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Incidence of canine mammary carcinoma

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Abstract
The present investigation aimed to determine the incidence of canine mammary carcinoma in dogs presented to veterinary hospitals. Out of a total of 42, 505 dogs examined, 422 cases were diagnosed with malignant neoplasms, indicating an overall incidence rate of 0.99%. Canine mammary carcinoma was most frequently observed in dogs aged between 6 and 10 years (66.67%), while the lowest incidence was recorded in the 0 to 5-year age group (7.41%). Among the affected breeds, Labrador Retrievers exhibited the highest breed-specific incidence at 38.28%, with a marked prevalence in intact female dogs (88.89%).

Keywords: Canine, canine mammary carcinoma, incidence, mammary tumor

Introduction
Companion animals, like dogs, coexist with humans. This coexistence has been emphasizing the importance of maintaining the health of the dogs. The pet dogs suffer with both infectious and non-infectious diseases commonly. Apart from these, cancer has emerged as an important concern in veterinary health care of dogs. Approximately one in four dogs develop cancer at some point in their lives, making it one of the prime cause of mortality in pets. Cancer indicates the uncontrolled proliferation with infiltration into the surrounding tissues and dissemination of abnormal cells to various other organs of the body. These cells derived from the body's own tissues, lead to the formation of a neoplastic mass, commonly referred to as tumor. This pathological growth disrupts normal tissue architecture and function. Cancer remains one of the leading causes of mortality in both humans and canines, posing significant challenges to veterinary and human healthcare systems alike (Kumar *et al.*, 2017) [8]. Carcinomas, which originate from epithelial cells, represent the most common type of malignant tumor in dogs, accounting for nearly 90% of all canine cancers. This high incidence shows the predominance of epithelial malignancies within the canine population. In contrast, sarcomas, though relatively uncommon in dogs, are solid tumors that arise from connective tissues, including muscle, bone, cartilage, and fibrous tissue. These findings also highlight the high prevalence of malignancy among mammary tumors in dogs, emphasizing the clinical importance of early detection and accurate diagnosis (Nunes *et al.*, 2018) [12]. Leukemias and lymphomas, together comprise around 8% of malignancies, which originate from hematopoietic cells and components of the immune system. These malignancies are of blood, bone marrow, lymph nodes, and other lymphoid tissues, and are distinct from solid tumors due to their systemic nature and diffuse involvement. Tumors are further categorized based on their tissue of origin, and specific cell type from which they develop. Fibro-sarcomas originate from fibroblasts, while erythroid leukemia's arise from erythrocyte precursors. Canine mammary cancer (CMC) and human breast cancer (HBC) exhibit numerous similarities beyond their general biological behavior. These share a wide range of epidemiological, environmental, genetic, clinical, and pathological similar characteristics. Both these cancers share considerable histological and molecular heterogeneity. Due to these shared features, CMC has been increasingly recognized as a valuable spontaneous animal model for investigating various aspects of human breast cancer, including tumor development, progression, and therapeutic responses. This comparative relevance shows the importance of translational research using CMC to enhance the understanding and management of HBC (Valdivia *et al.*, 2021) [19].

The mammary gland in dogs is a modified apocrine sweat gland composed of alveoli and ductal structures, supported by surrounding connective tissue, blood vessels, and nerves. Female dogs possess five pairs of mammary glands, categorized as thoracic (two pairs), abdominal (two pairs), and inguinal (one pair). The mammary glands tumors are both benign and malignant in bitches. Benign tumors are generally small, well-defined, firm on palpation, and exhibit slow growth. Where as, malignant tumors tend to be locally invasive, often adherent to the overlying skin or underlying tissues, and may present with ulceration, hemorrhage, and rapid growth. Distant metastasis in canine mammary tumors occurs in the lungs. Other commonly affected organs include the liver, kidneys, spleen, bones, central nervous system, and pleura. These metastatic patterns significantly aid the prognosis and therapeutic approach in affected animals (Nunes *et al.*, 2018) [12]. Mammary gland tumors are the most frequently encountered neoplasms in veterinary pathology, particularly in unspayed female dogs. The development of mammary gland tumors is associated with abnormal cellular proliferation, insufficient apoptosis, and disruptions in normal cell differentiation. Despite their high prevalence in veterinary medicine, the underlying mechanisms of mammary tumor development remain incompletely understood, paralleling the complexities observed in human breast cancer. As a result, the existing literature contains a wide range of studies, some with conflicting findings, which complicates the clinical understanding and management of the disease. In recent years, the incidence of cancer has risen significantly in both human and veterinary populations. Assessment of mammary carcinoma is based on several histopathological criteria, including tumor type, the degree of nuclear and cellular pleomorphism, mitotic index, presence of necrosis, peritumoral and lymphatic invasion, and metastasis to regional lymph nodes (Kaszak *et al.*, 2022). Mammary gland tumors represent the second most frequently diagnosed neoplasms in female dogs (Nunes *et al.*, 2018) [12] and can arise at any location along the mammary chain (Salas *et al.*, 2015) [17]. The commonly recognized factors, age, breed predisposition, and the animal's reproductive and hormonal status are frequently cited in scientific literature as key contributors for tumor development. Additionally, various elements such as hormonal imbalances, receptor expression, nutritional factors, obesity, exposure to radiation, and genetic predispositions play a critical role in the progression of these tumors. The diversity in these contributing factors leads to considerable morphological and biological variability in canine mammary tumors.

Materials and Methods

The present study on the incidence of canine mammary carcinoma was conducted at the Veterinary Clinical Complex and the Veterinary Ambulatory Clinic of the College of Veterinary Science, Rajendranagar, Hyderabad. The study period extended from July 2023 to June 2025. Detailed case histories were obtained from the dog owners and systematically recorded for the assessment of incidence.

Results and Discussion

The total of 42, 505 dogs presented to the veterinary hospitals during the study period, 2, 155 animals were initially suspected for various types of tumors. Of these, 422 dogs of varying ages, breeds, and sexes were diagnosed with malignant neoplasms, corresponding to an incidence of 0.99%. These 422 confirmed malignant cases were categorized into specific tumor types, including: skin tumors, mammary tumors, TVT, peri-anal tumors, oral tumors, liposarcoma, lymphoma, osteosarcoma, mesothelioma, sertoli cell tumor, melanoma, and transitional cell carcinoma with an incidence rate of 25.37% (107 dogs), 19.19% (81 dogs), 14.22% (60 dogs), 13.27% (56 dogs), 5.92% (25 dogs), 5.45% (23 dogs), 4.27% (18 dogs), 3.79% (16 dogs), 2.84% (12 dogs), 2.84% (12 dogs), 2.37% (10 dogs), and 0.47% (2 dogs), respectively (table 1 and figure 1). Skin tumors were identified as the most prevalent malignant neoplasms, followed by mammary gland tumors. These findings are consistent with the reports of Salas *et al.* (2015) [17] who noted that mammary tumors represent the second most frequently diagnosed neoplasms in dogs, comprising approximately 25-50% of all tumor cases. Similarly, Kumar V V V A and Kumar K S (2023) stated that among the 458 dogs diagnosed with neoplasia, dogs affected with malignant mammary tumours incidence were 22.27% (102 dogs).

In the current study, the incidence of canine mammary carcinoma was predominantly observed in the age group between 6 to 10 years (54 dogs) followed by >10 years (21 dogs) and lowest in the age group of 0-5 years (6 dogs) with 66.67%, 25.92% and 7.41%, respectively (table 2 and figure 2). The present findings align with those of Nosalova *et al.* (2024) [11] reviewed that canine mammary tumor usually occurs in middle-aged and elderly dogs between 8-10 years old. Similar observations were made by (Kumar *et al.*, 2017 and Pastor *et al.*, 2018) [8, 13], who found a higher prevalence of mammary tumors in dogs aged between >5-10 years. Additionally, Devarathnam *et al.* (2021) [2] and Patel *et al.* (2019) [14] noted the highest incidence in the 7-9 year age group, while Esteves *et al.* (2022) [3] indicated that these tumors are more common in middle-aged to older female dogs, particularly between 8-10 years of age. In contrast, Kumar and Parasar (2020) [6] reported the lowest incidence in dogs aged 0-3 years. The increased occurrence of mammary tumors with advancing age may be attributed to hormonal influences, particularly estrogen and progesterone, as well as age-related physiological changes. These include the gradual accumulation of tumorigenic factors, decline in immune surveillance, and the extended latency period between the initial malignant transformation of cells and the clinical manifestation of tumors, typically occurring in the latter third of the animal's lifespan (Sharma, 2007 and Devarathnam *et al.*, 2021) [18, 2].

Among the 81 dogs diagnosed with mammary carcinoma, the highest breed-wise incidence was observed 38.28% in Labrador Retriever (31 dogs) followed by 17.28% (14 dogs) in Pomeranian, 11.11% (9 dogs) in German Shepherd, 9.88% (8 dogs) in Beagle, 8.64% (7 dogs) in Golden Retriever, 6.17% (5 dogs) in Spitz, 3.70% (3 dogs) in Great Dane, while Dachshunds and Mongrels each accounted for 2.47% (2 dogs) (table 3 and figure 3). Comparable results were reported by Kavya *et al.* (2019) [4] who found that the highest incidence of mammary tumors occurred in Labrador Retrievers (40%), followed by German Shepherds (25%). Similarly, Mondal *et al.* (2023) [9] stated that breed wise incidence was highest in Labrador (36.67%), followed by German shepherd (20% each), Mongrel (10%), Dachshund (6.67%), Rottweiler and Beagle (3.33% each) affected with mammary carcinomas. Breed predisposition to mammary

tumors may vary depending on geographical location, as regional differences influence breed population dynamics, environmental exposure to carcinogens, dietary habits, and climatic conditions (Devarathnam *et al.*, 2021) [2].

In the present study, mammary carcinomas were exclusively observed in female dogs, accounting for 100% of the cases (81 dogs) (table 4 and figure 4). The findings of the present study align with those reported by Kavya *et al.* (2019) [4], Devarathnam *et al.* (2021) [2], Valdivia *et al.* (2021) [19] and Rokad *et al.* (2023) [16] who documented that mammary tumors predominantly occurred in female dogs, attributing this trend to hormonal influences, as such tumors are rarely observed in males. Similarly, the approximately 98% of mammary tumor cases were found in females, with only about 2% occurring in males (Patel *et al.*, 2019 and Krasnoslobodtsev *et al.*, 2020) [14, 5]. The higher prevalence in females could be associated with hormonal interactions, as evidenced by the presence of estrogen and progesterone receptors in neoplastic tissues, along with the expression of gastrin-releasing peptide receptors, which are indicative of growth-promoting stimuli (Arya *et al.*, 2018 and Vazquez *et al.*, 2023) [1, 20].

Spaying is considered a significant factor influencing the development of mammary tumors, with early spaying potentially reducing the risk of tumor occurrence. In the present study, the incidence of mammary carcinoma was notably lower in spayed dogs 11.11% (9 dogs) reported. In contrast, a higher incidence was observed in intact dogs, accounting for 88.89% (72 dogs) (table 5 and figure 5). The present findings are consistent with those reported by Moon *et al.* (2022) [10] stated that out of 60 dogs, 51 dogs (85.0%) were intact females and 9 dogs (15.0%) were spayed females affected with mammary gland tumors. According to Nunes *et al.* (2018) [12] and Zuchi *et al.* (2021) [21], spaying performed at an early age significantly reduces the risk of mammary tumor development, particularly when conducted before 2.5 years of age. The associated risk for developing mammary tumors was reported as 0.5% when spayed before the first estrous cycle, increasing to 8% and 26% if spaying was performed before the second and third cycles, respectively. The protective effect of ovariohysterectomy is most effective when conducted before the onset of the first estrus, with its efficacy declining notably thereafter. Pereira *et al.* (2013) [15] explained that estrogens may undergo epoxidation, leading to DNA damage and playing a role in the initiation of mammary carcinogenesis. Furthermore, Salas (2017) [17] emphasized that unspayed females face a higher risk due to the affinity of natural estrogens for mammary gland tissues.

Table 1: Incidence of different types of malignant tumors in dogs

Sl. No	Tumour type	Incidence	Percentage
1.	Skin tumors	107	25.37
2.	Mammary tumors	81	19.19
3.	TVT	60	14.22
4.	Peri-anal tumors	56	13.27
5.	Oral tumors	25	5.92
6.	Liposarcoma	23	5.45
7.	Lymphoma	18	4.27
8.	Osteosarcoma	16	3.79
9.	Mesothelioma	12	2.84
10.	Sertoli cell tumor	12	2.84
11.	Melanoma	10	2.37
12.	TCC	02	0.47
Total		422	100.00

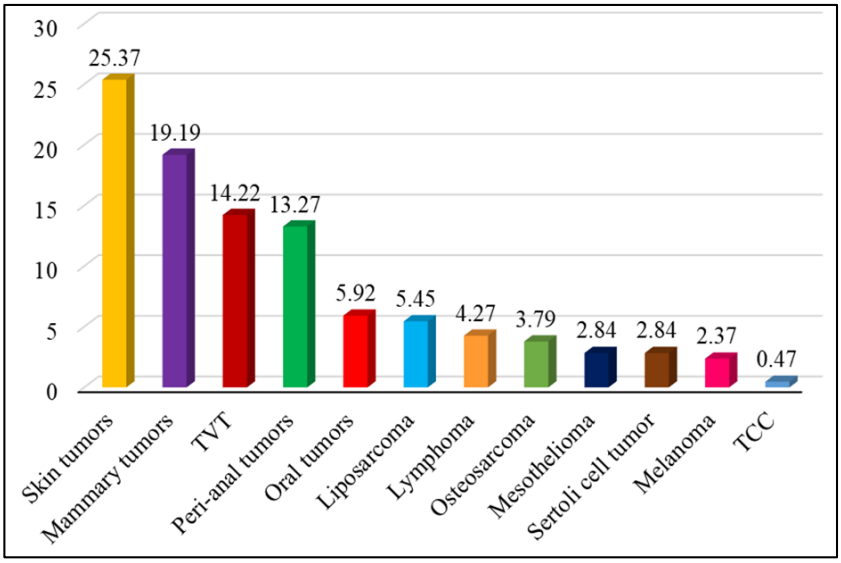

Fig 1: Incidence of different types of malignant tumors in dogs.

Table 2: Age-wise incidence of canine mammary carcinoma

Sl. No	Age group	Number of dogs	Percentage
1.	0-5 Years	6	07.41
2.	6-10 Years	54	66.67
3.	> 10 Years	21	25.92
Total		81	100.00

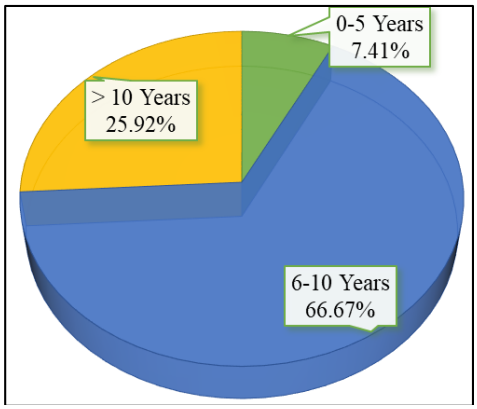

Fig 2: Age-wise incidence of canine mammary carcinoma.

Table 3: Breed-wise incidence of canine mammary carcinoma

Sl. No	Breed	Number of dogs	Percentage
1.	Labrador Retriever	31	38.28
2.	Pomeranian	14	17.28
3.	German Shepherd	09	11.11
4.	Beagle	08	09.88
5.	Golden Retriever	07	08.64
6.	Spitz	05	06.17
7.	Great Dane	03	03.70
8.	Dachshund	02	02.47
9.	Mongrel	02	02.47
Total		81	100.00

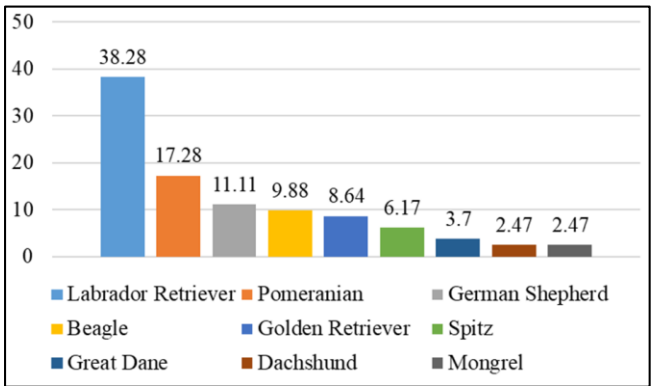

Fig 3: Breed-wise incidence of canine mammary carcinoma.

Table 4: Gender-wise incidence of canine mammary carcinoma

Sl. No	Gender	Number of dogs	Percentage
1.	Male	0	0.00
2.	Female	81	100.00
Total		81	100.00

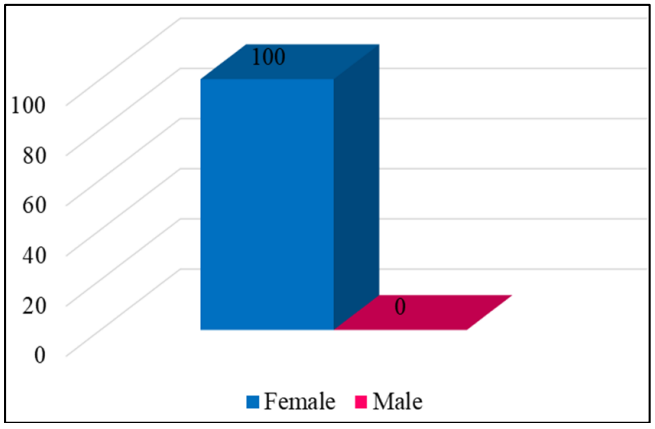

Fig 4: Gender-wise incidence of canine mammary carcinoma.

Table 5: Reproductive status in dogs with mammary carcinoma

Sl. No	Reproductive status	Number of dogs	Percentage
1.	Intact	72	88.89
2.	Spayed	09	11.11
Total		81	100.00

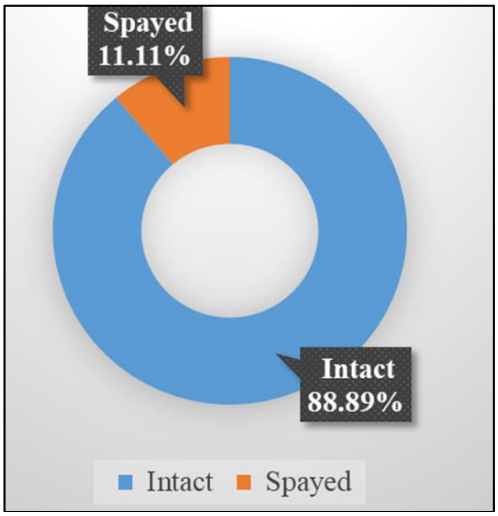

Fig 5: Reproductive status in dogs with mammary carcinoma.

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