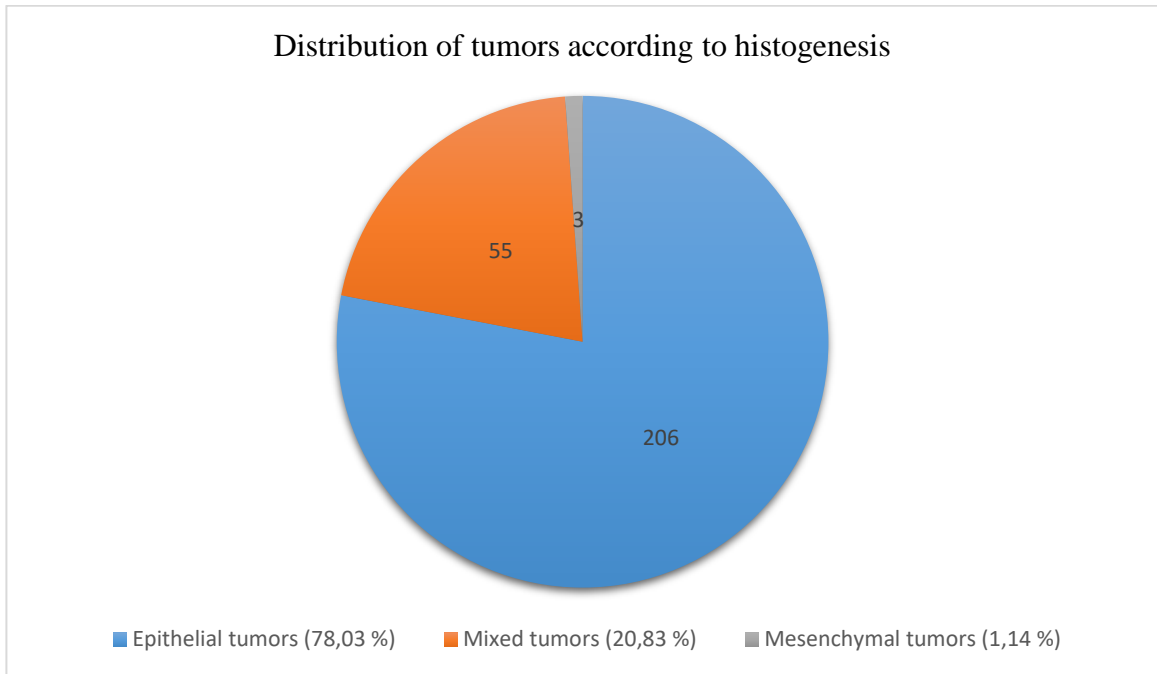


Fig. 1. Distribution of tumors according to histogenesis

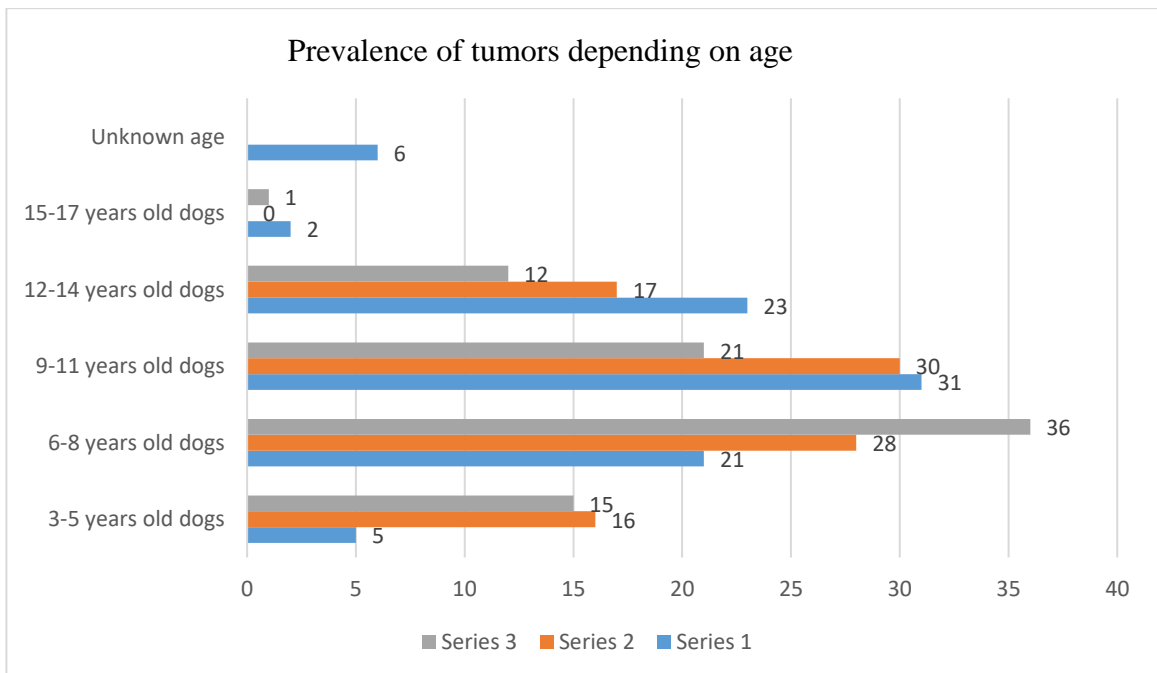


Fig. 2. Prevalence of tumors depending on age

Breed	Percentage of affected dogs
Yorkshire Terrier	15.53%
Crossreeds	14.77%
Pinscher	9.85%
Cocker Spaniel	4.92%
Jack Russell Terrier	3.79%
Pomeranian	3.79%
German Shepherd	3.79%
Siberian Husky	3.4%
French Bulldog	3.4%
Cane Corso	3.4%
German Spitz	2.65%
Chihuahua	2.27%

Fig. 3. Breeds most commonly affected by Canine Mammary Tumors



Fig. 4. Macroscopic finding in a benign mixed tumor measuring 15 cm.