**University of Veterinary Medicine Budapest**

**Department of Clinical Pathology and Oncology**

# Canine Tumour Incidence Survey

Statistical survey of Canine Tumour incidences by owner's response, veterinarian's opinion and statistics of histopathological labs

# Kutyák daganatos megbetegedéseiről szóló felmérés

Statisztikai felmérés a kutyák daganatos megbetegedéseiről a tulajdonosok válaszai, az állatorvos véleménye és a szövettani laboratóriumok statisztikái alapján

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## Abstract

Cancer is one of the most significant health problems in companion animals, particularly in dogs, where it is a leading cause of death and a growing concern in veterinary medicine. Canine tumours share many biological and environmental similarities with human cancers, making dogs valuable models for comparative oncology. Previous studies have highlighted variations in tumour incidence based on breed, age, sex, and geographic location, but cross-country data integrating multiple perspectives remain limited.

The aim of this study was to investigate and compare the incidence and characteristics of canine tumours in Switzerland and Hungary using three complementary data sources: questionnaires completed by dog owners, surveys conducted by veterinarians, and histopathological laboratory records. The questionnaires were designed in collaboration with Prof. Dr. Peter Vajdovich and Prof. Zolt Abonyi-Tóth and distributed between 2024 and 2025. A total of 47 responses were collected from owners in Switzerland and 70 from Hungary, along with limited veterinary data from one clinic in each country.

Descriptive statistical analyses were performed to evaluate tumour incidence, tumour type (benign or malignant), affected body parts, and mortality rates. The results revealed notable differences in the incidence of reported tumours between the two countries, which may reflect variations in the canine population, reporting practices, and level of awareness among owners and veterinarians. Although veterinarian participation was limited, the study provides a valuable initial dataset for future comparative research in oncology.

This study highlights the importance of integrating data provided by owners, veterinarians, and laboratories to gain a more comprehensive understanding of canine tumour epidemiology. The results provide foundational information that can support future studies, improve awareness among dog owners, and enhance veterinary diagnostic and reporting practices in both countries.

## Absztrakt

A rák az egyik legjelentősebb egészségügyi probléma a háziállatoknál, különösen a kutyáknál, ahol a vezető halálokok közé tartozik, és egyre nagyobb aggodalomra ad okot az állatgyógyászatban. A kutyák daganatai számos biológiai és környezeti hasonlóságot mutatnak az emberi rákos megbetegedésekkel, így a kutyák értékes modellek az összehasonlító onkológiában. Korábbi tanulmányok rávilágítottak a daganatok előfordulásának eltéréseire a fajta, az életkor, a nem és a földrajzi elhelyezkedés alapján, de a több perspektívát integráló, országokon átívelő adatok továbbra is korlátozottak.

A tanulmány célja a kutyák daganatainak előfordulásának és jellemzőinek vizsgálata és összehasonlítása Svájcban és Magyarországon három egymást kiegészítő adatforrás felhasználásával: kutyatulajdonosok által kitöltött kérdőívek, állatorvosok által végzett felmérések és hisztopatológiai laboratóriumi feljegyzések. A kérdőíveket Dr. Peter Vajdovich professzorral és Abonyi-Tóth Zolt professzorral együttműködve tervezték, és 2024 és 2025 között terjesztették. Összesen 47 svájci és 70 magyar tulajdonos válaszát gyűjtötték össze, valamint korlátozott számú állatorvosi adatot gyűjtöttek mindkét országban egy-egy klinikáról.

Leíró statisztikai elemzéseket végeztek a daganatok előfordulásának, típusának (jóindulatú vagy rosszindulatú), az érintett testrészeknek és a halálozási arányoknak az értékelésére. Az eredmények jelentős különbségeket mutattak a jelentett daganatok előfordulásában a két ország között, ami tükrözheti a kutyapopuláció, a jelentési gyakorlatok, valamint a tulajdonosok és az állatorvosok tudatossági szintjének eltéréseit. Bár az állatorvosok részvétele korlátozott volt, a tanulmány értékes kezdeti adatkészletet biztosít a jövőbeli összehasonlító onkológiai kutatásokhoz.

Ez a tanulmány kiemeli a tulajdonosok, állatorvosok és laboratóriumok által szolgáltatott adatok integrálásának fontosságát a kutyák daganatos megbetegedéseinek epidemiológiájának átfogóbb megértése érdekében. Az eredmények alapvető információkat szolgáltatnak, amelyek támogathatják a jövőbeli tanulmányokat, növelhetik a kutyatulajdonosok tudatosságát, valamint javíthatják az állatorvosi diagnosztikai és jelentési gyakorlatokat mindkét országban.

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# 1. Introduction

Neoplasia refers to the abnormal and uncontrolled growth of cells or tissues within the body, leading to the formation of tumours [1]. These growths are generally classified as benign or malignant, based on their biological behaviour. Benign tumours grow slowly, remain localized, and do not invade surrounding tissues, whereas malignant tumours proliferate rapidly, infiltrate adjacent structures, and often metastasize to distant organs. Malignant neoplasia, commonly known as cancer, is therefore one of the most serious and challenging disease to treat in both human and veterinary medicine.

All types of cancer are multifactorial [2]. At the cellular level, cancer arises through a series of complex biological processes. It is characterized by sustained cell proliferation, evasion of apoptosis (programmed cell death), the ability to induce angiogenesis (formation of new blood vessels), and the capacity to invade tissues and metastasize. These characteristics are determined by genetic mutations that alter normal regulatory mechanisms. Mutations affecting proto-oncogenes – genes that normally regulate cell growth, signalling, and differentiation – can transform them into oncogenes, promoting uncontrolled cell division and tumour development. The process of tumorigenesis typically involves the sequential accumulation of multiple genetic mutations that together result in the characteristic hallmarks of cancer: increased sensitivity to growth signals, resistance to anti-growth signals, evasion of apoptosis, unlimited replicative potential, sustained angiogenesis, and the ability to invade and metastasize [3].

Cancer has become a central topic in veterinary medicine due to its high prevalence, clinical importance, and emotional impact on pet owners. Among companion animals, dogs and cats are the species most frequently affected by neoplastic diseases, with dogs being particularly susceptible [4].

According to the Veterinary Cancer Society, cancer is the leading cause of death in approximately 47% of dogs over the age of ten [5], and it is estimated that one in four dogs [6] will develop some form of neoplasia during their lifetime. This high incidence is very similar to that seen in humans, reflecting common environmental exposures and lifestyle factors [6].

Dogs occupy a unique position among animal species, as they share the human living environment more closely than any other companion animal, being exposed to similar diets,

lifestyles, and household settings. Advances in veterinary care, nutrition, and preventive medicine have contributed to extending the lifespan of dogs, allowing them to live longer, healthier lives. However, this increased longevity has also led to a higher incidence of age-related diseases, including cancer [6].

Epidemiological data indicate that certain types of tumour are more common in dogs. Skin tumours account for about one-third of all neoplasms, with up to 20% being mast cell tumours, which can occur in the skin, spleen, liver, or bone marrow. Lymphoma accounts for about 24% of all canine cancers, while mammary gland tumours are the most common neoplasm in intact female dogs, about half of which are malignant. It is important to note that the risk of mammary tumours decreases dramatically when females are spayed before their first oestrus cycle [5]. Osteosarcoma, the most common primary bone tumour, accounts for approximately 85% of all skeletal neoplasms, while melanomas and hemangiosarcomas also occur with notable frequency, particularly in regions such as the oral cavity, spleen, and heart [7].

Breed predisposition plays an important role in canine oncology, as some breeds are at higher risk for specific types of tumours. For example, Schnauzers have a high incidence of squamous cell carcinoma (SCC), Rottweilers are more susceptible to malignant melanoma (MM) and osteosarcoma [8, 9] while Poodles, English Cocker Spaniels, and Dachshunds are more likely to develop mammary gland tumours [10].

The aim of this thesis is to conduct a comparative statistical survey on the canine tumour incidence in Switzerland and Hungary, using three complementary approaches: questionnaires distributed to dog owners and grooming salons, surveys conducted among veterinary clinics, and data collection from histopathological laboratories. By integrating and comparing of these data sources, the study seeks to identify similarities, discrepancies, and patterns in tumour incidence and reporting practices between the two countries.

This multi-perspective approach provides a comprehensive view of the current situation, offering insights into both professional awareness and public perception of canine cancer. The results should contribute to improving veterinary knowledge, enhancing owner education, and establish valuable epidemiological baseline data, thereby contributing to future research and advances in veterinary oncology.

This thesis is organized into several chapters. Following this introduction, the literature review provides an overview of existing research on canine tumours and relevant epidemiological findings. The chapter on materials and methods outlines the study design and data collection procedures, followed by sections on results and discussion, which present and interpret the findings. The thesis concludes with a summary, references, and acknowledgements.

# 2. Literature review

This chapter reviews current literature on the incidence, risk factors and classification of canine tumours, as well as methods used for their epidemiological assessment.

## 2.1. Biological Basis and Comparative Aspects of Neoplasia

**Definition and Classification of Neoplasia**: The term neoplasia refers to the abnormal and uncontrolled growth of cells or tissues within the body, leading to the formation of tumours [1]. The term *neoplasia* literally means "new, abnormal growth." Tumours are generally classified as benign or malignant, based on their biological behaviour. Benign neoplasms grow slowly, remain localized, and do not invade surrounding tissues. In contrast, malignant neoplasms grow more rapidly, infiltrate adjacent structures, and often metastasize to distant organs. The latter form, malignant neoplasia, is commonly referred to as cancer.

**Tumour Formation and Cancer Stem Cells**: The development of tumours involves a subset of specialized cells known as cancer stem cells (CSCs). These cells have the capacity for excessive self-renewal and continuous proliferation, behaving similarly to normal stem cells. CSCs evade apoptosis (programmed cell death), promote angiogenesis (formation of new blood vessels), and can effectively resist immune destruction. This makes the tumour mass resilient against conventional treatments such as chemotherapy and radiotherapy, as residual CSCs may survive, enabling cancer relapse and contributing to invasiveness and resistance to therapy [11].

While benign tumours originate from stem-like cells that later differentiate into mature tissue types and proliferate slowly, often causing compression without invasion, malignant tumours exhibit rapid growth, poor differentiation, and increased capacity for invasion and metastasis.

**Proto-oncogenes and Tumour Suppressor Genes**: At the genetic level, tumour formation is driven by alterations in two key gene groups: proto-oncogenes and tumour suppressor genes.

Proto-oncogenes are normal cellular genes that regulate essential functions such as cell signalling, proliferation, and differentiation. When mutated, they become oncogenes, promoting uncontrolled cell growth and contributing to tumorigenesis. Typically, tumour development requires the accumulation of five to six genetic mutations, which collectively lead to the so-called hallmarks of cancer, including increased sensitivity to growth stimuli, resistance to anti-growth signals, evasion of apoptosis, limitless replicative capacity, sustained angiogenesis, tissue invasion, and the ability to metastasize [3].

On the contrary, tumour suppressor genes act as the body's natural defence system against uncontrolled cell growth. They regulate cell cycle progression, proliferation, DNA repair, and apoptosis. When these genes are lost or inactivated, cells escape normal growth control mechanisms, significantly increasing the risk of neoplastic transformation [12].

**The Hallmarks of Cancer**: The progression of cancer is defined by several fundamental biological capabilities, often referred to as the hallmarks of cancer. These include:

1. Evading growth suppressors,
2. Activating invasion and metastasis,
3. Enabling replicative immortality,
4. Inducing angiogenesis,
5. Resisting cell death, and
6. Sustaining proliferative signalling [13]

Normal tissues maintain homeostasis through tightly regulated growth-promoting signals that control cell division and tissue architecture. Cancer cells, however, deregulate these pathways, allowing continuous proliferation even in the absence of external growth signals or despite anti-growth signals. This uncontrolled proliferation forms the basis of malignant behaviour.

**Cellular Behaviour of Benign and Malignant Tumours**: Under normal conditions, cells grow and divide in a controlled manner through four main phases of the cell cycle: $G_1$, S, $G_2$, and M. In malignant cells, this regulatory mechanism is disrupted, leading to accelerated and uncontrolled proliferation [14].

Malignant cells also exhibit metabolic abnormalities, relying heavily on glucose rather than oxygen for energy, consuming 5-10 times more glucose than normal cells and converting it into lactic acid. While benign tumours grow slowly and remain well-circumscribed, malignant tumours grow rapidly, invade adjacent tissues, and lose their normal differentiation. Tumour growth is strongly influenced by vascularization: poorly vascularized tumours tend to grow slowly or even regress, whereas malignant cells can secrete angiogenic factors to stimulate the formation of new blood vessels, supporting their rapid expansion [14].

A distinctive feature of malignancy lies in alterations to the cell membrane. In malignant cells, changes in surface receptors, enzyme activity, and carbohydrate composition disrupt normal signalling and cell adhesion. These changes reduce sensitivity to growth regulation, increase nutrient uptake, and promote invasion. Consequently, malignant cells lose contact inhibition and gain metabolic autonomy, allowing for uncontrolled proliferation and migration. In contrast, benign tumour cells maintain more stable membrane characteristics and partial responsiveness to regulatory mechanisms, thus limiting their growth potential [14].

**Comparative Oncology Perspective**: Comparative oncology, or the study of naturally occurring cancers across species, has demonstrated strong parallels between canine and human tumours. Dogs spontaneously develop cancers that closely mirror human neoplasms in their clinical presentation, histopathology, and molecular characteristics. Genomic studies have revealed common molecular features between canine and human cancers, making dogs useful models for cancer research. Due to limited genetic diversity and selective breeding, many purebred dogs show increased susceptibility to specific tumour types, providing natural models for hereditary cancer syndromes. For example, germline mutations in BRCA1/2 and TP53 genes have been identified in some dog breeds, mirroring the mutations responsible for hereditary breast/ovarian cancer and Li-Fraumeni syndrome[1] in humans [15].

[1] rare, inherited disorder that increases the risk of developing many types of cancer, often at an early age.

Furthermore, the shorter lifespan of dogs allow for faster evaluation of tumour progression and therapeutic responses compared to human studies.

**Shared Environmental and Genetic Risk Factors**: Environmental exposures also plays a key role in the development of cancer in both humans and dogs. Because dogs share their owners' living environments, they are exposed to many of the same environmental contaminants, including air, water, and soil pollutants, making them valuable indicators of environmental carcinogenesis. Epidemiological studies have linked exposure to lawn and garden herbicides (e.g. 2,4-dichlorophenoxyacetic acid) to an increased risk of lymphoma and urothelial carcinoma in dogs. Similarly, residence near industrial areas, chemical plants, or waste incinerators is related to a higher incidence of lymphoma and bladder cancer. Exposure to paints, solvents, heavy metals, and asbestos has also been linked to elevated cancer rates, paralleling patterns seen in human populations [16].

Airborne pollutants such as ozone, formaldehyde, and 1,3-butadiene have been linked to lymphoma, mammary, and urinary tract cancers, while drinking water contaminants, including chlorination by-products and industrial effluents, have been linked to bladder cancer in both dogs and humans. Exposure to tobacco smoke, although less pronounced in dogs, shows similar trends, particularly in long-nosed breeds, where passive smoking is linked to nasal and lung cancers. In addition, the use of indoor heating sources (e.g. coal or kerosene) and the storage of solvents in homes have been linked to nasal and respiratory cancers, mirroring occupational risks in humans [16].

Due to their shorter lifespan, dogs develop spontaneous cancers at an earlier age, allowing researchers to study environmental carcinogens and therapeutic outcomes more efficiently than in human populations. Their shared exposure to environmental factors, combined with the absence of certain human variables such as smoking or diet, makes dogs an useful model for exploring the environmental and genetic origins of cancer [16].

Additionally, some rare human cancers, such as osteosarcoma and hemangiosarcoma, are more common in dogs. This higher incidence allows for large-scale studies that can deepen our understanding of tumour biology and provide useful information for the development of new treatments relevant to both species [17].

## 2.2. Epidemiology of Canine Tumours

**Global Incidence and Prevalence**: Epidemiological studies on canine tumours have provided valuable insights into their global incidence, distribution, and risk factors. One of the first large-scale studies was conducted by the Animal Tumour Registry (ATR) in Genoa, Italy, which analysed 6'643 biopsy specimens submitted by local veterinarians between 1985 and 2002 (Table 1). Of these, 3'303 samples (48.9%) were confirmed as neoplastic, with mammary cancer representing the most frequently diagnosed malignant neoplasm in female dogs, accounting for approximately 70% of all cancer cases. The highest incidence rate (IR) was observed for mammary tumours, and the incidence of cancer increased progressively with age. Overall, female dogs showed a threefold higher incidence compared to males [18].

*Table 1 Canine Tumour from ATR*

| Age Group (years) | Cancers | | | | | Noncancers | | Canine Population | |
|---|---|---|---|---|---|---|---|---|---|
| | Males | | Females | | Total | Total | | Males | Females |
| | No. | % | No. | % | No. | No. | % | Dog-Years | |
| 0–3 | 65 | 5.7 | 67 | 3.1 | 132 | 389 | 11.3 | 393,134 | 281,983 |
| >3–5 | 80 | 7.0 | 130 | 6.0 | 210 | 355 | 10.3 | 175,938 | 123,249 |
| >5–7 | 142 | 12.4 | 285 | 13.2 | 427 | 533 | 15.5 | 156,658 | 108,066 |
| >7–9 | 263 | 23.0 | 550 | 25.5 | 813 | 844 | 24.5 | 132,699 | 90,489 |
| >9–11 | 250 | 21.9 | 544 | 25.2 | 794 | 664 | 19.3 | 105,212 | 71,279 |
| >11 | 342 | 30.0 | 585 | 27.1 | 927 | 655 | 19.0 | 185,925 | 119,028 |
| Total | 1,142 | 100 | 2,161 | 100 | 3,303 | 3,440 | 100 | 1,149,566 | 794,094 |

*1 Copyright Wiley Online Library, Inc.; Image by Domenico Franco Merlo. Republished with permission. https://onlinelibrary.wiley.com/doi/10.1111/j.1939-1676.2008.0133.x*

A later study by (Baioni et al., 2017) using data from the Piedmont Canine Cancer Registry (2001–2008) reported 1’172 tumour cases, of which 618 were benign and 554 malignant, as confirmed by histopathology. The incidence rates were 804/100’000 dog-years for malignant tumours and 897/100’000 dog-years for benign tumours. Again, the high incidence among females was mainly attributed to mammary tumours. Overall higher cancer rates were also observed among purebred dogs, particularly Yorkshire Terriers and Boxers. The most common malignant neoplasms in this cohort were cutaneous mastocytoma, hemangiopericytoma, and mammary gland carcinomas (both complex and simplex) [19].

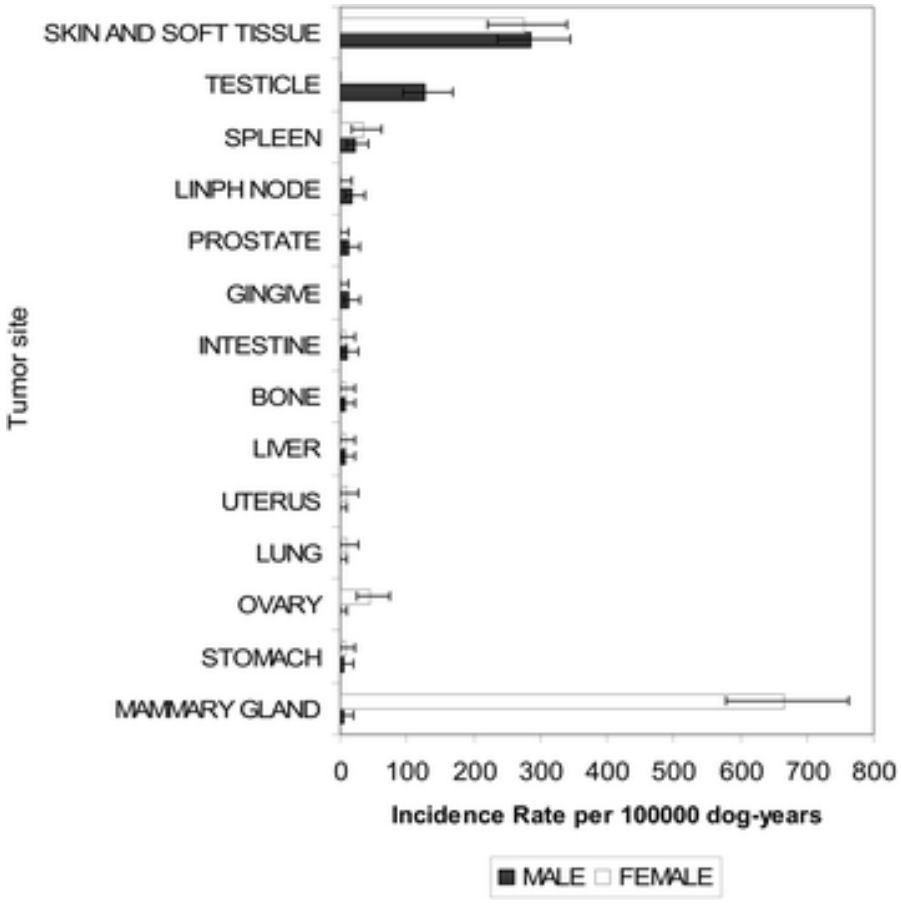



*Figure 1 Malignant Tumours, site- and sex-specific. Copyright BMC Veterinary Research, Inc.; Image by E. Baioni. Republished with permission. https://doi.org/10.1186/s12917-017-1126-0*

As illustrated in Figure 1, the organs most commonly affected were the mammary gland, skin and ovaries in females, and the skin, testicles, and spleen in males. The study also showed that cancer rates by age group were similar in both sexes up to approximately 4-5.9 years, after which rates began to diverge, increasing in females but declining in males beyond 10-11.9 years of age (Figure 2) [19].

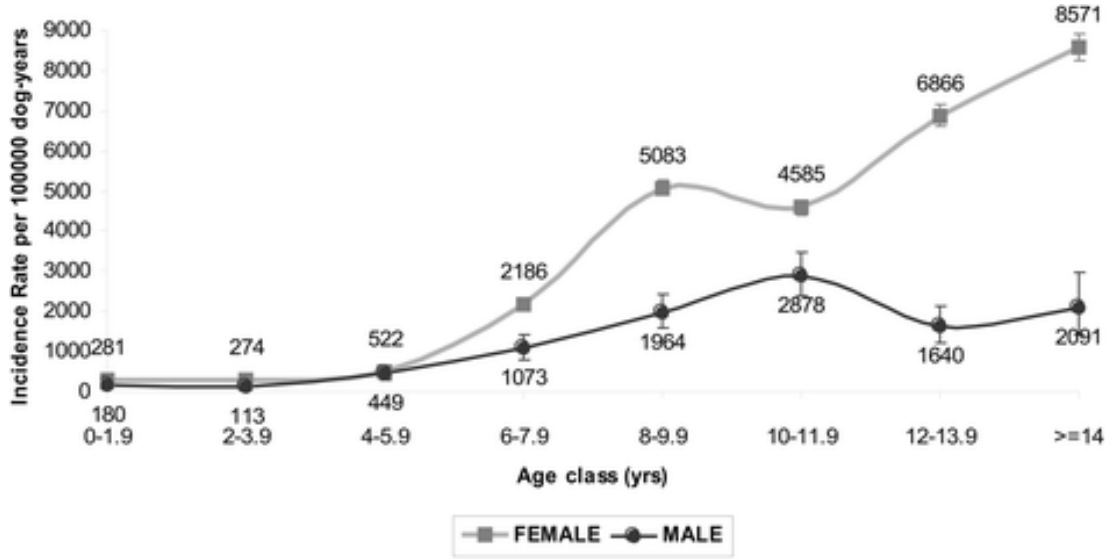



*Figure 2 Age- and Sex-specific Incidence Rates. Copyright BMC Veterinary Research, Inc.; Image by E. Baioni. Republished with permission. https://doi.org/10.1186/s12917-017-1126-0*

The latest findings from the Dog Aging Project (DAP) in the United States expanded the global understanding of canine tumour epidemiology. As reported by (Schwartz et al., 2022), the DAP cohort included 27'541 living dogs as of December 2020. Analyses revealed that the prevalence both benign and malignant tumours increased with age. Females had a higher number of malignant tumours, while males developed benign tumours more frequently. Purebred dogs showed a higher overall tumour incidence compared to mixed breed dogs. When grouped by size, standard-sized dogs showed the highest tumour incidence for both benign and malignant neoplasms, while giant breeds showed the lowest rates [17].

Figure 3 shows the ten most frequently reported tumour sites for malignant (A) and benign (B) tumours [17].

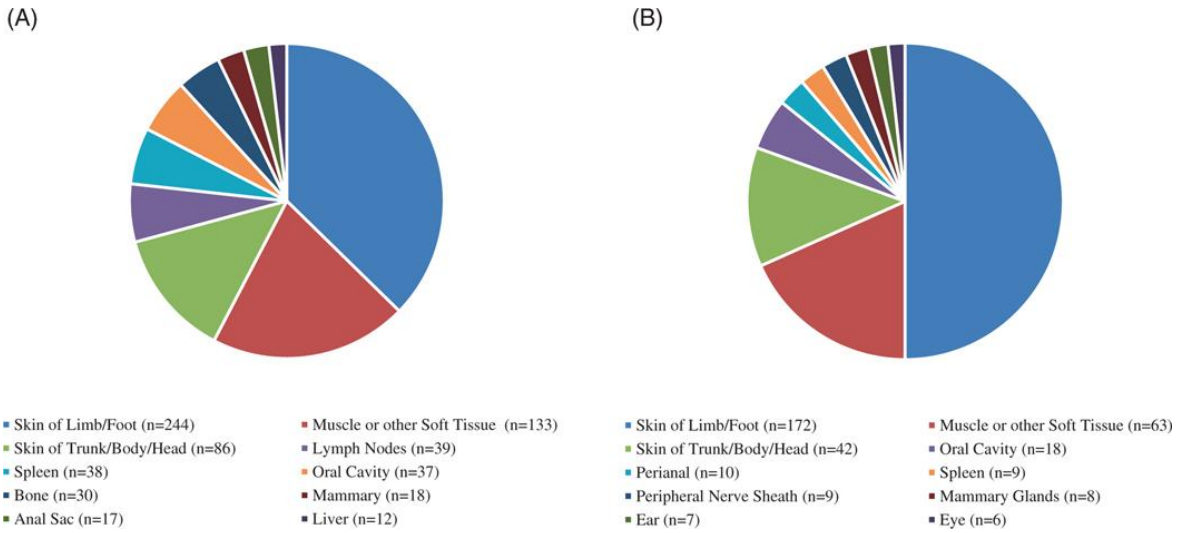



*Figure 3 Ten most frequently reported tumour locations. Copyright National Library of Medicine, Inc.; Image by S. M. Schwartz. Republished with permission. https://pmc.ncbi.nlm.nih.gov/articles/PMC10089278/*

In summary, in the studies examined, approximately half of all reported tumours were malignant. Females consistently showed higher overall tumour rates, largely due to mammary neoplasms, while males more frequently developed skin and testicular tumours. The incidence of tumour increased steadily with age, peaking in senior dogs (≥10 years). The incidence in females increased more rapidly with age, while that in males showed a tendency to stabilise or decrease slightly in older age groups. In addition, purebred dogs were more frequently affected than mixed-breed dogs. Overall, mammary gland and skin tumours were the most common, with mast cell tumours, hemangiopericytoma, and mammary carcinomas dominating the malignant spectrum. Overall, the Italian registry data provide valuable incidence-based estimates, while the U.S. DAP offers large-scale prevalence data and insights into risk factors, together highlighting globally consistent trends across sex, age, and breed.

**Canine Tumours in Switzerland**: In Switzerland, the most comprehensive data originate from (Dhein et al., 2024), which used the official national dog registration database Amicus. The study analysed 54’986 tumours diagnosed by histology or cytology between 2008 and 2020. The most commonly affected sites were the skin (n = 19’045; 34.64%), soft tissues (n = 11’092; 20.17%), and mammary gland (n = 7’974; 14.50%). The overall incidence rate was 775/100’000 dog-years, with 338/100’000 representing malignant tumours. Females showed a higher tumour incidence than males, and the peak incidence was observed at 11

years of age. Further details regarding breed predispositions, age, and sex differences are discussed in chapter 2.3.

**Canine Tumours in Hungary**: In Hungary, the available data are more fragmentary, but still provide significant information on tumour patterns. The Hungarian Vizsla, for example, shows an increasing prevalence of hemangiosarcoma and lymphoma, as observed by ("Cancer – Hungarian Vizsla Club," n.d.) [20]. A study conducted by (Boldizsár et al., 1992) at the University of Veterinary Science, Budapest (1985–1989) examined canine mammary tumours, revealing a steady increase in incidence with age, peaking at 10 years and continuing up to 14 years [20, 21].

A larger-scale survey conducted between 1992 and 2010 at the National Frédéric Joliot-Curie Research Institute for Radiobiology and Radiohygiene (OSSKI) examined 8'760 dogs. Of these, 8'205 cases (93.6%) were confirmed as cancer, with 6'715 (81.8%) classified as malignant tumours, including 406 malignant melanomas (MM; 6%). The most common primary tumour sites were the oral cavity (42.2%), followed by the eyes and periocular region (20.4%), lips (16.4%), feet (13.8%), skin and ear canal (5.9%), and other sites such as the penis, vagina, mammary glands, and rectum (1.3%) [21].

Among purebred dogs, the breeds most affected were Poodles (27; 6.6%), Schnauzers (25, 6.1%), Newfoundands (20; 4.9%), Bernese Shepherd Dogs (11; 2.7%), German Shepherds (11; 2.7%), Spaniels (10; 2.4%), Retrievers (8; 1.9%) and Chow Chows (6; 1.5%). Affected dogs ranged in age from 4.5 to 15 years, with a mean age of 8.7 years. No melanomas were diagnosed in dogs younger than one year of age. For all malignant tumours, the age range was 4 months to 18 years, with a mean age of 9.1 years. Among dogs diagnosed with MM, 62.8% were male (including 14 neutered) and 37.2% were female (including 42 neutered) [22].

**Comparison and Data Gaps between Switzerland and Hungary**: A comparative assessment of Swiss and Hungarian data reveals significant differences in term of data quality, structure, and scope.
Switzerland benefits from a comprehensive, population-based tumour registry that records both benign and malignant tumours, stratified by breed, sex, and age. This allows for reliable calculation of incidence rates per dog-year and facilitates epidemiological comparisons.

In contrast, the data available in Hungary are more fragmented and localized, often derived from individual clinics or university departments. Most Hungarian studies focus on specific

types of tumour (e.g., mammary tumours, lymphomas, melanomas) rather than national surveillance, and generally lack standardized denominators such as dog-years. As a result, Hungary currently does not have a comprehensive, population-based canine tumour registry comparable to the Swiss system.

## 2.3. Breed, Demographic, and Environmental Risk Factors for Canine Tumours in Switzerland

**Genetic and Breed Predispositions**: A study conducted by (Pospischil et al., 2013) examined the evolution of the canine population in Switzerland between 1955 and 2008 to support the development of a national canine tumour registry. During this period, the canine population increased from approximately 309’000 to 500’000, mirroring human population growth and maintaining a stable dog-to-human ratio. Regional variations were observed, with fewer dogs in German-speaking cantons compared to western Switzerland. The popularity of breeds has also changed over time, with an increase in the number of Retrievers and small Terriers, while German Shepherds and Poodles have declined [23].

Analysis of tumour incidence revealed several breed-specific predispositions. The Polski Owczarek Nizinnys showed high incidence rates (IRs) for multiple benign and malignant tumours, while Russian Black Terriers were particularly prone to melanomas. Elevated IRs for adenocarcinomas were observed in Field Spaniels, while Dogo Argentinos showed a strong association with mast cell tumours. King Charles Spaniels and Manchester Terriers showed a higher risk of lymphomas, while Landseers were predisposed to osteosarcomas and Bouvier des Flandres to hemangiosarcomas. Gliomas were most common in Bearded Collies and Cane Corso Italianos. Among breed groups, Nordic hunting dogs had the highest overall cancer incidence rate ratios (IRRs), while Chihuahuas had the lowest [23].

Figure 4: The five most frequent tumour categories include lipomatous neoplasms (n = 7’954), mast cell neoplasms (n = 5’485), adnexal and skin appendage neoplasms (n = 4’416), adenomas and adenocarcinomas (n = 4’146) [24].

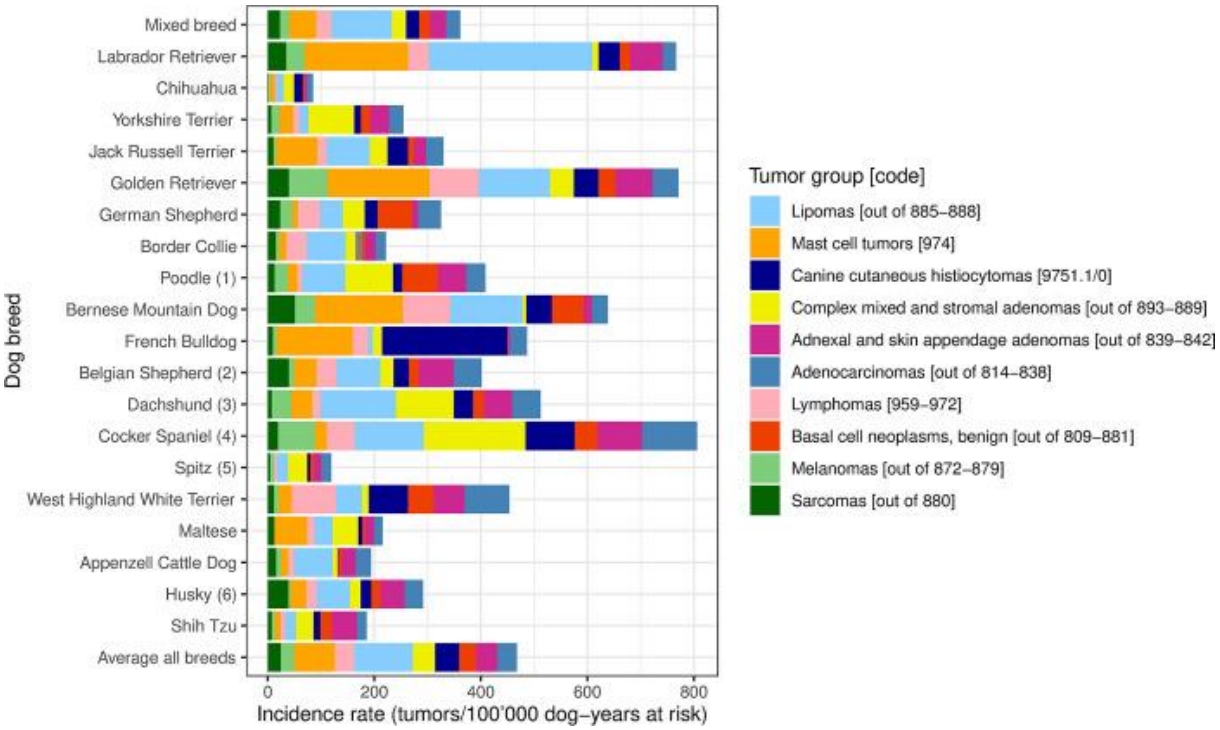



*Figure 4 Incidence Rates of the 10 most common tumour groups in the 20 most popular Swiss dog breeds. Copyright PLOS One, Inc.; Image by F. Guscetti. Republished with permission. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0302231*

**Age, and Sex**: The average age (Fig. 5) at diagnosis was nine years, with a peak incidence of the tumour at the age of ten [24].

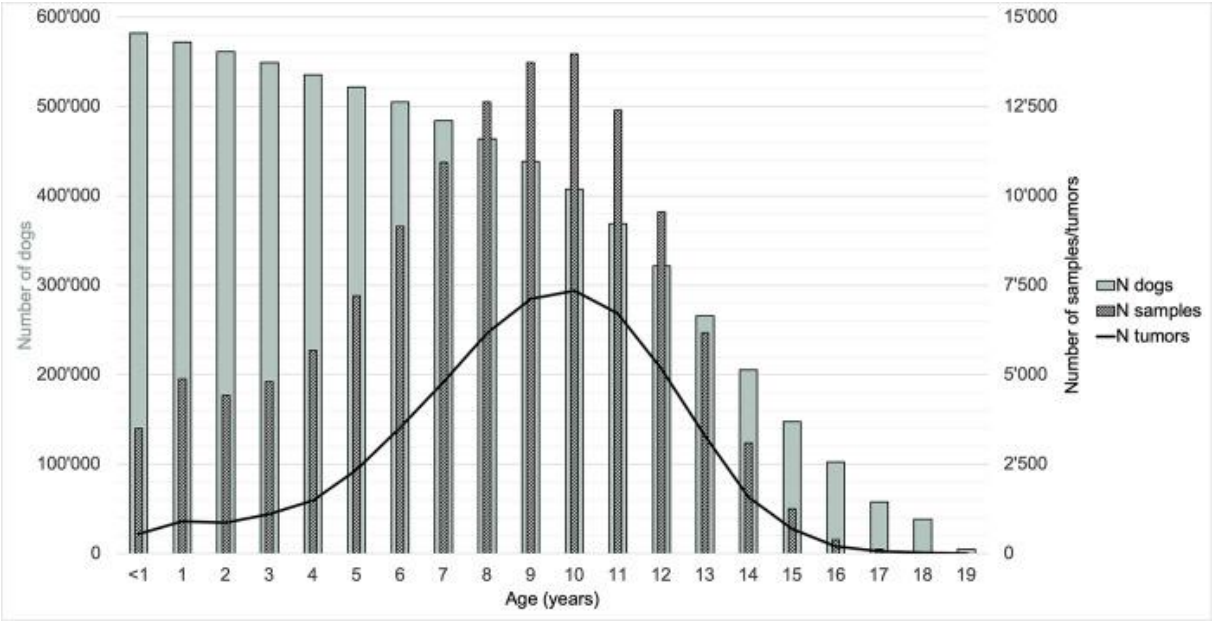



*Figure 5 Number of tumours diagnosed in relation to age (2008-2020). Copyright PLOS One, Inc.; Image by F. Guscetti. Republished with permission. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0302231*

Sex also played an important role in the distribution of tumours. Of the 54’986 tumours analysed, most came from female dogs (n = 30’540; 55.54%), of which 15’577 (28.33%) were from neutered females and 14’963 (27.21%) from intact females. Among male dogs (n = 23’733; 43.16%), 13’712 tumours (24.94%) occurred in intact males, while 10’021 (18.22%) occurred in neutered males. The lowest overall number of tumours was found in neutered males [24].

In terms of topographical distribution, tumours most frequently affected the lip, oral cavity, and pharynx, with melanocytomas and melanomas representing the most common categories (Dhein et al., 2024).

**Geographic and Regional Factors**: According to (Boo et al., 2018), the incidence of canine cancer at the municipal level in Switzerland was calculated annually for the period 2008–2013, using data from the national Animal Identity Service (ANIS) database. The study revealed that urban municipalities generally have higher rates of cancer in dogs, probably because pets receive more frequent veterinary care and cases are less likely to go undetected. Wealthier regions also showed higher detection rates, reflecting greater financial access to veterinary care and diagnostic services [25].

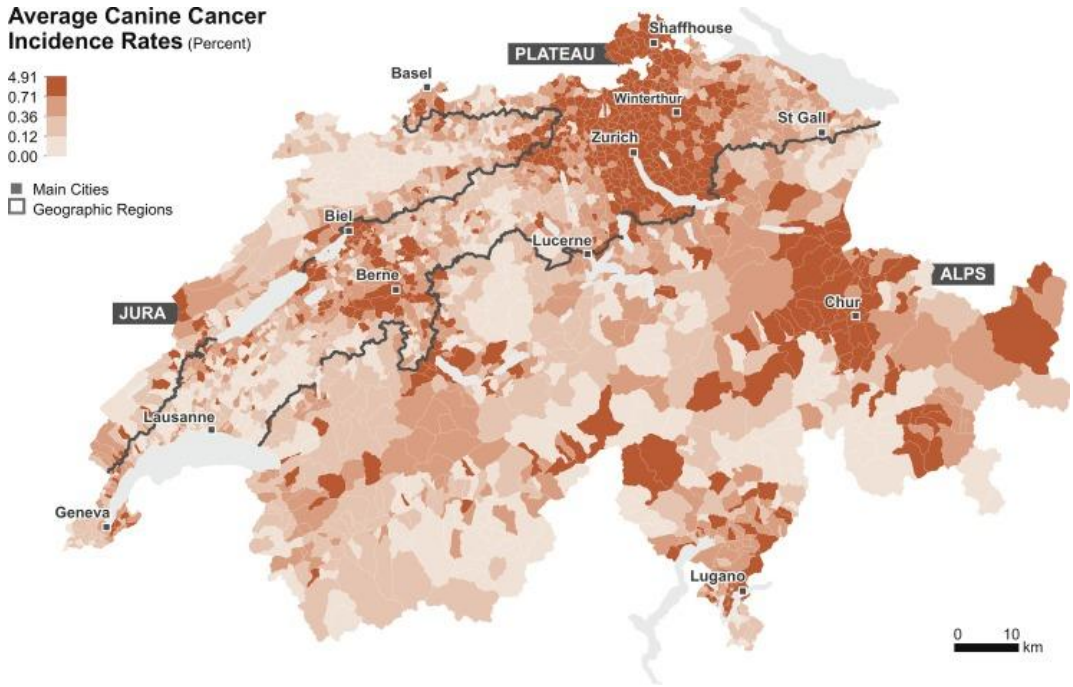



*Figure 6 Average canine cancer incidence rates (2008-2013). Copyright PLOS One, Inc.; Image by G. Boo. Republished with permission. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0195970*

# 3. Objectives and Hypothesis

The aim of this study is to investigate the incidence of canine tumours using three complementary data sources: questionnaires completed by owners, surveys conducted by veterinarians, and histopathological laboratory records. The specific objectives are:

1. To collect and analyse data reported by owners on the occurrence of canine tumours.
2. To evaluate the professional opinions of veterinarians regarding tumour incidence and patterns.
3. To evaluate statistical analysis based on the results of the canine tumour survey
4. To compare the results of the three data sources, identifying similarities, discrepancies, and general trends.

The hypothesis is that tumour incidence patterns will differ between Switzerland and Hungary, reflecting variations in the canine populations, reporting practices, and professional or public awareness of canine tumours.

# 4. Materials and Methods

This study was designed as a comparative cross-sectional survey to investigate the incidence of canine tumours in Switzerland and Hungary. The study used three complementary sources of data, currently focusing on questionnaires completed by dog owners and veterinarians. The general approach was to collect as much information as possible regarding tumour occurrence, types, and mortality in dogs, and to compare the results between the two countries. The study timeframe began in 2024 and is still ongoing, with the most recent responses received on 1st October 2025.

The surveys were developed in collaboration with Prof. Dr. Peter Vajdovich. Two separate questionnaires were designed: one for dogs owners and another for veterinarians. The questionnaires were structured to collect demographic information, tumour incidence, and treatment patterns.

**Dog Owner Questionnaire**:

- Location of residence
- Number of current dogs

- Total number of dogs owned (including past dogs)
- Tumour incidence (dogs diagnosed with a tumour)
- Mortality (dogs that died due to a tumour)
- Age of dog(s)

**Veterinarian Questionnaire**:

- Clinic name and location
- Clinic type (primary care, referral)
- Data availability period (from … to …)
- Number of treated dogs
- Number of prior and newly diagnosed neoplasia cases
- Tumour classification for newly diagnosed and prior cases (benign vs malignant, specific tumour types, tumour locations)

Participating dog owners were recruited through universities, friends and families, dog grooming salons, and animal shelters. Respondents were encouraged to forward the survey to other dog owners to increase reach. In total, 47 participants were recruited from Switzerland and 70 participants from Hungary.

As for veterinarians, over 200 emails were sent to veterinary clinics, animal hospitals, and histopathological laboratories in Switzerland, and a similar approach was applied in Hungary. Despite the outreach, only two veterinary participants completed the survey: one primary-care clinic in Switzerland and one referral clinic in Hungary.

The inclusion criterion for owners was to own at least one dog, while for veterinarians, it was to treat canine patients and have access to clinical or laboratory records related to tumours.

The surveys were administered online and shared via email and social media platforms, including Facebook groups targeting dog owners and veterinary professionals. The online format allowed for broad accessibility and efficient data collection in both countries. Data on tumour occurrence, type, location, age at diagnosis, and mortality were collected as reported by owners and veterinarians.

All responses collected were compiled into a structured database. Data analysis involved:

- Descriptive statistics relating to tumour incidence and mortality reported by owners and veterinarians.
- Comparative analysis between the two countries to identify similarities, discrepancies, and trends.

Due to the limited number of responses from veterinarians, the analysis focused primarily on data reported by owners, while responses from veterinarians were used for qualitative comparison. Statistical procedures included the calculation of percentages, averages, and frequencies. Data visualization was prepared using charts and tables to illustrate tumour incidence patterns.

Participation was voluntary, and respondents provided their informed consent. All data were anonymized to ensure confidentiality.

# 5. Results

This chapter presents the findings of the Canine Tumour Surveys conducted among dog owners and veterinary clinics in Switzerland and Hungary. The results are organized by country and data source, highlighting dog ownership patterns, tumour prevalence, tumour types and locations, mortality, and age at diagnosis or death. Both descriptive statistics and key interpretations are provided to properly place the observed trends in context.

## 5.1. Summary of the Canine Tumour Survey among Dog Owners in Switzerland

A total of 47 responses were collected from dog owners across Switzerland as part of the Canine Tumour Survey, which consisted of five questions aimed at evaluating the incidence of tumour, ownership patterns, and the age of dogs affected by tumours. Responses were mainly obtained from the German-speaking region, with limited participation from the French-speaking region and no responses from the Italian-speaking regions.

**Regional Participation:**

From the French-speaking part of Switzerland, only one respondent (from Genève) participated. This owner currently has three living dogs and has owned five dogs in total; among these, two dogs were diagnosed with tumours, and one dog died due to a tumour at the age of seven.

No responses were received from the Italian-speaking region.

In contrast, the German-speaking region contributed 46 responses. The geographical distribution of these respondents was as follows:

- St. Gallen: 23 respondents (50%)
- Appenzell A. Rh.: 6 respondents (13%)
- Thurgau: 5 respondents (10.9%)
- Zurich: 5 respondents (10.9%)
- Wallis: 2 respondents (4.3%)
- Berne: 2 respondents (4.3%)
- Aargau, Appenzell I. Rh., and Fribourg: 1 respondent each (2.2%)

This shows a clear overrepresentation of dog owners from eastern German-speaking cantons, particularly St. Gallen.

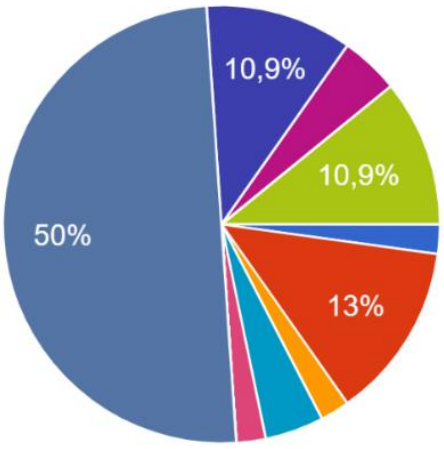



*Figure 7 Diagram of the Swiss Cantons*

**Dog Ownership Patterns**:

When asked, "*How many dogs do you currently own*?", most participants (35; 76.1%) reported owning one dog, followed by 8 (17.4%) who owned two dogs, 1 (2.2%) who owned four dogs, and 2 (4.3%) who said they did not currently own any dogs (Fig. 8).

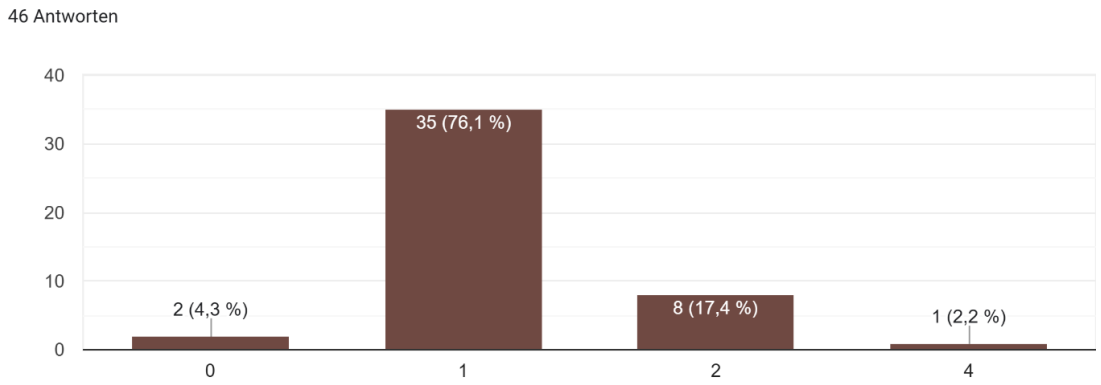



*Figure 8 Dog Ownership Patterns*

When asked "*How many dogs have you owned in your lifetime, including your current dogs?*", ownership history varied considerably, as showed in Figure 9:

- 14 respondents (30.4%) reported owning one dog in total,
- 8 respondents (17.4%) reported two or three dogs, respectively,
- 4 respondents (8.7%) had owned four or six dogs,
- 2 respondents (4.3%) reported five or twenty dogs,
- 1 respondent (2.2%) each reported none, 10, 16, or 120 dogs – the latter likely representing a breeder or kennel owner.

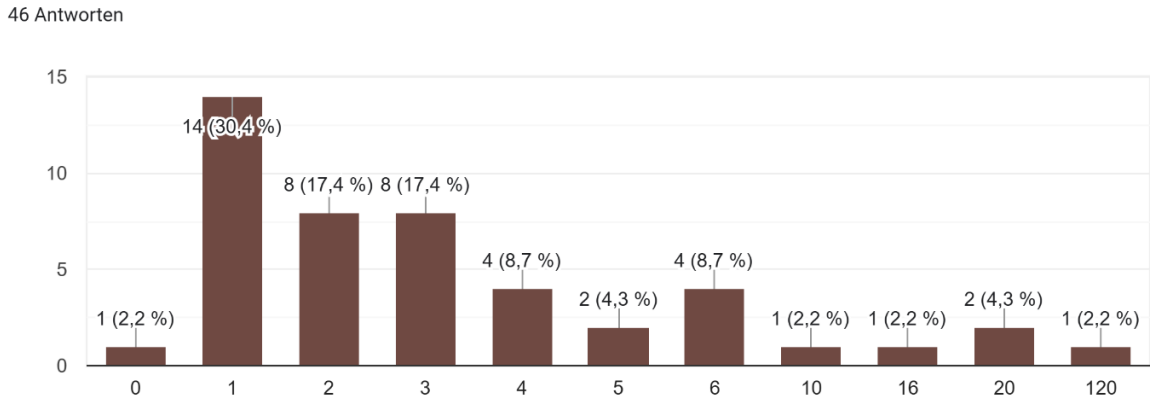



*Figure 9 Dogs owned in total*

**Tumour Occurrence**:

When asked "*How many of your current or previous dogs have been diagnosed with a tumour?*", the following results were obtained:

- 50% (n = 23) reported no dogs diagnosed with tumours,
- 21.7% (n = 10) had two dogs diagnosed,
- 13% (n = 6) had one dog diagnosed,
- 4.3% (n = 2) explicitly reported no dogs diagnosed.
- 2.2% (n = 1 each) reported five dogs, "so far none", "none", "probably one", or "no idea",

Overall, most respondents (50%) had never encountered cases of tumour, while about one-third reported one or two affected dogs. (Fig. 10)

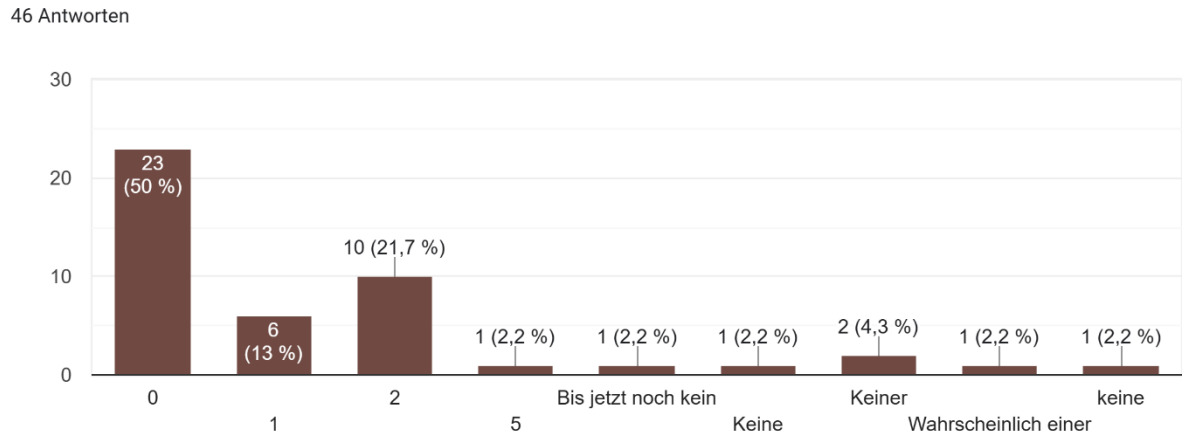



*Figure 10 Tumour Occurrence*

**Mortality Associated with Tumours**:

Responses to the question "*How many of your dogs have died due to tumours?*" showed similar trends (Fig. 11):

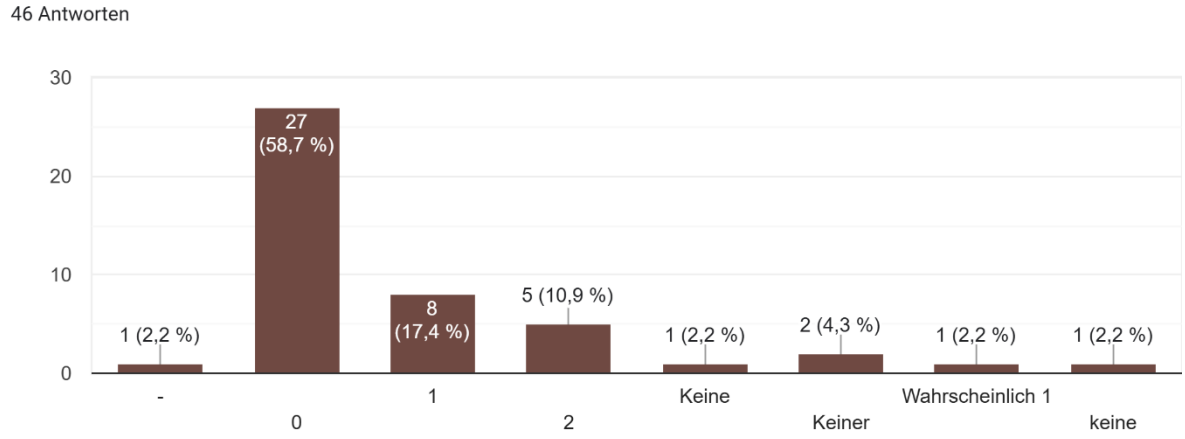



*Figure 11 Mortality Associated with Tumours*

- 67.4% (n = 31) reported no dogs that had died due to tumours,
- 17.4% (n = 8) reported one dog,
- 10.9% (n = 5) reported two dogs,
- 2.2% (n = 1) provided responses such as "probably one".

Thus, 67.4% of respondents had no tumour-related deaths, 28.3% had one or two dogs die from tumours, and about 2.2% provided unclear responses.

**Age of Dogs at Death due to Tumours**:

For the final question, "*What was the age of your dog who died due to tumours?*", the answers were grouped by age range (Fig. 12):

- 68% (n = 30) reported no tumour / none,
- 14% (n = 6) indicated 9-12years,
- 7% (n = 3) each reported 2-4 years and (n = 3) 13-17 years,
- 5% (n = 2) reported 5-8 years, and another 5% (n = 2) "still alive / unclear".

These results indicate that tumour-related deaths occurred most commonly in the 9- to 12-year-old age group, consistent with known patterns of age-related cancer risk in dogs.

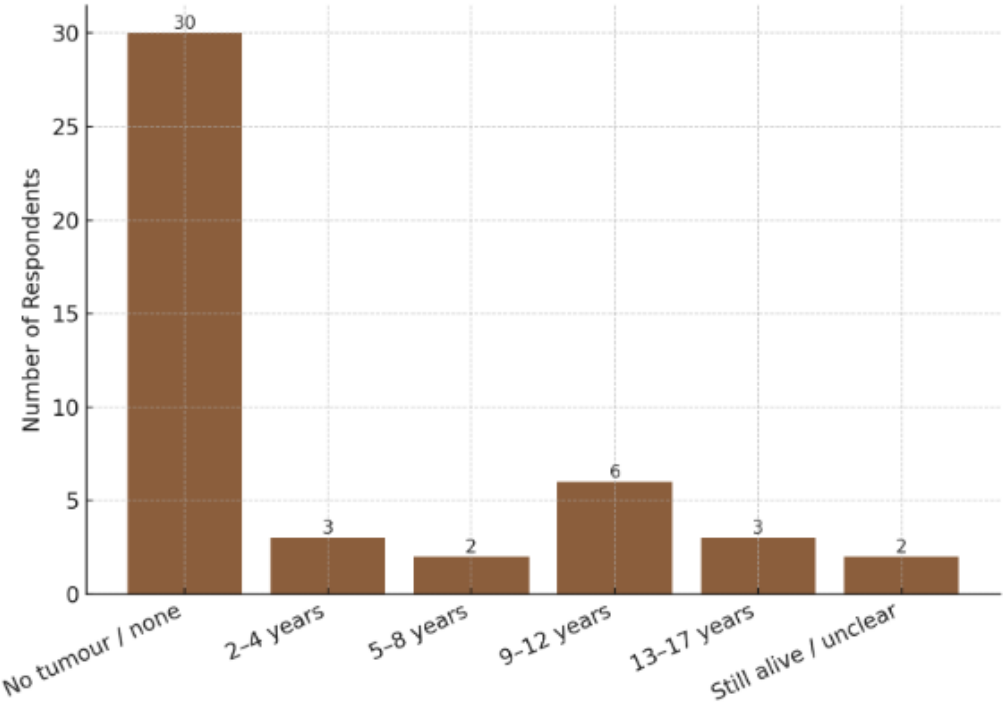



*Figure 12 Age of Dogs at Death. This figure was generated with the help of ChatGPT for clearer illustration of the results, as respondents gave confusing numbers.*

**Summary and Interpretation**:

Overall, the survey revealed that the majority of respondents (about two-thirds) had no experience of tumour with their dogs. Among affected dogs, tumours occurred predominantly between the ages of 9 and 12. There was no substantial evidence of early-onset tumours, as few cases were reported below the ages of 5. German-speaking cantons, particularly St. Gallen, were strongly represented, while French- and Italian-speaking regions were underrepresented.

These findings suggest that, although canine tumours are present in the Swiss pet population, they remain relatively infrequent among companion dogs, and their incidence is consistent with age-related cancer development patterns observed in other international studies.

**Limitations, Data Gaps and Challenges**:

Although the Canine Tumour Survey conducted among Swiss dog owners provides valuable preliminary information on the occurrence of tumour and its demographic distribution, certain methodological and data-related limitations must be take into account.

The survey sample size was small (n = 47) and not representative of all regions of Switzerland. German-speaking cantons, particularly St. Gallen, provided approximately 50% of all responses, while the French-speaking region contributed only one response and the Italian-speaking region provided none. This geographical imbalance introduces a potential sampling bias, limiting the generalizability of the findings across Switzerland.

All data were provided by the dog owners themselves, which may lead to inaccuracies regarding tumour diagnoses, causes of death, and the age of the dogs. Owners may have misclassified medical conditions or underreported tumours that were never formally diagnosed by a veterinarian. Responses such as “probably one”, “no idea”, or “none” suggest uncertainty or inconsistent understanding of the survey questions.

The survey did not include histopathological confirmation of tumour diagnoses. Without professional diagnostic data, it is impossible to verify the accuracy, type, or malignancy of the reported tumours, which limits the epidemiological reliability of the dataset.

The survey consisted of only five questions, providing a limited view of the factors that influence tumour risk (for example, factors such as breed, diet, environment, neuter status, or lifestyle were not assessed). The absence of data on breed-specific predispositions, exposure to environmental carcinogens, and frequency of veterinary care prevents a more thorough interpretation of potential risk factors.

The survey did not specify the timing of tumour diagnoses or deaths. As a result, it is unclear whether tumour cases occurred recently or many years ago, which complicates the assessment of current trends relative to historical trends.

Some respondents reported that dogs were “still alive” or that the “cause of death was unknown”, which limits the accuracy of estimates of tumour-related mortality. The absence of follow-up data makes it impossible to distinguish between dogs that survived tumours and those that succumbed to it.

In summary, this survey serves as an exploratory and descriptive dataset, but not as a statistically representative epidemiological study. Its main limitations include small sample

size, uneven regional participation, and lack of veterinary confirmation. Nevertheless, it provides a valuable baseline for future population-based canine tumour registries in Switzerland, emphasizing the need for standardized, verified, and regionally inclusive data collection.

## 5.2. Summary of the Canine Tumour Survey among Veterinary Clinics in Switzerland

In addition to the survey distributed among dog owners, a separate questionnaire was sent to veterinary clinics across Switzerland to collect clinical data on the occurrence of tumours in dogs. In total, over 200 emails were sent to veterinary practices across the country. Despite the extensive distribution, only one response was received.

The sole response came from the Veterinary Clinic Rotkreut, located in the canton of Zug. This clinic operates as a first-opinion clinic (primary care) and had only recently commenced operations on 1 July 2023. Consequently, the clinic was unable to provide data regarding tumour cases prior to that date.

The clinic's records covered the period from 1 July 2023 to 28 October 2024, during which approximately 250 dogs were treated.

When asked, "*How many dogs had neoplasia before this time period?*", no data were available due to the clinics recent establishment.

However, in response to the question, "*How many dogs were newly diagnosed with neoplasia during this time period?*", the clinic reported 10 cases of neoplasia, of which:

- Nine (9) were classified as benign tumours, and
- One (1) was classified as a malignant tumour.

When askes about the specific tumour types, the following were identified:

- Lymphoma: 1 case
- Mast cell tumour: 1 case
- Histiocytic tumour: 1 case

The anatomical locations of the tumours were reported as follows:

- Mammary gland: 1 case
- Intestines: 1 case
- Head: 1 case

In response to the question, "*What was the average age of the dogs diagnosed with neoplasia?*", the clinic reported an average of 5 years among affected dogs.

Unfortunately, the clinic did not provide further information on previous tumour cases.

**Interpretation and Observations**:

The response rate from veterinary clinics was extremely low (less than 1%), representing a significant challenge in acquiring data for this part of the study. The only participating clinic provided limited but valuable preliminary data, indicating that over a 16-month period, 4% of all treated dogs (10 out of approximately 250) were diagnosed with neoplasia, with benign tumours being predominant.

## 5.3. Summary of the Canine Tumour Survey among Dog Owners in Hungary

A total of 70 Hungarian dog owners participated in the survey. The majority of respondents were from Budapest (n = 28; 40%) and Pest county (n = 20; 28.6%), followed by a minority from Csongrád-Csanád (n = 4; 5.7%) and Bács-Kiskun (n = 4, 5.7%). Additional responses were received from Békés, Zala, and Szabolcs-Szatmár-Bereg (each n = 2; 2.9%), and single responses (n = 1; 1.4% each) came from Nógrad, Hajdú-Bihar, Gyór-Moson-Sopron, Fejér, Somogy, Vas, and Veszprém counties. Overall, this regional distribution shows the strongest involvement from central parts of Hungary, particularly the capital region.

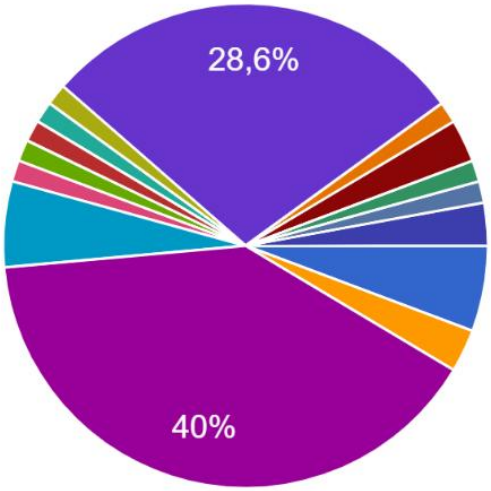



*Figure 13 Diagram of Hungarian Counties*

**Dog Ownership Patterns**:

When asked, "*How many dogs do you currently own?*", the responses were as follows:

- 37 respondents (51.4%) currently own one dog,
- 17 respondents (24.3%) own two dogs,
- 8 respondents (11.4%) currently have no dogs,
- 4 respondents (5.7%) own four dogs,
- 2 respondents (2.9%) own three dogs,
- and 2 respondents (2.9%) own five dogs.

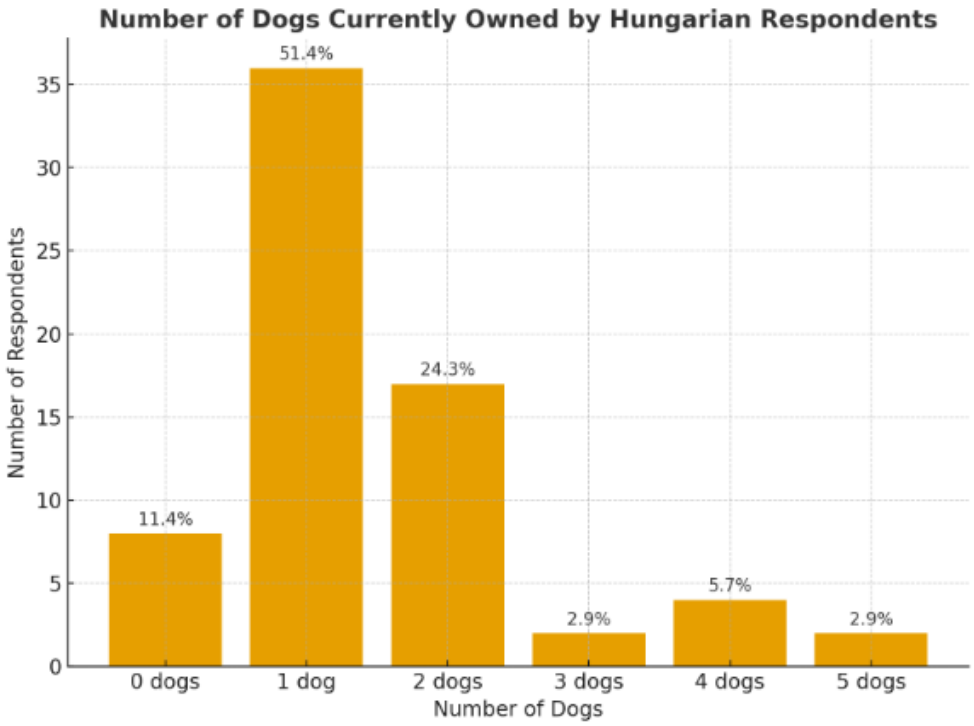



*Figure 14 Dog Ownership Pattern of Hungary. This figure was generated with the help of ChatGPT for clearer illustration of the results.*

These data show that the majority of Hungarian dog owners (over 75%) own one or two dogs, while households with multiple dogs (three or more) are relatively uncommon. A smaller group (about 11%) consisted of participations who did not currently own a dog but had previous ownership experience.

When asked "*How many dogs have you owned in your lifetime, including your current dogs?*", ownership history varied widely, as showed in Fig. 15:

- 15 respondents (21.4%) reported owning one dog in total,
- 13 respondents (18.5%) reported three
- 12 respondents (17.1%) reported four dogs,
- 9 respondents (12.9%) had owned two or five dogs, respectively,
- 3 respondents (4.3%) reported seven dogs,
- 2 respondents (2.9%) reported six or eight dogs, respectively,
- 1 respondent (1.4%) each reported none, nine, 10, 11, or 50 dogs.

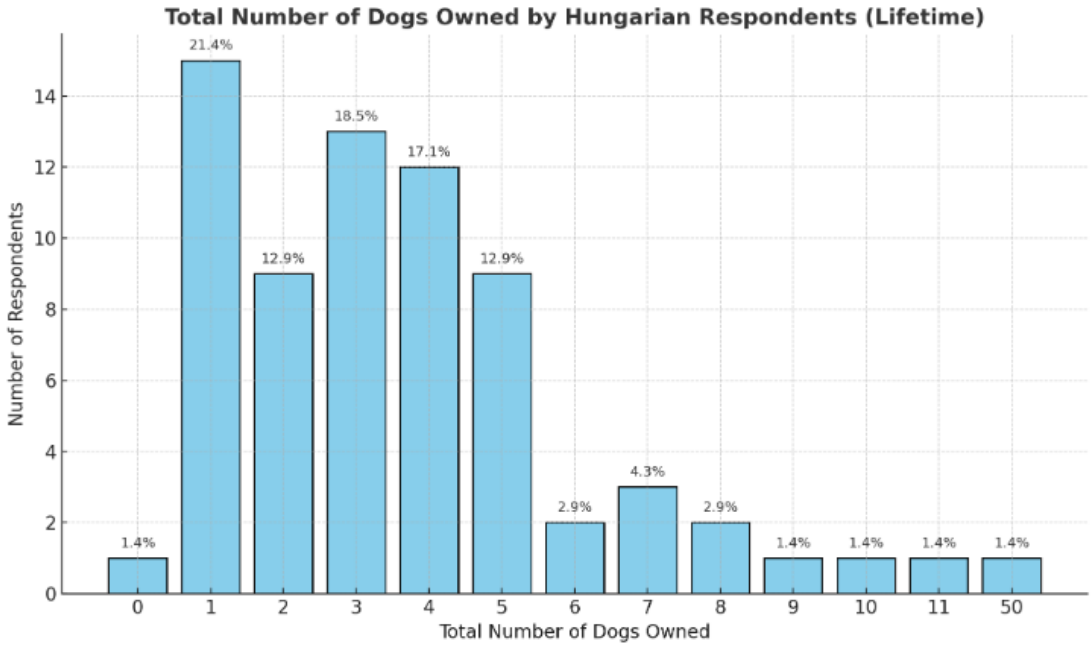



*Figure 15 Dogs owned during a lifetime by Hungarians. This figure was generated with the help of ChatGPT for clearer illustration of the results.*

**Tumour Occurrence**:

The responses to the question "*How many of your current or previous dogs have been diagnosed with a tumour?*" provided valuable information on the incidence of tumour among owned dogs in Hungary.

The majority of respondents (n = 40; 57.1%) reported that one of their dogs had been diagnosed with a tumour. Thirteen respondents (18.6%) indicated that two of their dogs had been affected, while 12 respondents (17.1%) stated that none of their dogs had ever been diagnosed with a tumour.

A smaller percentage, three respondents (4.3%), reported that three dogs had been diagnosed with tumours.

Additionally, two respondents provided clarification:

- One mentioned two or possibly three dogs, emphasizing the uncertainty because one of their dogs had never received a confirmed diagnosis.
- Another respondent reported two dogs with diagnoses, specifying that one tumour was benign.

In summary, approximately 81.5% of Hungarian respondents had at least one dog diagnosed with a tumour, suggesting a relatively high awareness and incidence rate among the surveyed population.

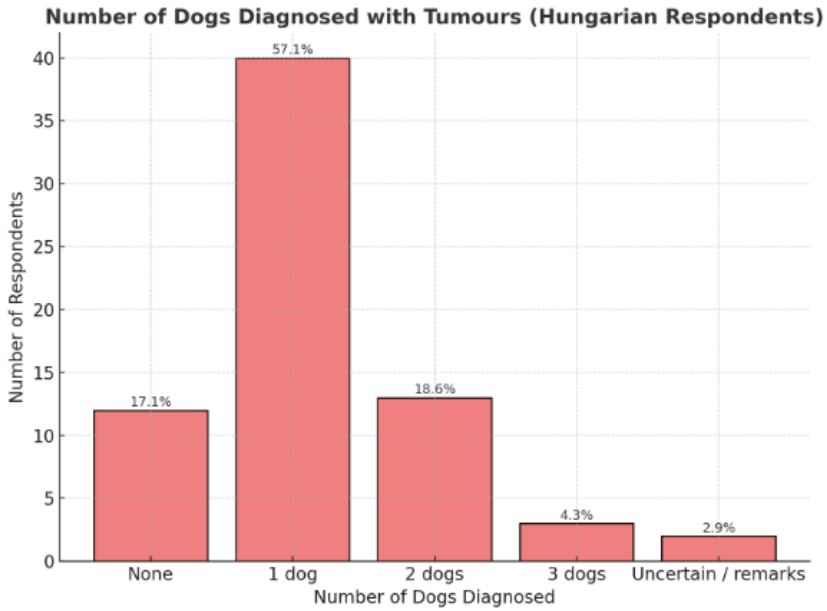



*Figure 16 Number of Dogs diagnosed wit Tumours. This figure was generated with the help of ChatGPT for clearer illustration of the results.*

**Mortality Associated with Tumours**:

Responses to the question "*How many of your dogs have died due to tumours?*" provided information on tumour-related mortality among the Hungarian dog owners surveyed (Fig. 17).

A total of 31 respondents (41.4%) reported that none of their dogs had died from a tumour, while 26 respondents (37.1%) reported that one dog had died due to a tumour. In addition, eight respondents (11.4%) indicated that two dogs had died, and two respondents (2.9%) reported three tumour-related deaths among their dogs.

A small number of participants provided additional details: one respondent (1.4%) noted that their dog was still battling a tumour, another (1.4%) repeated that none of their dogs had died, and one (1.4%) mentioned that their dog with a malignant tumour was still alive at the time of the survey.

Overall, the majority of respondents (over 78%) had no dogs that had died from tumours or had only one, while a smaller percentage reported multiple tumour-related deaths. These findings suggest that although the incidence of tumour is relatively common, mortality rates appear to be moderate among the surveyed population.

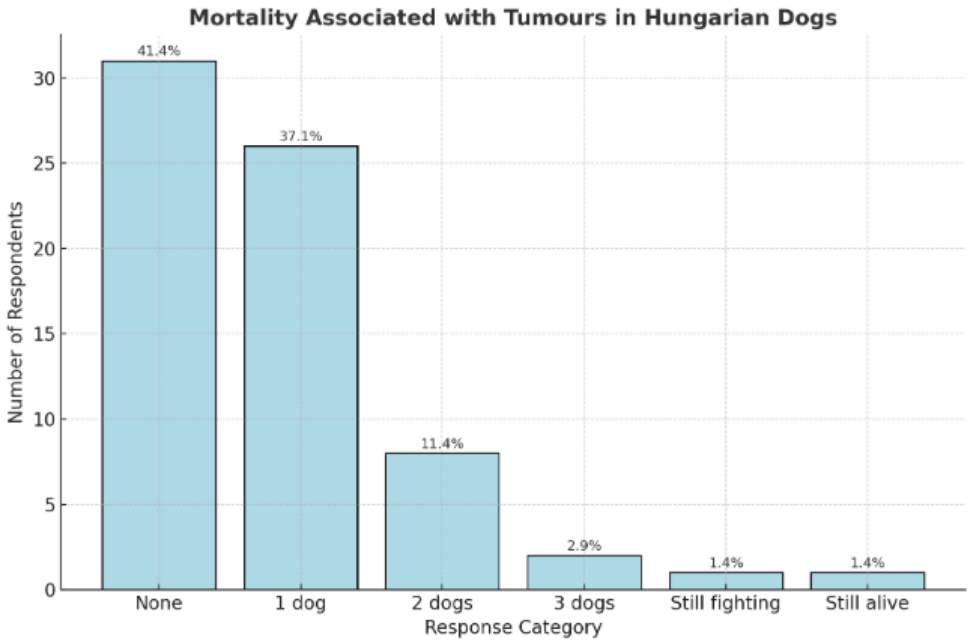



*Figure 17 Mortality associated with Tumour. This figure was generated with the help of ChatGPT for clearer illustration of the results.*

**Age of Dogs at Death due to Tumours**:

For the final question, "*What was the age of your dog who died due to tumour?*", the responses were grouped by age class (Fig. 18):

Respondents reported a wide variation in the ages of dogs that died due to tumours. The majority of owners (n = 20) stated that none of their dogs had died from a tumour. Among those who reported tumour-related death, the ages at death ranged from 4 to 16.5 years.

In most cases, deaths occurred between the ages of 9 and 14, reflecting the typical age-associated cancer risk observed in dogs. Specifically, five respondents reported tumour-related deaths at age 9, four at age 11, six at age 13, and several between 12-14 years. Some cases occurred in younger dogs, such as one at age 4 and one at age 7, indicating that tumours can also affect dogs at an earlier stage of life.

Additionally, there were a few isolated reports of dogs that were still alive but battling tumours (for example, an 8-year-old dog and a 14.5-year-old dog). One of the respondents noted that both cases involved mastocytoma (mast cell tumours).

Overall, these findings indicate that most tumour-related mortalities occurred in older dogs, primarily between the ages of 9 and 14, consistent with established data on the prevalence of age-related cancer in dogs.

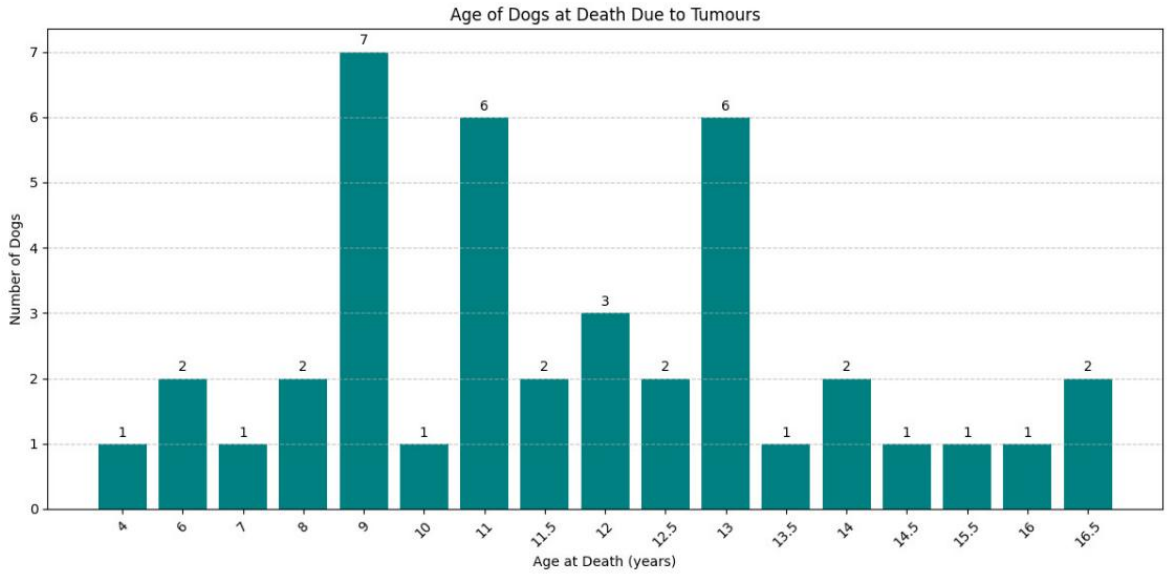



*Figure 18 Age of Dogs at Death. This figure was generated with the help of ChatGPT for clearer illustration of the results.*

**Summary and Interpretation**:

The survey reveals several significant patterns related to canine tumours among Hungarian dog owners. The prevalence of tumours was relatively high, with approximately three-quarters of respondents reporting that at least one of their dogs had been diagnosed with a tumour. Despite this, tumour-related mortality was moderate, as most respondents reported no more than one dog had died from a tumour, suggesting that clinical outcomes are often manageable with timely diagnosis and treatment.

The age-related risk was evident, with tumour-related deaths primarily occurring in dogs aged between 9 and 14 years, consistent with established patterns of age-associated cancer in canines. With regard to ownership patterns, Hungarian households with dogs were typically small, usually consisting of one or two dogs, although the duration of ownership varied considerably among participants.

It is worth mentioning a potential sampling bias: most respondents were concentrated in central Hungary, which may limit the generalizability of these findings to more rural regions.

Overall, these findings underline the prevalence of canine tumours in Hungary and emphasize the importance of regular monitoring, early detection, and timely intervention, particularly in aging dogs, to improve clinical outcomes and quality of life.

**Limitations, Data Gaps, and Challenges**:

The survey respondents were predominantly from Budapest and Pest County, resulting in an overrepresentation of central Hungary. This limits the generalizability of the results to the broader Hungarian canine population, particularly in rural areas where ownership patterns, access to veterinary care, and tumour prevalence may differ.

The total number of participants was relatively small (n = 70), which may reduce statistical significance and increase the variability of the reported results.

The survey was based on information provided by owners, which could potentially introduce distortions due to the recall bias or misclassification. Owners may be unaware of subclinical tumours or uncertain about the exact diagnosis (benign or malignant), potentially affecting the accuracy of data on tumours prevalence and mortality.

Differences in access to veterinary care and diagnostic capabilities between regions may affect the reported incidence of tumours. Some owners reported uncertainty about the diagnosis, indicating that not all tumours may have been confirmed by histopathology.

The survey did not collect specific data on tumour types, stages, or treatments, limiting the ability to analyse tumour aggressiveness patterns or treatment outcomes.

Although age at death was reported, there may be a survival bias, as older dogs are more exposed to tumour risk, while younger dogs may still develop tumours in the future.

Some respondents provided ambiguous answers (e.g., uncertain tumour diagnoses, ongoing cases), which introduces variability and potential underestimates or overestimates of tumour prevalence and mortality.

## 5.4. Summary of the Canine Tumour Survey among Veterinary Clinics in Hungary

The data from Hungarian veterinary clinics were limited, with only a single response received from Net Vet, a referral clinic located in Hajdú-Bihar County. The data collection period was between 24 September 2023 and 24 September 2024. During this period, a total of 12’500 dogs were treated at the clinic.

Of these, 500 dogs had been diagnosed with neoplasia prior to the survey period, and an additional 500 dogs were newly diagnosed with neoplasia during the survey timeframe. Among all dogs treated for neoplasia, 350 cases were classified as benign and 150 cases as malignant.

**Tumour Types**:

The distribution of specific tumour types among the treated dogs was as follows:

- Lymphoma: 20 cases
- Carcinoma: 70 cases
- Sarcoma: 10 cases
- Mast cell tumours: 40 cases
- Histiocytic tumours: 5 cases

**Tumour Locations**:

The anatomical locations of the tumours were reported as:

- Uroepithelial tumour: 15 cases
- Melanoma: 4 cases
- Mammary neoplasia: 300 cases
- Liver: 5 cases
- Intestine: 3 cases
- Adrenal gland: 3 cases
- Lungs: 15 cases
- Brain: 3 cases
- Head: 8 cases
- Kidney: 5 cases
- Oral cavity: 2 cases

The average age of dogs diagnosed with neoplasia was 7 years.

**Previous Diagnosed Cases**:

Of the 500 dogs with neoplasia diagnosed prior to the survey period, 350 were benign and 150 were malignant. The distribution of tumour types and locations among these previously diagnosed cases closely mirrored the data for newly diagnosed dogs:

**Tumour Types**:

- Lymphoma: 20 cases
- Carcinoma: 70 cases
- Sarcoma: 10 cases
- Mast cell tumour: 40 cases
- Histiocytic tumour: 5 cases

**Tumour Locations**:

- Uroepithelial tumour: 15 cases
- Melanoma: 4 cases
- Mammary neoplasia: 300 cases
- Liver: 5 cases
- Intestine: 3 cases

- Adrenal gland: 3 cases
- Lungs: 15 cases
- Brain: 2 cases
- Head: 5 cases
- Kidney: 3 cases
- Oral cavity: 3 cases

The data provided by Net Vet offer a snapshot of the prevalence and distribution of tumours in a referral clinic in Hungary. Mammary neoplasia was the most frequently diagnosed tumour type and site, consistent with patterns reported in canine oncology. The findings highlight that both benign and malignant tumours are common in middle-aged dogs, with an average age of 7 years at diagnosis. However, the limited response from a single clinic limits the possibility of generalizing these results to the wider Hungarian canine population and highlights the need for broader participation of clinics in future studies.

## 5.5. Summary and Findings of Statistical Analysis based on Dog Owners' Survey Data

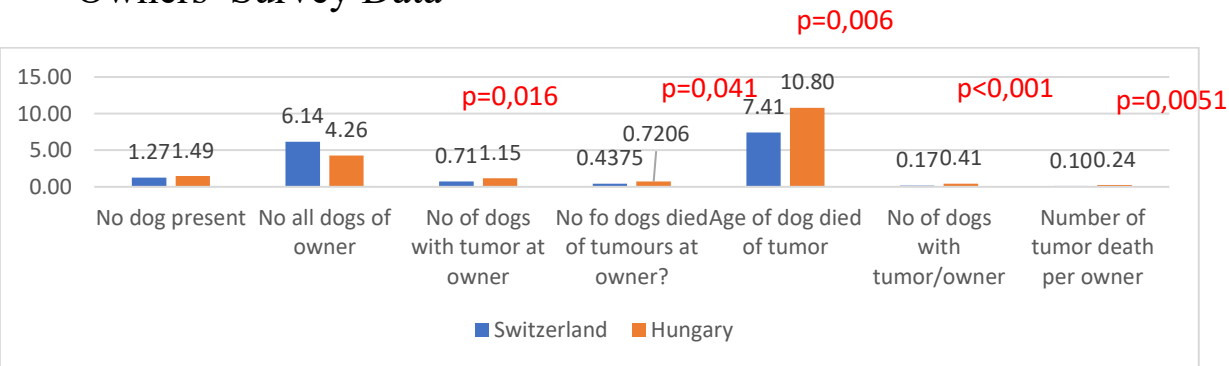



*Figure 19 Comparison of Dog Ownership and Tumour-related Parameters between Switzerland and Hungary*

A comparison between Switzerland and Hungary regarding dog ownership and tumour-related variables revealed several statistically significant differences (Fig. 19). The average number of dogs that owners had owned to a certain point was almost identical in both countries (Switzerland: 6.14; Hungary: 4.26), indicating comparable patterns of pet ownership. The percentage of dogs present was also identical (1.27 and 1.49, respectively).

However, significant differences emerged in the variables relating to tumours. Swiss dog owners reported on average a slightly lower number of dogs affected by tumours (0.71) compared to Hungarian owners (1.15); this difference was statistically significant (0.016). Similarly, the number of dogs that died from tumours was slightly higher in Hungary (0.72) than in Switzerland (0.44), with a p-value of 0.041, indicating a statistically significant difference.

The average age of dogs that died form tumours also differed significantly between the two populations ($p = 0.006$). Dogs in Switzerland died at a slightly younger age (average 7.41 years) compared to those in Hungary (10.8 years), suggesting a modest but consistent difference in life expectancy associated with tumour-related mortality.

Furthermore, the ratio of dogs with tumours per owner differed markedly between the countries ($p < 0.001$), with Hungarian owners showing a slightly higher percentage (0.41) compared to Swiss owners (0.17). Similarly, the number of tumour-related deaths per owner was significantly different ($p = 0.0051$), again indicating a higher burden among Hungarian dogs (0.24) compared to Swiss dogs (0.10).

A comparative analysis between Hungary and Switzerland revealed several significant differences in dog ownership and tumour-related parameters. Hungarian dog owners reported a higher average number of dogs developing tumours compared to their Swiss counterparts. In addition, more dogs in Hungary died from tumours, indicating a more pronounced burden of tumour-related mortality within the Hungarian population. Interestingly, dogs that succumbed to tumours in Hungary were, on average, older than those in Switzerland, suggesting potential differences in disease progression, veterinary care, or timing of diagnosis between the two countries.

Although the overall number of dogs per household did not differ significantly between Hungary and Switzerland, the relative frequency of tumour cases and tumour-related deaths per owner was substantially higher in Hungary. Furthermore, the number of dogs per owner was higher in Switzerland (although not significantly) than in Hungary. This trend raises important questions about the factors contributing to the observed disparity in canine health outcomes between the two countries.

The results suggest that within each country, differences between urban and rural areas have minimal influence on tumour incidence and mortality among dogs. This implies that geographical location, whether urban or rural, does not play a decisive role in determining

the risk of tumour development. However, a comparison between the two countries clearly highlights a more worrying trend in Hungary, where both the prevalence and mortality rates for cancer are high compared to Switzerland.

These disparities likely originate from factors beyond the environmental context, including:

- Veterinary screening practices: Variations in the frequency, accessibility, and quality of veterinary health checks.
- Owner awareness: Differences in owners' knowledge and attention to tumour symptoms and early warning signs.
- Access to diagnosis and treatment: Unequal availability of advanced veterinary care and timely interventions.
- Breed distribution: potential differences in the most commonly owned breeds, affecting susceptibility to certain tumours.
- Preventive healthcare: distinct approaches to nutrition, vaccination, and general health maintenance among populations.

A throughout understanding of these factors is essential for addressing the underlying causes of canine tumour prevalence in Hungary and for developing targeted strategies aimed at improving the health and longevity of dogs in both countries.

### 5.5.1. Comparison of Dog Ownership and Tumour-Related Variables between Urban and Rural Hungarian Dog Owners

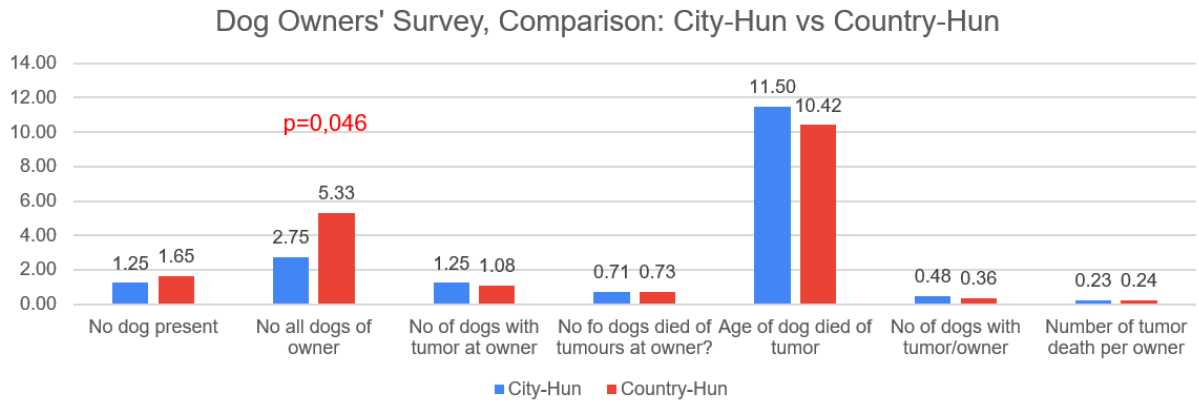



*Figure 20 Differences in Dog Ownership and Tumour Incidence Between City and Country Owners in Hungary*

This bar chart compares different variables related to dog ownership and tumours between City-Hun (blue) and Country-Hun (red) – i.e. Hungarian dog owners living in cities versus those living in the countryside. Key variables include the number of dogs that remained free of tumours, the rate of dogs diagnosed with tumours per owner, the number of dogs that succumbed to tumours, the average age of dogs that died from tumours, and the incidence of tumour-related deaths per owner.

A comparison between Hungarian dog owners residing in cities and in the countryside (City-Hun vs Country-Hun) revealed notable differences in dog ownership patterns, but minimal variation in tumour-related outcomes (Fig. 20). Rural owners owned significantly more dogs on average ($5.33 \pm$ SD vs $2.75 \pm$ SD; $p = 0.046$), reflecting typically larger household size and different functional roles for dogs in rural areas. In addition, most dog breeders live in countryside, where they can provide adequate space for breeding. Despite this difference, the number of dogs with tumours per owner and the number of tumour-related deaths per owner were comparable between the two groups. The average number of dogs with tumours was 1.25 among owners living in cities and 1.08 among owners living in the countryside, while the average number of dogs that died from tumours was 0.71 and 0.73, respectively. Similarly, the ratio of dogs with tumours to the total number of dogs owned, as well as the number of tumour deaths per owner, did not differ significantly between the two populations. Interestingly, the average age of dogs that died of tumours was slightly higher among city dogs (11.50 years) than among rural dogs (10.42 years), suggesting potential differences in

life expectancy that could be related to access to veterinary care or environmental factors. Overall, these findings indicate that while rural owners tend to have more dogs, the incidence of tumour and mortality are broadly similar between urban and rural areas in Hungary.

### 5.5.2. Comparison of Dog Ownership and Tumour-Related Variables between Urban and Rural Swiss Dog Owners

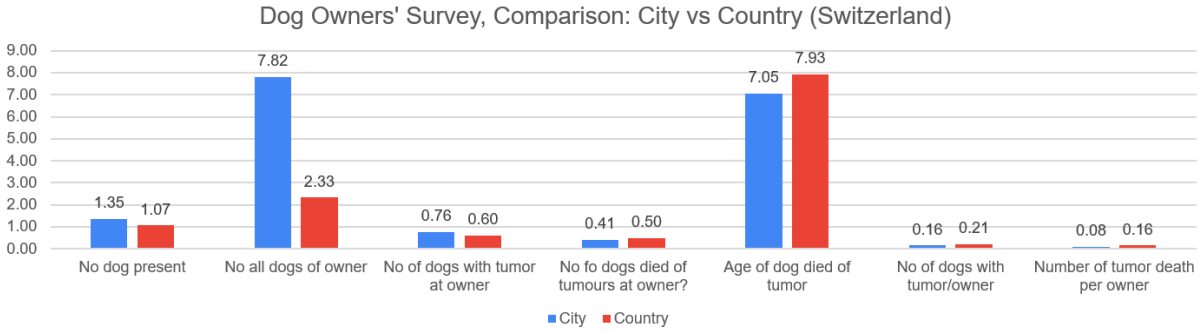



*Figure 21 Differences in Dog Ownership and Tumour Incidence Between City and Country Owners in Switzerland*

This bar chart compares dog ownership and tumour-related variables among dog owners living in cities and those living in rural areas in Switzerland. The blue bars represent owners living in cities, while the red bars represent owners living in the countryside. The variables included the average number of dogs per household, the prevalence of dogs diagnosed with tumour, the number of dogs that died from tumours, and the incidence of tumour-related deaths per owner.

A comparison between urban and rural dog owners Switzerland revealed distinct patterns in ownership, but only minor differences in tumour-related outcomes (Fig. 21). City owners reported a significantly higher average number of dogs (7.82) than rural owners (2.33), suggesting differences in sample composition or the presence of some city owners with a large number of dogs, which may have inflated the average. The percentage of dogs with tumours per owner was comparable between the two groups (0.76 in cities versus 0.60 in rural areas), as was the average number of dogs that died from tumours (0.41 and 0.50, respectively). Similarly, the ratio of dogs with tumour to tumour-related deaths per owner did not differ substantially between the two locations. Interestingly, the average age of dogs

that died of tumours was slightly higher among dogs in rural areas (7.93 years) than in cities (7.05 years), suggesting a potential trend toward greater longevity in rural environments. Overall, these findings indicate that while urban and rural dog owners in Switzerland differ in the number of dogs they own, tumour incidence and mortality patterns are largely consistent across regions.

# 6. Discussion

## 6.1. Comparison of the Swiss and Hungarian Dog Owners' Surveys

Surveys on canine tumour conducted among dog owners in Switzerland and Hungary provided valuable preliminary information on the occurrence of tumour, mortality, and age distribution of affected dogs in two different European countries. Although both surveys aimed to collect comparable information, clear differences were observed in sample size, regional representativeness and the percentage of tumour cases reported by owners.

The Swiss survey involved 47 respondents, while the Hungarian survey involved 70. Participation in Switzerland was dominated by the German-speaking cantons, particularly St. Gallen (23 respondents; 50%), followed by Appenzell A. Rh. (13%), Thurgau and Zurich (each 10.9%), and smaller contributions from Wallis and Berne (each 4.3%). Only one response came from the French-speaking region (Genève), and none from the Italian-speaking region. Therefore, the Swiss sample mainly represents eastern Switzerland.

In contrast, the Hungarian survey recorded the highest participation from Budapest (40%) and Pest County (28.6%), followed by lower numbers from Csongrád-Csanád and Bács-Kiskun (each 5.7%), and single responses from several other counties. The Hungarian dataset therefore reflects the central region of the country, particularly the capital area.

### 6.1.1. Dog Ownership Patterns

Dog ownership patterns were similar in both countries, with most respondents owing only one dog. In Switzerland, 76.1% (n = 35) owned one dog, 17.4% (n = 8) owned two, 2.2% (n = 1) owned four, and 4.3% (n = 2) reported no current dogs. In Hungary, 51.4% (n = 37)

owned one dog, 24.3% (n = 17) owned two, 11.4% (n = 8) had no current dogs, and only a few owned three or more (5.7% owned four dogs, 2.9% owned three, and 2.9% owned five).

Lifetime ownership patterns also showed considerable variation in both surveys. Swiss respondents reported having mostly one (30.4%) or two to three (each 17.4%) dogs during their lifetime, while Hungarian owners reported having one (21.4%), three (18.5%), four (17.1%), or two/five (12.9% each). Both groups included a some respondents with unusually high numbers of dogs (e.g., 120 in Switzerland; 50 in Hungary), likely breeders or kennel owners. Overall, single-dog ownership predominated in both countries, with Hungary showing slightly higher number of households with multiple dogs.

### 6.1.2. Tumour occurrence

There was a notable contrast in the reported experience of tumour between the two countries. In Switzerland, 50% (n = 23) of respondents stated that none of their dogs had ever been diagnosed with a tumour. A further 13% (n = 6) reported one dog diagnosed, and 21.7% (n = 10) had two dogs diagnosed. Some responses were unclear or unusual (e.g., “five dogs”, “probably one”, “no idea”). In total, about one-third of Swiss owners had at least one tumour case, while half had not encountered any.

In contrast, the Hungarian survey revealed a substantially higher rate of tumour experience. 57.1% (n = 40) of respondents reported that one dog had been diagnosed with a tumour, 18.6% (n = 13) had two dogs affected, and 17.1% (n = 12) had none diagnosed. A small group, 4.3% (n = 3), reported having three affected dogs, whole two respondents added further comments (uncertain diagnoses or benign tumours). Overall, approximately 81.5% of Hungarian respondents had experienced at least one tumour case in their dogs, indicating a significantly higher level of awareness or incidence than the Swiss sample.

### 6.1.3. Mortality Associated with Tumours

The patterns of tumour-related mortality also differed between countries but were consistent with the overall incidence pattern. In Switzerland, 58.7% (n = 27) of respondents reported no tumour-related death, 17.4% (n = 8) reported one dog, 10.9% (n = 5) reported two dogs, and a small number provided unclear responses such as “none” or “probably one”. Thus,

approximately 60% of Swiss owners did not experience tumour-related losses, while approximately 30% lost one or two dogs to tumours.

Among Hungarian respondents, 41.4% (n = 31) reported no death, 37.1% (n = 26) reported one dog death, 11.4% (n = 8) reported two, and 2.9% (n = 2) reported three dogs that had died form tumours. Further observations indicated that some dogs were still alive but undergoing treatment. These findings suggest that although the incidence of tumour appeared to be common in Hungary, the mortality rate was moderate, with most respondents reporting only one tumour-related loss.

### 6.1.4. Age of Dogs at Death due to Tumours

The age at death related to tumour showed similar distributions in both countries, with a higher incidence in older dogs.

In Switzerland, 68% (n = 30) reported no tumour-related deaths, while among those who did, most death occurred between the ages of 9 and 12 years (14%), followed by a smaller number in the 2-4 age range (7%), 5-8 years (5%), and 13-17 years (7%).

In Hungary, deaths have been reported among dogs aged between 4 and 16.5 years, most commonly between 9 and 14 years. Specifically, five dogs died at the age of 9, four at 11, and six at 13 years. Isolated cases involving younger dogs (4 and 7 years old) have shown that tumours can appear even earlier, although infrequently.

Overall, both datasets confirm that tumour-related mortality in dogs is primarily associated with age, consistent with previous literature demonstrating that the risk of cancer increases in older animals.

### 6.1.5. Conclusion

In summary, the Hungarian survey showed a substantially higher proportion of dog owners reporting tumour cases compared to Switzerland, while both countries showed similar patterns with regard to age of onset and mortality. These differences are likely to be due to sampling and awareness factors rather than biological variations in tumour risk. The results highlight the value of owner-based surveys from generating preliminary data, but also highlight the need for larger, standardised, veterinarian-confirmed studies to assess the true epidemiology of canine tumours in different countries.

## 6.2. Comparison of the Swiss and Hungarian Veterinary Clinic Surveys

Surveys on canine tumours conducted at veterinary clinics in Switzerland and Hungary aimed to supplement data provided by owners with information from professional medical records. However, both surveys experienced limited institutional participation, with only one response received from each country. Although these responses provide valuable information on the types and frequency of canine tumours encountered in different clinical environments, the results must be interpreted with caution due to the extremely limited sample size and lack of national representativeness.

In Switzerland, only one response was received – from the Veterinary Clinic Rotkreuz in the canton Zug – despite more than 200 clinics being contacted throughout the country. This clinic, a primary care (first opinion) facility, began operations only on 1 July 2023 and therefore had no historical data on tumours. In contrast, the Hungarian dataset came from Net Vet, a referral veterinary clinic in Hajdú-Bihar County, which provided data for the entire year between 24 September 2023 to 24 September 2024. The Hungarian clinic treated a larger number of cases, approximately 12’500 dogs during that year, providing a more comprehensive picture of the presence and classification of tumours.

Thus, the fundamental difference between the two sets of data lies in the type of clinic and its operational focus: The Swiss response came from a small, newly established primary practice, while the Hungarian response represented a large, specialised referral centre with a high number of cases treated and detailed documentation.

### 6.2.1. Tumour Frequency and Classification

At the Swiss clinic, 10 dogs were newly diagnosed with neoplasia over a 15-month period (July 2023 – October 2024), representing an approximately 4% of the 250 dogs treated. Of these ten cases, nine (9) were classified as benign and one (1) as malignant. The specific tumour types included lymphoma (1), mast cell tumour (1), and histiocytic tumour (1). The reported anatomical sites included the mammary gland (1 case), intestines (1 case), and head (1 case). The average age of the affected dogs was five years.

During the same period, the Hungarian referral clinic recorded 500 new cases of neoplasia in 12’500 dogs treated, corresponding to an approximately annual tumour rate of 4%, which

is remarkably similar in proportion to the Swiss data despite the very different sample sizes. Of these newly diagnosed cases, 350 were benign and 150 were malignant.

The distribution of tumour types was as follows:

- Lymphoma (20)
- Carcinoma (70)
- Sarcoma (10)
- Mast cell tumour (40)
- Histiocytic tumour (5)

The tumours were mainly mammary neoplasms (300 cases), followed by a smaller number of uroepithelial (15), liver (5), lungs (15), head (8), and other less frequent sites (intestine, brain, adrenal gland, kidney, oral cavity). The average age of affected dogs was seven years.

The Hungarian clinic also provided historical data for 500 previously diagnosed cases, which reflect the same distribution and rations between benign and malignant neoplasms (350 benign; 150 malignant).

Overall, both sets of clinical data suggest that canine neoplasia accounts for approximately 4% of the total clinical burden, although the Hungarian data are much more robust. The predominance of benign tumours and the overrepresentation of mammary tumours in Hungary are consistent with known pattens in canine oncology, where mammary neoplasms, particularly in intact females, is among the most common tumour types reported globally.

### 6.2.2. Age at Diagnosis

The Swiss data indicated an average age of 5 years for dogs diagnosed with tumours, while the Hungarian clinic reported an average age of 7 years. Although both figures are lower than the expected age range of 8-10 years often associated with increased risk of cancer, several factors may explain this discrepancy:

- As a new first-opinion clinic, the Swiss clinic, may have seen a relatively younger clientele or fewer geriatric patients.
- The Hungarian referral centre may attract more complex and chronic cases, including older dogs referred for tumour management.

However, both datasets confirm that neoplasia can occur across a wide age range and that the incidence of tumours increases with age, consistent with the patterns identified in the owner-reported data.

### 6.2.3. Tumour Type and Anatomical Distribution

A comparison of tumour types reveals both overlap and contrast between the two countries:

- Common tumour types: Both Swiss and Hungarian clinics reported lymphoma, mast cell tumour, and histiocytic tumour, suggesting that these are common neoplastic entities encountered in both general and referral practice.
- Differences: The Hungarian dataset also documented carcinomas and sarcomas, reflecting the more advanced role of that clinic in diagnosis and referral of cases. The Swiss clinic, being newly established and operating at the primary-care level, may not yet have encountered or recorded a comparable diversity of tumour types.

From an anatomical point of view, mammary gland tumours are present in both datasets, but were significantly more frequent in Hungary (300 of 500 new cases). This reinforces the continuing importance of mammary oncology in unspayed female dogs and the potential need for preventive strategies such as early neutering. In Switzerland, by contrast, only one mammary tumour was recorded – probably due to the very small sample size rather than any real epidemiological difference.

### 6.2.4. Conclusion

In conclusion, data from surveys conducted at Swiss and Hungarian veterinary clinic provide conflicting but complementary information on the occurrence of tumours in dogs. The Swiss clinic, which is small and recently established, reported 10 cases (mostly benign, average age 5 years) out of 250 dogs. The Hungarian referral clinic, with a much higher number of cases, recorded 500 new cases of neoplasia (350 benign, 150 malignant; average age 7 years) out of 12’500 dogs. Despite the profound differences in case size and composition, both datasets reveal a remarkably similar tumour frequency of approximately 4% of treated dogs and a predominance of benign tumours. The predominance of mammary neoplasia in the Hungarian data reflects both biological prevalence and referral bias.

These preliminary results highlight the need for more extensive and coordinated data collection by veterinary clinics in order to accurately characterise the incidence, distribution and age-related dynamics of canine tumours in Europe.

## 6.3. Comparative summary of Canine Tumour Data reported by Veterinary Clinics in Switzerland and Hungary

*Table 2 Comparative Summary of Canine Tumour Data*

| **Parameter** | **Switzerland** (Veterinary Clinic Rotkreuz, Zug) | **Hungary** (Net Vet, Hajdú-Bihar County) |
|---|---|---|
| **Clinic type** | Primary care (first opinion) | Referral centre |
| **Operational period covered** | 1 July 2023 – 28 October 2024 | 24 September 2023 – 24 September 2024 |
| **Total dogs treated during period** | ~ 250 | 12’500 |
| **Total dogs diagnosed with neoplasia (new cases)** | 10 | 500 |
| **Approx. proportion of dogs with neoplasia** | 4% | 4% |
| **Previously diagnosed neoplasia cases** | No data (new clinic) | 500 |
| **Benign tumours (new cases)** | 9 (90%) | 350 (70%) |
| **Malignant tumours (new cases)** | 1 (10%) | 150 (30%) |
| **Average age of affected dogs** | 5 years | 7 years |
| **Most common tumour types** | Lymphoma (1), Mast cell tumour (1), Histiocytic tumour (1) | Carcinoma (70), Mast cell tumour (40), Lymphoma (20), Sarcoma (10), Histiocytic tumour (5) |
| **Most common tumour locations** | Mammary gland (1), Intestines (1), Head (1) | Mammary gland (300), Uroepithelial (15), Lungs (15), Head (8), Liver (5) |
| **Predominant tumour pattern** | Mostly benign; few malignant cases | Mammary neoplasia dominant; both benign and malignant common |
| **Average case load per year** | Small (~250 dogs total) | Large (12’500 dogs/year) |

# 7. Summary

This study examined the incidence and characteristics of canine tumours through surveys conducted among dog owners and veterinary clinics in Switzerland and Hungary. The aim was to explore national patterns of tumour prevalence, tumour-related mortality, and the age distribution of affected dogs, while identifying regional and clinical differences in tumour occurrence.

Among Swiss dog owners (n = 47), responses came predominantly from the German-speaking region, especially St. Gallen, with minimal participation from other regions. Most respondents (76%) owned one dog, and half (50%) reported no tumour cases, while about one-third had one or two affected dogs. Approximately 40% had experienced at least one tumour-related death, typically in dogs aged between 9 and 12 years. These findings indicate that tumours are relatively infrequent among Swiss dogs and occur mainly in older animals.

In Hungary (n = 70), most respondents were from Budapest and Pest County. Most participants (over 75%) also owned one or two dogs, but the incidence of tumour was significantly higher: 81.5% had at least one dog diagnosed with a tumour. Mortality was moderate, with most tumour-related death occurring between the ages of 9 and 14. The results suggest a higher prevalence of reported tumour and greater awareness among Hungarian dog owners than among Swiss respondents.

Data from veterinary clinics reflected similar trends, but on a different scale. In Switzerland, only one newly established primary-care clinic participated, reporting 10 cases of neoplasia (4% of treated dogs) between July 2023 and October 2024 – most of which were benign and diagnosed at an average of five years. In Hungary, a referral clinic reported 500 new tumour cases (4% of 12’500 treated dogs) over the course of one year, in addition to the 500 cases already known. Seventy percent (70%) were benign and 30% malignant, with an average age of diagnosis of seven years. Mammary neoplasia was the most common type of tumour, followed by carcinoma, mast cell tumour, and lymphoma.

In both countries, tumours were predominantly associated with age and mainly affected middle-aged and older dogs. Although prevalence rates were clinically comparable, Hungarian owners reported significantly more cases of tumour than Swiss owners. These differences may reflect variations in diagnostic awareness, access to veterinary care, or reporting habits rather than true disparities in prevalence. Overall, the findings support the

importance of early diagnosis and ongoing data collection to improve understanding of canine cancer patterns in Europe.

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