Revista Veterinaria. 2023; 34(2): 36-47.
http://dx.doi.org/
Artículo Original

Revista Veterinaria
Facultad de Ciencias Veterinarias-UNNE
ISSN: 1668-4834 / ISSN-e: 1669-6840

Registry of canine neoplasias diagnosed at the Veterinary Practice Unit, Maza University, Argentina, 2006-2020

Caliri, M.N.[2]; Ferré, D.[1,2]; Palma Leotta, M.E.[2]; Gorla, N.B.[1,2*]

[1]CONICET. [2]Laboratorio de Genética, Ambiente y Reproducción, Facultad de Ciencias Veterinarias y Ambientales, Universidad Juan Agustín Maza (UMaza), acceso este, lateral sur 2245, Mendoza, Argentina. Tel. 54- 61-4056222, postal code: 5519. ✉noragorla@gmail.com

Abstract. This study aims to present the relative frequency of canine tumors diagnosed at a Veterinary Practice Unit, University service with regional scope, in the period 2006- 2020. A retrospective analysis was carried out based on the information extracted from the medical records. In total, 4500 clinical histories were consulted, among which 238 cases of canine tumors were diagnosed. Information about epidemiological aspects was recorded. Neoplasms were confirmed by histological or cytological analysis in 49% of the cases, which were mostly malignant (60%). In the canine population under study, the animals manifested tumors primarily between 9 and 10 years of age. The 49.5% of the animals with neoplasia were of purebreds, represented mostly by Argentinian Dogo with squamous cell carcinoma and hemangiosarcoma, and boxer with mast cell tumor and multicentric lymphoma, which suggests a predisposition of certain breeds to some type of neoplasms. The most common tumor was Transmissible Venereal Tumor TVT (16% of the total neoplasms), presented mainly in mixed breeds. Next in order of frequency, mast cell tumors and hemangiosarcoma (8.4% each), followed by squamous cell carcinoma (7.6%). The registration of animal tumors is important to delineate the behavior of cancer in the canine population and to provide data that can be compared with human ones, useful for identifying possible risk factors. This study constitutes a preliminary step to characterize and understand the occurrence of canine tumors in the region.

Key words: Dog, Tumor, Cancer Registry, Histopathology, Cytology, Epidemiology

Registro de neoplasias caninas diagnosticadas en la Unidad de Prácticas Veterinarias, Universidad Maza, Mendoza, Argentina, 2006-2020

Resumen

Este estudio tiene como objetivo presentar la frecuencia relativa de tumores caninos diagnosticados en una Unidad de Prácticas Veterinarias, servicio universitario de ámbito regional, en el periodo 2006- 2020. El análisis retrospectivo se realizó a partir de la información extraída de las historias clínicas, se consultaron 4500 en total, que evidenciaron 238 casos de tumores caninos. Se registró la información disponible acerca de aspectos epidemiológicos. Las neoplasias se confirmaron mediante análisis histológico o citológico en el 49% de los casos, los que en su mayoría fueron malignos (60%). En la población canina objeto de estudio, los animales manifestaron tumores principalmente entre los 9 y 10 años de edad. El 49,5% de los animales con neoplasia eran de raza pura, representados en su mayoría por Dogo Argentino con carcinoma de células escamosas y hemangiosarcoma, y bóxer con mastocitoma y linfoma multicéntrico, lo que sugiere una predisposición de ciertas razas a algún tipo de neoplasias. El tumor más frecuente fue el Tumor Venéreo Transmisible TVT (16% del total), presentado principalmente en mestizos. Le siguen en orden de frecuencia el mastocitoma y el hemangiosarcoma (8,4% cada uno), seguidos del carcinoma de células escamosas (7,6%). El registro de tumores en animales es importante para delinear el comportamiento del cáncer en la población canina y proporcionar datos que puedan compararse con los humanos, lo cual es útil para identificar posibles factores de riesgo. Este estudio constituye un paso preliminar para caracterizar y comprender la ocurrencia de tumores caninos en la región.

Palabras clave: Perro, Tumor, Registro de cáncer, Histopatología, Citología, Epidemiología.

Recibido: 17 febrero 2023. **Aceptado:** 15 julio 2023

INTRODUCTION

Cancer is common in canines and constitutes almost 50% of the causes of death in animals above 10 years of age. Over the world, most of the epidemiological oncology information on incidences and population frequencies comes from studies limited to patients in University veterinary hospitals, to records of biological samples received in pathology laboratories, or from animals registered in insurance companies. The first records of canine neoplasia started in the early 1960s (Brønden et al. 2007). In parallel, human cancer registries systematically collect and analyze data from hospitals and health centers on cancer types and frequency of presentation, and are considered a key component in the control of these diseases. There are 449 human registries in the world, covering data from 21% of the world's population. In veterinary medicine, registries are scarce, comprise short study periods and suffer from a lack of communication and collaboration from both veterinary professionals and animal owners (O'Neill et al. 2014). Our country is currently without a national registry of neoplasms in animals. The existence of provincial or regional registries is also unknown. The improvement in canine longevity, attributed to an enhanced quality of life, has led to a higher occurrence of geriatric diseases in general, with tumor-related conditions being especially prevalent. In parallel, the diagnosis and treatment of tumors in companion animals is becoming an increasingly important part of the small animal clinic (Zachary and Mc Gavin 2012). Veterinary cancer registries facilitate the identification of geographic disparities, the assessment of incidences, and the identification of high or low-risk animal groups. This, in turn, contributes significantly to the comprehension of neoplasm etiology. The data obtained from both human and animal cancer registries play a crucial role in comparative epidemiology, preventive medicine, the formulation of prevention and control strategies, as well as advancing pathogenic and therapeutic research.

Advances in comparative oncology have confirmed that dogs can serve as valuable models for the spontaneous development of cancer. This knowledge has mostly been obtained from experimental studies with induction of neoplasia, but geo-spatial analyses of canine cancer may also allow the detection of risk factors for human populations, as both species share their living environment. This approach could be of great relevance in reducing the incidence of cancer in humans, again highlighting the importance of canine cancer registries. However, spatial analyses comparing canine and human cancers are currently limited (Boo et al. 2018).

Cancer development is influenced by a multitude of factors, which can be categorized into two main groups: intrinsic factors that are unique to the individual animal, and extrinsic factors that are promoted by the environment (Benavente et al. 2016). In the former, there is a higher genetic tumor risk in an animal or groups of animals than in the rest of the population to which they belong. The age of the animal stands out, since, in general, the probabilities of developing tumors increase in animals older than 5 years (García et al. 2019). Nevertheless, certain specific types of tumors exhibit distinctive distribution patterns concerning age. For instance, lymphosarcoma or osteosarcoma may display a bimodal pattern, with an initial peak occurring at early ages and a second peak manifesting at more advanced ages (García et al. 2019). Thus, recording the age of neoplasm presentation proves to be invaluable in understanding such trends. Most authors agree that there are no significant differences with respect to sex, but that a higher proportion of affected females has been reported in some studies (Franco and Silva-Molano 2009, de Vivero et al. 2013). The genetic homogeneity of breed animals would represent a greater predisposition to develop neoplasms.

Extrinsic or environmental factors are particularly relevant because, due to the close contact between the animal and its owner, both share the air, soil and water components and their possible contaminants, and even partially their food. The identification of environmental factors that favor or trigger the development of tumors can be of great importance in the epidemiology of cancer in canines and humans (Dobson 2013). To date, the International Agency for Research on Cancer (IARC 2023) has confirmed the existence of 121 human carcinogens; of which canines could also be exposed due to the similarity in the living habits with their owners. Epidemiological studies on oncology are scarce in Latin American countries, the information is limited to undergraduate and graduate theses and abstracts presented at congresses. In the USA and Europe, the registration of animal tumors has been sporadic or are limited in their duration (O'Neill et al. 2014).

The list of environmental risk factors associated with cancers in canines and humans is extensive and includes various factors that have been found to contribute to the development of specific types of tumors. For example: Canine and human pulmonary mesothelioma have been linked to exposure to asbestos, with dogs also showing a correlation with the use of flea repellents; Wild boars with mesothelioma have been found to have asbestos fibers in their lungs due to geological characteristics in their grazing areas; Cancer of the nasal cavity and paranasal sinusoids in both pet canines and their owners has been associated with exposure to environmental tobacco smoke; The lawn application of various chemicals, such as fertilizers, herbicides, insecticides, insect growth regulators, fungicides, and rodent killers, has been connected to a significantly increased risk (70%) of developing canine malignant lymphoma; Military working dogs serving in Vietnam showed an elevated mortality rate from testicular seminoma, potentially due to exposure to pesticides (picloram, malathion), phenoxyacid herbicides (2, 4-D; 2, 4, 5 T), zoonotic diseases, and therapeutic agents, particularly tetracycline. A similar association was observed in military personnel; Soft tissue sarcomas in dogs have been linked to various exogenous factors, including parasites, radiation, trauma, and orthopedic implants, Organochlorine pesticides have been associated with gastrointestinal cancers in 900 beluga whales in the St. Lawrence Estuary, Canada, as they feed in the benthic zone with contaminated sediments, Dogs residing in areas of illegal dumping of high-hazard waste in the USA were found to have a statistically 2.4-fold increased risk of developing canine lymphoma (Gorla 2023). Gathering and understanding this information is essential for delineating the behavior of

cancer in the canine population and identifying potential risk factors. By recognizing these associations, researchers and veterinarians can take steps towards implementing preventive measures and devising appropriate treatment strategies to address these health concerns.

The aim of this study was to conduct a comprehensive survey and analysis of the types and frequency of canine tumors diagnosed at the University Veterinary Practice Unit (UPV), a regional service, spanning the period from 2006 to 2020.

MATERIALS AND METHODS

The UPV is a Veterinary hospital for educational purposes. The schedule of care is planned with shifts, without attending emergencies, and at no cost to the general public, except for complementary studies. A retrospective study was carried out based on the information extracted from the medical records of all the canines treated at the UPV, from the histopathological reports of neoplasm biopsies obtained during surgical procedures and from samples obtained in necropsies, received during the period from 2006 to 2020. From the medical records with a definitive diagnosis of neoplasia it was possible to extract data on sex, age at diagnosis, breed and the biological behavior of the tumors. Information on extrinsic data such as type of diet, type of habitat, medication is incomplete, so this information cannot be registered. In this study, all patients with confirmed neoplasia, established through cytological or histological examination, were included in the analysis. The classification employed aimed to ascertain the specific cell type responsible for the development of the neoplasm, along with considering macroscopic characteristics, location, and the degree of differentiation. Histologically characterized neoplasms were designated following the criteria outlined in the classification of tumors in domestic animals by the World Health Organization. The types of canine neoplasms were identified based on the classification provided by Meuten (2017) for tumors in domestic animals.

The complete and detailed data of all the cases analyzed are provided as supplementary material. Type and number of the most frequent neoplasias (≥3 cases per type) and the distribution of the most frequent neoplasia by breed (≥2 cases per type of neoplasia) are presented in Tables.

Statistical analysis. The frequency of each type of canine neoplasm was estimated in percentages over the total number of confirmed neoplasias. A hypothesis test was performed to compare the age at diagnosis between female and male canines (Graph Pad Prism 8.4.3). In order to investigate whether canine breeds were predisposed to any type of neoplasia, we observed which type of neoplasia was presented by two or more canines of the same breed.

RESULTS

During the years previously indicated in which the study took place, a total of 4,500 medical records were obtained and analyzed. Of the total number of patients, 10.7% had an initial presumptive diagnosis of neoplasia. Of these, 49% were confirmed by cytology or histopathology, the remaining 51% were diagnosed only by clinical examination with other complementary methods, such as imaging, blood count, blood biochemistry and/or urinalysis. And lastly, 5.3% of the patients with a presumptive diagnosis of neoplasia were substantiated. Type and number of the most frequent neoplasia (≥3 cases per type) in canines are included in Table 1. In total, sixty-two different types of neoplasms were reported (see supplementary material on page 44). In male dogs, the most frequently diagnosed neoplasms were tumors of the skin and subcutaneous (48%), genital tract (28%) and skeletal system (9.3%). In female dogs, tumors of the skin and subcutaneous (44%), mammary gland (18.4%), genital tract (18%) and hematopoietic cells (6.7%) were the most dominant. Malignant neoplasms (60%) were more frequent than neoplasms classified as benign (40%). More tumors were recorded in females (62%) than in males (38%). The mean ± standard deviation of the age at diagnosis in females (8.5 ± 3.5 years) and males (7.8 ± 4.4 years) did not differ significantly between the two groups.

Table 1. Type and number of the most frequent neoplasias (≥3 cases per type) in canines that were diagnosed at the Veterinary Practice Unit, regional University, 2006- 2020.

			Diagnostic study		Biological behavior		Sex		Breed		Age
Site of neoplasm	**Neoplasia**	**N**	C	HP	B	M[1]	M[2]	F	M[3]	P	(years)
Tumors of skin and subcutaneous	Squamous cell carcinoma	18	3	15		18	6	12	6	12	6.8±2.8
	Sebaceous adenoma	6	2	4	6		2	4	3	3	10.3±4.8
	Melanocytoma	4	2	2		4	3	1	2	2	11.7±3.7
	Fibrosarcoma	5	3	2		5	1	4	3	2	9±2.3
	Lipoma	16	8	8	16		5	11	9	7	9.3±3.4
	Hemangio-sarcoma	19	1	18		19	7	12	6	13	7.7±3.1
	Sarcoma of soft tissues	3	3			3	1	2	1	2	8±2.6
	Canine mast cell tumors	20	11	9		20	2	18	14	6	8.4±3.29

Tumors of hemolymphatic system	Lymphoma	13	11	2		13	2	11	5	8	6.5±3.9
Tumors of bone	Osteosarcoma	9	2	7		9	5	4	5	4	5±4.2
Tumors of genital system	Leydig cell tumor	4		4	4		4		1	3	10±2.9
	Seminoma	4		4	4		4		2	2	10±5.3
	TVT	38	37	1	38		11	27	34	4	4.8±3.1
Tumors of the mammary gland	Benign mixed tumor	7	1	6	7		1	6	1	6	10±3.7
	Adenocarcima	9	3	6		9	2	7	5	4	10±3.3
	Carcinoma – in situ	3	2	1		3		3	1	2	10±1.7

N: number of cases: C: cytology: HP: histopathology; B: benign; M1: malignant: M2: male; F: Female; M3: mixed breed; P: purebred. TVT: transmissible venereal tumor.

Neoplasms were recorded in 118 purebred dogs (49%) and in 120 mixed-breed dogs (51%). Distribution of the most frequent neoplasia by breed (≥2 cases per type of neoplasia) are presented in Table 2. In total, thirteen different types of neoplasms were reported in 18 breeds (see supplementary material on page 44). The most represented breeds were the Argentinian Dogo mainly with hemangiosarcoma; the boxer, with a higher number of mastocytomas, and the Rottweiler with lipoma and other tumors. Eight different types of neoplasms were exhibited by the boxer breed.

Table 2. Distribution of the most frequent neoplasia by breed (≥2 cases per type of neoplasia), in canines that were diagnosed at the Veterinary Practice Unit, regional University, 2006- 2020.

Neoplasia	**Breed**	**Number of cases**
Squamous cell carcinoma	Argentinian Dogo	6
	Mixed breed	5
	Cocker spaniel	2
Sebaceous adenoma	Mixed breed	3
Melanocytoma	Mixed breed	2
	Rottweiler	2
Fibrosarcoma	Mixed breed	3
Lipoma	Mixed breed	9
	Rottweiler	3
Hemangiosarcoma	Argentinian Dogo	8
	Mixed breed	6
	Rottweiler	2
Mast cell tumors	Boxer	8
	Mixed breed	7
	Labrador retriever	2
Multicentric Lymphoma	Mixed breed	5
	Boxer	4
Osteosarcoma	Mixed breed	5
	Bull mastiff	2
Seminoma	Mixed breed	2
TVT	Mixed breed	34
	German shepherd	2
Benign mixed tumor	Mixed breed	2
	Boxer	2
Mammary adenocarcinoma	Mixed breed	5

DISCUSSION

In the fifteen years covered by the present study, 5.3% of the canine patients attended had a definitive diagnosis of neoplasia. This number is lower compared to that reported in a University Hospital in Lima (Peru), where a rate of 24.60% was observed among a similar total of clinical records over an 11-year period (de Vivero et al. 2013). Another study shows an estimated incidence of tumors in canines of 1.23/1000 in the municipality of Toluca (Mexico) and 3.71/1000 in an Italian county (Merlo et al. 2008). Although the data obtained may not fully represent the general population of dogs in our city, they allow an estimation of the casuistry to describe the general characteristics of the distribution of cancer in canines, in terms of types of neoplasms, breed, sex and age. In our country, the only survey of neoplasms in canines that we have found is limited to canines with lymphoma, during 5 years from 2012, with 96 cases out of 2597 cytological studies (De la Torre 2017). The author reports a prevalence of 3.70% for lymphomas in the total cytological studies, which is significantly lower than the 15.6% we observed in our study combining cytological and histological examinations.

According to the IARC, the occurrence of cancer and subsequent mortality is rapidly and progressively increasing in the human population worldwide, and the same trend is observed among companion animals. It is well known that cancer registries are the key tool for cancer surveillance. In this regard, the Global Initiative for Veterinary Cancer Surveillance (GIVCS) and the Veterinary Medical Database (VMDB), initiated by the National Cancer Institute, are of extreme significance. At the moment they gather data obtained from 26 North American teaching hospitals with a total of 7 million records (Paynter et al. 2021). The VMDB data is currently coded according to the International Classification of Diseases for Oncology used in human cancer registries (WHO 2013), which facilitates the exchange of comparable data and the possibility of multicenter studies.

To contextualize the importance of the present study, it should be noted that ours is the only Veterinary University in the region, situated the 4th largest city in our country in terms of population. It would be optimal to have an overall estimate of the number and type of neoplasms with respect to the total number of canine diseases, and to estimate a possible association with risk factors. For this reason, it is necessary, in addition to the biological data of the animal, to collect epidemiological data in the anamnesis, such as type of food, origin of drinking water, habitat, chronic consumption of medication and presentation of any other types of pathologies. Additional information required includes whether the animals have lived with people who have suffered from cancer and the specific type of cancer, their residence in areas with known water or atmospheric contamination, or proximity to industries, among other data. Unfortunately, we do not have access to this information at present, but based on the findings of this study, we will ensure its collection in future anamnesis.

It is difficult to compare the results obtained with similar ones from other latitudes because most scientific reports of this type estimate frequencies or incidences using partial populations of dogs, either from clinics and hospitals or from insurance companies (the latter is almost non existent in our country). In addition, there are no prevalence reports that consider the total population of dogs (sick plus healthy) in a city or town. To outline the estimated annual incidence rate (IR) per 100,000 dogs for all tumors we refer to some articles that have collected incidences of canine cancer. An IR of 748 in the UK (1997-1998), 381 in California (1963-1966), 850 in Ontario (1999); 2671 cases in UK (Dobson et al. 2002); 310 and 958 in two Italian studies (Merlo et al. 2008); 695 cases per 100,000 in Switzerland, 282 for northern Italy, 500 for Sweden and 1416 in Tulsa (USA) (Grüntzig et al. 2015). In Latin America, we have found a study in Uruguay that lasted for 6 years, with a calculated ratio of 2.11 (Elgue et al. 2012). Another study, this time from the National University of Colombia, between the years of 1975 to 2007 which had 4676 canine cases of either necropsies or histopathology, 1692 of them corresponded to neoplasms (González Paya 2010). Brazil has created the first Animal Cancer Registry in South America in Sao Paulo, the most populated city in the country, and therefore with excellent potential for comparative epidemiological investigations with studies involving canines as sentinels of environmental contamination (Tedardi et al. 2015).

The most frequently detected neoplasms in the present study in both males and females were skin and subcutaneous tumors. This coincides with that reported in a study conducted in another province with only 99 total cases (Dubarry et al. 2000). It has been established that skin, mammary gland, hematopoietic, digestive, respiratory and reproductive tract tumors are the most frequent, supported by data generated in countries such as Denmark, Switzerland and Korea (Brønden et al. 2007, Grüntzig et al. 2015, de Araújo Viana et al. 2019). The same studies confirm that the mammary gland is the second most affected organ with regard to tumors. The skin (43%) and the female reproductive system, including mammary tissue (28%), were the most common location of neoplasms found in a study between 2005 to 2008, in the 1878 cases of canine neoplasms as detailed in the Danish Veterinary Cancer Registry (Brønden et al. 2007), in addition to a report by Noury et al. (2020) in Morocco with 46.4% and 25.9% of cases respectively.

In a retrospective, cross-sectional epidemiological study of 292 tumors in dogs diagnosed by histopathology in Mexico during 14 years until 2016, skin tumors were the most frequent (59.0%), followed by those of the reproductive tract (16.3%), and mammary gland (12.5%) (García et al. 2019). Similar results were reported in another state of Mexico (Fajardo et al. 2013). In a study conducted in Peru, it was reported that during the period 2003-2015 based on a total of 2620 reports cases, mammary adenocarcinomas were the most frequent group of neoplasia followed by squamous cell carcinoma (Aco et al. 2020). This may be due in part to the fact that tumors of the mammary glands, genitalia, and skin are easier to recognize by physical examination as opposed to tumors in internal organs that require specific examinations such as radiographs, computed tomography, magnetic resonance

imaging, and/or ultrasonography (Merlo et al. 2008). An additional noteworthy observation is the high percentage of Transmissible Venereal Tumor (TVT) cases in mixed-breed dogs (as shown in Table 1), particularly among females. The same was reported by authors from Peru (de Vivero et al. 2013), and Uruguay, where TVT ranked 3rd. (Elgue et al. 2012). TVT is related to the abundance of free-roaming dogs as a reservoir of the disease. In contrast, in the United Kingdom it has been possible to reverse this situation, with no cases during the 20th century, due to population control policies (Strakova and Murchison 2014).

In terms of biological behavior, we observed a higher incidence of malignant tumors by histopathological diagnosis, as reported by other authors (Collazos Paz 2010, González Paya 2010). The most common malignant tumors reported in the literature were: adenocarcinomas (21%), mastocytomas (19%) and lymphomas (17%), as for benign tumors the most frequent were lipomas (24%), adenomas (22%) and histiocytomas (14%) (Brønden et al. 2007). In our study, regarding neoplasms, the most represented were canine mast cell (8.4%) hemangiosarcoma (7.9%), squamous cell carcinoma (7.6%), lymphoma (5.4%) and osteosarcomas and mammary adenocarcinomas (both 3.8%). As for benign tumors, TVT and lipomas (6.7%) were the most common.

Although the diagnosis and classification of tumors often requires multiple techniques, cytology and histopathology remain the most commonly used methods for diagnosis. The Swiss Canine Cancer Registry comprises 121,963 diagnostic records of dogs collected between 1955 and 2008, in which 63,214 (51.83%) animals with tumor lesions were diagnosed by microscopic analysis (Grüntzig et al. 2015). Sixty percent of the neoplasms in our study were confirmed by histopathology. Among the neoplasms in dogs seen at the Veterinary Hospital of Maranhão (Brazil) 2008-2015, the medical records of 1089 dogs affected by neoplasms were analyzed, of which 70% were confirmed by cytopathology (Ribeiro et al. 2020). Cytology is one of the most widely used diagnostic tools in veterinary pathology due to easy sampling, being minimally invasive, having rapid diagnosis and easy availability (Ranieri et al. 2013). For many tumors, cytology is as accurate as histopathology, can be used at the patient's side, and can provide samples for molecular studies (Meuten 2017). Cytologic evaluation can even replace biopsy, and if no treatments are considered to be performed or palliative measures are not a consideration, cytology can provide a final diagnosis for many solid tumors (Oikonomidis and Tsouloufi 2021) and most leukemias. Cytology can differentiate an inflammatory process from neoplastic lesions and indicate the possible cell type involved. Cytology alone should not be solely relied upon to establish a definitive diagnosis for many tumor types, nor can it be effectively used for their classification. Additional diagnostic methods, such as histopathology are often necessary to achieve a more accurate and comprehensive diagnosis. However, when combined with immunophenotyping techniques such as flow cytometry, it can be a powerful diagnostic tool, especially in lymphoid tumors and leukemias (Dobson 2019). On the other hand, histopathology offers the advantage of examining the morphological, structural, and cellular characteristics of tissues, allowing us to understand the biological behavior of tumors. It provides valuable information on the histological grade, degree of invasion of neoplastic cells, stage of neoplastic proliferation, degree of malignancy, and enables an approximate morphological classification, leading to a better prognosis and more appropriate treatment decisions. Immunohistochemistry (IHC) has now become a routine component of diagnostic evaluations in many parts of the world. However, it is yet to be widely adopted in our country. IHC facilitates the diagnosis of specific neoplasms that are difficult to differentiate with histopathology, such as lymphomas, which even admit immunocytochemistry, as well as diffuse mastocytomas (Spugnini et al. 2021). It is optimal to include IHC, fine needle aspiration, molecular and other ancillary tests in an integrated manner with all other available data (Meuten 2017).

To provide information on the possibility of breeds more susceptible to specific neoplasms, a similar proportion of purebreds and mixed breeds was observed. The boxer was represented in more types of neoplasms, together with the Argentinian Dogo and the German shepherd, followed by the Rottweiler. The boxer has been reported in other studies similar to ours as a very susceptible breed (de Vivero et al. 2013). In a study conducted in Sweden, the Boxer breed was among the 5 breeds with the highest mortality rates from tumors. Glioma and Mast cell tumor are the neoplasms that have been shown to have predisposition in this breed (Dobson 2013). In our study, there were 8 boxers with Mast cell tumor. Hemangiosarcoma has a higher presentation in German shepherds and boxers. Both breeds were also represented in our study for this tumor. In a study conducted in Uruguay, Rottweiler and boxer tended to have a higher proportion of cancers than others (Elgue et al. 2012). For mammary tumors, in a study conducted by Zatloukal et al. (2005), in the Czech Republic, they reported that the breeds with the highest incidence were Cocker Spaniel, Poodle and Dachshund, while in a study conducted only for this type of neoplasia, in our country, the breeds most diagnosed with this neoplasia were also the Cocker Spaniel, in addition to the Pekingese and the German shepherd (Benavente et al. 2016), We agree about Cocker Spaniel, although we observed five times more mestizos than purebred dogs for this neoplasia.

In general, it has been observed that purebred animals and those older than four years of age have a probability of developing tumors up to 70% higher than that of mixed-breed (mestizo) animals of a similar age (Vinueza et al. 2017). In our study, we detected the highest frequency of tumors in canines between 9 and 10 years of age (59.3%). It is stated that sex, age and breed are factors associated with the presence of cancer (Elgue et al. 2012). The occurrence of tumors was higher in females, although it did not appear to be due to any particular type of tumor. We do not know whether or not the females in the present study had their ovary and uterus glands or had been sterilized at a juvenile age. Other authors have hypothesized that the difference between sexes could be influenced by the high incidence of mammary tumors, since it is one of the most common tumors in females (Aco et al. 2020). This study represents a significant first step in establishing a registry of canine tumors in our country, providing valuable insights into the

occurrence of this disease. It is hoped that this study will stimulate the preparation of others, and serve as a reference in the areas of animal and human oncology. We believe that continuous efforts should be dedicated to evaluating the occurrence of regional tumors, contributing to a better understanding and management of this health concern.

Acknowledgements. This research was possible thanks to the financial support of Maza University UMAZA (Mendoza) and the National Council of Scientific and Technical Research CONICET (Argentina).

ORCID

Caliri M.N. https://orcid.org/0000-0003-2107-188X
Ferré, D.M. https://orcid.org/0000-0002-4052-1922
Palma Leotta M.E. https://orcid.org/0009-0002-3142-0174
Gorla N.B.M. https://orcid.org/0000-0002-8539-6061

REFERENCES

1. Aco R, Mamani J, Grandez R. Caracterización de las neoplasias caninas diagnosticadas por histopatología en el Laboratorio de Histología y Patología Veterinaria de la Universidad Peruana Cayetano Heredia: Periodo 2003-2015. *Rev Inv. Vet. Peru*. 2020; 31: 1-7.
2. Benavente M, Bianchi C, Aba M. Canine Mammary Tumors: Risk Factors, Prognosis and Treatments. *J Vet. Adv*. 2016; 6: 1291-1300.
3. Boo G, Leyk S, Brunsdon C, Graf R, Pospischil A, Fabrikant SI. The importance of regional models in assessing canine cancer incidences in Switzerland. *PLoS One*. 2018; 13: 1-16.
4. Brønden LB, Flagstad A, Kristensen AT. Veterinary cancer registries in companion animal cancer: A review. *Vet. Comp. Oncol*. 2007; 5: 133-144.
5. Collazos Paz, M. Estudio retrospectivo de las neoplasias de sistema nervioso central en caninos en el laboratorio de patología veterinaria de la Universidad Nacional de Colombia entre los años 1977 y 2009. Tesis de especialización. Universidad Nacional de Colombia. 2010
6. de Araújo Viana D, de Farias KM, Lopes CE, Miranda AM, Pacheco AC, Souza LP, de Oliveira DM, da Silva LDM. Retrospective survey of neoplastic disease in dogs. *Rev. Bras. Hig. Sanid. Anim.* 2019; 13: 48-67.
7. De la Torre F. Estudio retrospectivo de linfomas caninos diagnosticados por citología en el Servicio de Anatomía Patológica del Laboratorio de Patología Especial. Tesis de especialización. Universidad Nacional de La Plata (UNLP). 2017.
8. de Vivero EL, Chavera C, Perales C, Fernández C. Frecuencia de neoplasias caninas en Lima: estudio retrospectivo en el período 1995-2006. *Rev. Inv. Vet. Peru*. 2013; 24: 182-188.
9. Dobson JM, Samuel S, Milstein H, Rogers K, Wood JLN. Canine neoplasia in the UK: Estimates of incidence rates from a population of insured dogs. *J. Small. Anim. Pract.* 2002; 43: 240-246.
10. Dobson JM. Breed-Predispositions to Cancer in Pedigree Dogs. *ISRN Vet. Sci.* 2013; 1-23.
11. Dobson JM. Significant advances in veterinary oncology – 60 years on. *J Small. Anim. Pract.* 2019; 60: 711-722.
12. Dubarry JR, Alvarez AR, Errea A, Vera OA, Adagio LM, D'amico G, Hierro JL. Neoplasias caninas diagnosticadas en General Pico, La Pampa: un estudio retrospectivo de 10 años. *Anuario Fac. Cias. Vet.* 2000; 2: 78-85.
13. Elgue V, Piaggio J, Amaral C, Pessina P. Factores asociados a la presentación del tipo de cáncer en caninos atendidos en el Hospital de la Facultad de Veterinaria de Uruguay. *Veterinaria*. 2012; 48: 25-30.
14. Fajardo R, Alpízar A, Pérez L, Martínez J, Córdova E. Prevalence of tumors in dogs from the municipality of Toluca, México, from 2002 to 2008. *Arch. Med. Vet*. 2013. 45: 305-309.
15. Franco LF, Silva-Molano RF. Frecuencia de presentación de la casuística atendida en el área de clínica quirúrgica del Hospital Veterinario de la Universidad de Caldas (2002-2004). *Rev Med Vet Zoot*. 2009; 3: 51-55.
16. García E, Alpízar A, Fajardo R, Córdova D, Perez L, Martínez S. Epidemiology of tumors in dogs in the capital of the state of Mexico from 2002-2016. *Arq. Bras. Med. Vet. Zootec*. 2019; 71: 1085-1092.
17. González Paya, G. Estudio retrospectivo de las neoplasias hepáticas en caninos en el laboratorio de patología veterinaria de la Universidad Nacional de Colombia entre los años 1975 y 2007. Tesis de especialización. Universidad Nacional de Colombia. 2010
18. Gorla NBM. Los animales centinelas son mucho más que un faro vigía, Cap. 1 en: Ferré DM y Gorla NBM. De relaciones tóxicas a un vínculo amoroso: el ambiente, los animales y nosotros. Mendoza: Editorial de la Universidad Nacional de Cuyo. 2023. p. 21- 46.
19. Grüntzig K, Graf R, Hässig M, Welle M, Meier D, Lott G, Erni D, Schenker NS, Guscetti F, Boo G, Axhausen K, Fabrikant S, Folkers G, Pospischil A. The Swiss Canine Cancer Registry: A Retrospective Study on the Occurrence of Tumours in Dogs in Switzerland from 1955 to 2008. *J. Comp. Pathol*. 2015; 152: 161-171.
20. International Agency for Research on Cancer. Iarc monographs on the identification of carcinogenic hazards to humans. Last update 2023. monographs.iarc.who.int/agents-classified-by-the-iarc/
21. Merlo D, Rossi L, Pellegrino C, Ceppi M, Cardellino U, Capurro C, Ratto A, Sambucco P, Sestito V, Tanara G and Bocchini V. Cancer Incidence in Pet Dogs: Findings of the Animal Tumor Registry of Genoa, Italy. *J. Vet. Intern. Med*. 2008; 22: 976-984.
22. Meuten DJ. Tumors in domestic animals. 5th ed. North Carolina: John Wiley & Sons. North Carolina. 2017.
23. Noury S, Bouayad H, Tligui N, Azrib R. A restrospective study on frequency of canine tumors at the veterinary teaching Hospital in Tabat (Morocco) Moroccan. *J. Agric. Sci*. 2020; 1: 34-38.

24. Oikonomidis I, Tsouloufi T. Diagnostic accuracy of cytology for canine osteosarcoma compared to histopathology. *Vet. evid*. 2021. 6: 1-11.
25. O'Neill DG, Church DB, Mc Greevy PD, Thomson PC, Brodbelt DC. Approaches to canine health surveillance. *Canine Genet. Epidemiol*. 2014; 1:1-13.
26. Paynter AN, Dunbar MD, Creevy KE, Ruple A. Veterinary Big Data: When Data Goes to the Dogs. *Animals*. 2021; 11: 1-10.
27. Ranieri G, Gadaleta CD, Patruno R, Zizzo N, Daidone MG. A model of study for human cancer: Spontaneous occurring tumors in dogs. Biological features and translation for new anticancer therapies. *Crit. Rev. Oncol/Hematol*. 2013; 88: 187-197.
28. Ribeiro TA, Ferreira VR, Mondêgo-Oliveira R, Andrade FH, Abreu-Silva AL, Oliveira IS, Araújo Melo S, da Silva Teófilo T, Oliveira Torres MA. Epidemiological profile of canine neoplasms in São Luís/MA: a retrospective study (2008-2015). *Res. Soc. Develop*. 2020; 9: 1-13.
29. Spugnini EP, Menicagli F, Giaconella R, Zanni F, Camponi C, De Luca A, Santoro A, Baldi A. Filling the gap between histology and cytology: Description of an innovative technology (Cytomatrix) to increase the diagnostic effectiveness of fine needle aspirates data. *J. Clin. Pathol*. 2021; 74: 269-270.
30. Strakova A, Murchison EP. The changing global distribution and prevalence of canine transmissible venereal tumour. *BMC Vet. Res*. 2014; 10: 1-10.
31. Tedardi MV, Veneziano DB, Kimura KC, Pedra-Mendonça P, Veneziano DB, Kimura KC, Pedra- Mendonça P, Biondi LR, Grandi F, Latorre Mdo R, Dagli ML. Sao Paulo Animal Cancer Registry, the first in Latin America: Animal Cancer Registry - Sao Paulo. *Vet. Comp. Oncol*. 2015; 13: 154-155.
32. Vinueza RL, Cabrera F, Donoso L, Pérez J, Díaz R. 2017. Frecuencia de Neoplasias en Caninos en Quito, Ecuador. *Rev. Inv. Vet. Peru*. 2017; 28: 92-100.
33. WHO (World Health Organization) International Classification of diseases for Oncology, 3rd ed. Geneva: Who press. 2013.
34. Zachary JF, Mc Gavin MD. 2012. Pathologic Basis of Veterinary Disease, 5th ed. Elsevier, Missouri.
35. Zatloukal J, Lorenzova J, Tichý F, Nečas A, Kecova H, Kohout P. Breed and age as risk factors for canine mammary tumours. *Acta Vet. Brno*. 2005: 74: 103-109.

Citación recomendada
Caliri MN, Ferré D, Palma Leotta ME, Gorla NB. Registry of canine neoplasias diagnosed at the Veterinary Practice Unit, Maza University, Argentina, 2006-2020. *Rev. Vet*. 2023; 34(2): 36-47. doi: hftp://dx.doi.org/

Supplementary material

Type and number of total neoplasms in canines that were diagnosed at the Veterinary Practice Unit, Universidad Juan Agustín Maza, Mendoza, Argentina, 2006- 2020.

Site of neoplasm	Type	n	Diagnostic study		Biological behavior		Sex		Breed		Age (years. $\overline{X}$±SD)
			C	HP	B	M	M	F	M	P	
Tumors of skin and subcutaneous	Basal cell neoplasm	1		1		1	1		1		7±0
	Papilloma	1		1	1		1			1	3±0
	Basosquamous carcinoma	2		2		2	1	1		2	9±0
	Carcinoma in situ	2		2		2	1	1		2	9±0
	Squamous cell carcinoma	18	3	15		18	6	12	6	12	6.8±2.8
	Infundibular keratinizing acanthoma	1		1	1			1		1	3±0
	Sebaceous adenoma	6	2	4	6		2	4	3	3	10.3±4.8
	Sebaceous epithelioma	1		1	1		1			1	9±0
	Apocrine carcinoma	1		1		1	1			1	9±0
	Hepatoid gland adenoma/circumanal adenoma	2	1	1	2		1	1		2	6±1.1
	Melanocytoma	4	2	2		4	3	1	2	2	11.7±3.7
	Fibroma	1		1	1		1		1		10±0
	Fibrosarcoma	5	3	2		5	1	4	3	2	9±2.3
	Hemangiopericytoma	2		2		2		2	2		10±0
	Lipoma	16	8	8	16		5	11	9	7	9.3±3.4
	Hemangioma	1		1	1			1		1	8±0
	Hemangiosarcoma	19	1	18		19	7	12	6	13	7.7±3.1
	Sarcoma of soft tissues	3	3			3	1	2	1	2	8±2.6
	Cutaneous lymphoma	2	1	1		2	1	1	1	1	6.5±0.7
	Canine mast cell tumors	20	11	9		20	2	18	14	6	8.4±3.3
Tumors of hemolymphatic system	Multicentric Lymphoma	13	11	2		13	2	11	5	8	6.5±3.9
	Digestive Lymphoma	1		1		1	1		1		1±0
	Mediastinal Lymphoma	1	1			1		1	1		1±0
	Splenic hemangioma	1		1	1			1	1		1±0
	Splenichemangiosarcoma	1		1		1		1		1	1±0

Tumors of the bone	Osteo-sarcoma	9	2	7		9	5	4	5	4	5±4.2
	Chondroma	2		2	2		1		1		8±0
	Chondrosarcoma	1		1		1	1		1		8±0
Tumors of the	Bronchioloalveolar adenocarcinoma	2		2		2		2	1	1	11.5±2.1
Respiratory tract	Nasal polyps	2		2	2		1	1	1	1	11±1.1
Tumors -of the Alimentary tract	Rectal adenocarcinoma	1	1			1		1		1	7±0
Tumors of the liver and gallbladder	Hepatocellular carcinoma	1		1		1	1			1	5±0
	Hemangiosarcoma	1		1		1		1	1		7±0
Tumors of the genital	Papillary cystadenoma	2		2	2			2	2		10±2.8
systems	Dysgerminoma	1		1	1			1	1		2±0
	Sertoli cell tumors	2		2	2		2		1	1	8±1.4
	Leydig cell tumor	4		4	4		4		1	3	10±2.9
	Seminoma	4		4	4		4		2	2	10±5.3
	Vaginal Polyps	1		1	1			1		1	7±0
	TVT (trans-missible venereal tumor)	38	37	1	38		11	27	34	4	4.8±3.1
Tumors of the mammary gland	Benign mixed tumor	7	1	6	7		1	6	1	6	10±3.7
	Adenoma simple	1		1	1			1		1	6±0
	Complex adenoma	1		1	1			1		1	7±0
	Adenocarcima	9	3	6		9	2	7	5	4	10±3.3
	Papillary carcinoma	1		1		1		1		1	12±0
	Carcinoma – in situ	3	2	1		3		3	1	2	10±1.7
	Squamous cell carcinoma	2		2		2		2	1	1	9.5±3.5
	Carcinoma – mixed type	1		1		1		1		1	9±0
	Carcinoma – complex type	3		3		3		3	2	1	12±5.3
	Basal cell carcinoma	1		1		1		1		1	5±0
	Mucinous carcinoma	1		1		1	1	1		2	7±4.2
	Inflammatory carcinoma*	2		2		2		2		2	8±0
	Fibrosarcoma	1		1		1		1		1	12±0
	Cortical adrenal carcinoma	1		1		1		1		1	5±0
	Thyroid carcinoma	2	1	1		2		2	1	1	12±0
Tumors of the nervous system	Carcinoma Neuroendocrine	1		1		1	1	1		1	8±0
	Neurofibrosarcoma	1		1		1				1	2±0
	Astrocytoma	1		1		1		1		1	0

Tumors of the eye	Ocular melanocytoma	1	1			1	1		1		10.5±2.1
	Meibomian adenoma	1		1	1			1		1	9±0
Tumors of theear	Ceruminous adenocarcinoma	1		1		1		1		1	9±0
Total	62	238	95	143	96	142	75	163	120	118	

Distribution of the most common neoplasm by breed, in canines that were diagnosed at the Veterinary Practice Unit, Universidad Juan Agustín Maza, Mendoza, Argentina, 2006- 2020.

Neoplasm	Breed	Number of canines
Squamous cell carcinoma	Argentinian Dogo	6
	Mixedbreed	5
	Cockerspaniel	2
	Rottweiler	1
	German shepherd	1
	Labrador retriever	1
	Dobermann	1
	Poodle	1
Sebaceous adenoma	Mixedbreed	3
	Cockerspaniel	1
	Yorkshire	1
	Boxer	1
Melanocytoma	Mixedbreed	2
	Rottweiler	2
Fibrosarcoma	Mixedbreed	3
	Boxer	1
	Cockerspaniel	1
Lipoma	Mixedbreed	9
	Rottweiler	3
	Poodle	1
	German shepherd	1
	Dobermann	1
	Collie	1
Hemangiosarcoma	Argentinian Dogo	8
	Mixedbreed	6
	Rottweiler	2
	German shepherd	1
	Boxer	1
	American pitbull terrier	1
Mastcelltumors	Boxer	8
	Mixedbreed	7
	Labrador retriever	2
	American pitbull terrier	1
	Pekingese	1
	Argentinian Dogo	1

MulticentricLymphoma	Mixedbreed	5
	Boxer	4
	German shepherd	1
	Pointer	1
	Argentinian Dogo	1
	Dobermann	1
Osteosarcoma	Mixedbreed	5
	Bullmastiff	2
	Rottweiler	1
	Dogue de Bordeaux	1
Seminoma	Mixedbreed	2
	English setter	1
	Weimaraner	1
TVT	Mixedbreed	34
	German shepherd	2
	Syberia nhusky	1
	Boxer	1
Benign mixed tumor	Mixedbreed	2
	Boxer	2
	Argentinian Dogo	1
	Pointer	1
	Poodle	1
Mammary adenocarcinoma	Mixedbreed	5
	Argentinian Dogo	1
	Poodle	1
	German shepherd	1
	Cocker spaniel	1