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Oftalmopathies in 574 dogs of the breed Shih tzus attended at the Veterinary Hospital: retrospective study

Oftalmopatias em 574 cães da raça Shih tzu atendidos em um Hospital Veterinário: estudo retrospectivo

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Abstract: Brachycephalic breeds, including Shih Tzus, are predisposed to developing ophthalmic conditions due to facial conformation. This study investigated the primary ophthalmic diseases in Shih Tzus treated at the Governador Laudo Natel's Veterinary Hospital of São Paulo State University Júlio de Mesquita Filho, Jaboticabal-São Paulo, Brazil, between 2014 and 2022. We selected 574 cases, totaling 1,724 diagnoses. Regarding sex, 50% (287/574) were female, and 50% (287/574) were male. Anatomically, diagnoses in group 1 (lacrimal system, eyelids, and adnexa) were the most common, comprising 55% (945/1,724), followed by group 2 (anterior segment) at 40% (683/1,724), group 4 (eyeball) at 4% (73/1,724), and group 3 (posterior segment) at 1% (23/1,724). The mean age at diagnosis was 5.2 years. Adult dogs were the most represented age group at 55% (317/574), followed by young dogs at 25% (145/574) and elderly dogs at 20% (112/574). Elderly dogs had more diagnoses of glaucoma and cataracts compared to young and adult dogs. In young dogs, the most diagnosed conditions were ulcerative keratitis and distichiasis, while in adults and elderly dogs, the predominant conditions were keratoconjunctivitis sicca and ulcerative keratitis.

Keywords: brachycephalic breed; cataract; ulcerative keratitis; keratoconjunctivitis sicca; distichiasis; entropion.

Resumo: Os cães das raças braquicefálicas incluindo os Shih tzu, são predispostos ao desenvolvimento de afecções oftálmicas em razão da sua conformação facial. O objetivo principal do presente trabalho foi investigar as principais oftalmopatias em cães da raça Shih tzu atendidos no Hospital Veterinário "Governador Laudo Natel" da Universidade Estadual Paulista Júlio de Mesquita Filho, Jaboticabal-São Paulo, Brasil, entre os anos de 2014 e 2022. Foram selecionadas 574 fichas totalizando 1724 diagnósticos. Em relação ao sexo 50% (287/574) eram fêmeas e 50% (287/574) eram machos. Em relação à classificação anatômica os diagnósticos do grupo 1 (sistema lacrimal, pálpebras e anexos) foram os mais expressivos com 55% (945/1724), seguido do grupo 2 (segmento anterior) com 40% (683/1724), grupo 4 (bulbo ocular) com 4% (73/1724) e grupo 3 (segmento posterior) com 1% (23/1724). A idade média do diagnóstico foi de 5,2 anos, sendo que os cães adultos foram os mais representativos

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com 55% (317/574), seguido dos jovens 25% (145/574) e dos idosos com 20% (112/574). Os cães idosos obtiveram mais diagnósticos de glaucoma e de catarata quando comparados aos animais jovens e adultos. Em cães jovens as afecções mais diagnosticadas foram as ceratites ulcerativas e distiquíase, enquanto nos adultos e nos idosos foram ceratoconjuntivite seca e ceratite ulcerativa.

Palavras-chave: braquicefálicos; catarata; ceratite ulcerativa; ceratoconjuntivite seca; distiquíase; entrópio.

1. Introduction

Brachycephalic dogs, resulting from years of artificial selection, are characterized by a short snout and rounded head [(1)]. These dogs continually exhibit anatomical and physiological particularities that lead to health and well-being issues, including changes in the ocular and periocular regions, consequently resulting in the development of ophthalmic disorders [(2,3)]. Among brachycephalic dogs, Shih Tzus were recognized as a breed by the American Kennel Club in 1969. Since then, they have become prolific, ranking twentieth in breed popularity. Unfortunately, they are among the breeds most prone to eye disorders [(4,5,6)].

According to the Brazilian Cinophilia Confederation, Shih Tzus have a friendly and affectionate temperament, a coat of variable colors, long and slightly wavy (not curled), and the hair should not obstruct their vision. They typically weigh between 4 and 7 kg and ideally, have a height at the withers of 20 to 27 centimeters. Their heads are wide and round, with a balanced size relative to their bodies. The eyes are large, round, not prominent, well separated, and dark, with the sclera not visible. In certain coat colors, the eyes may be lighter [(4)].

Numerous conditions impact brachycephalic dogs, such as lagophthalmos, macroblepharon, medial corner entropion, caruncle trichiasis, distichiasis, tear film disorders, ulcerative and non-ulcerative keratitis, and keratoconjunctivitis sicca. Additionally, studies show a greater predisposition of Shih Tzus to retinal detachment, progressive retinal atrophy, vitreous degeneration, corneal ulcers, and ciliary disorders such as distichiasis and ectopic eyelashes [(3,7)].

Early diagnosis of ophthalmic conditions is essential for choosing effective treatment, which can be either surgical or clinical, addressing the origin of the disorder [(3,8,9)]. This underscores the importance of understanding breed-specific and genetic particularities, which provide targeted information for a given breed.

This retrospective study aimed to investigate the primary ophthalmic diseases in Shih Tzus treated at the Governador Laudo Natel's Veterinary Hospital of São Paulo State University Júlio de Mesquita Filho, Jaboticabal-SP, between 2014 and 2022.

2. Material and methods

2.1 Animals

This retrospective research was conducted following ethical standards and approved by the Ethics Committee on the Use of Animals (CEUA) under protocol nº 2901/23. The study

included Shih Tzu dogs, both male and female, of any age, treated in the Ophthalmology sector of the Governador Laudo Natel's Veterinary Hospital at São Paulo State University Júlio de Mesquita Filho, Jaboticabal Campus, between 2014 and 2022. Only dogs diagnosed with at least one ophthalmic disorder were included, while those with incomplete records were excluded.

The study aimed to identify the prevalence, characterize, and recognize the patterns of the most common ophthalmic conditions. Additionally, the distribution by sex and age group was analyzed, and possible associations between the age of the dogs and the incidence of certain conditions were investigated to improve veterinary ophthalmological clinical practice and to guide owners. The goal was to promote the ocular health and well-being of Shih Tzus and emphasize the need for routine consultations with a veterinarian specialized in ophthalmology.

2.2 Review of medical records

Data were collected from each patient's medical record or ophthalmological examination form, covering diagnosis, sex, and age. Different conditions in the same patient were counted separately. Ophthalmic diseases were grouped based on anatomical location into four categories: group 1 – lacrimal system, eyelids, and adnexa; group 2 – anterior segment (sclera, cornea, iris, ciliary body, aqueous humor, and lens); group 3 – posterior segment (vitreous humor, retina, choroid, and optic nerve); and group 4 – ocular bulb (involving both anterior and posterior structures, including glaucoma cases).

When correlating ophthalmic diseases with age, the dogs were categorized according to the American Veterinary Medical Association (AVMA) standards: young (up to one year of age), adult (between one and eight years of age), and elderly (over eight years of age).

2.3 Statistical analyses

Descriptive statistical analyses regarding breed, sex, age at first diagnosis, and diagnosis were performed using software (Excel 2018; Microsoft Corp). P values ≤ 0.05 were considered statistically significant. Statistical analysis was completed using descriptive statistics and the Chi-Square test. The probabilities of dogs (n= 574) developing ophthalmic diseases (glaucoma and cataracts) in relation to age group were calculated using odds ratios (OR) and were considered statistically significant at $p<0.05$. To assess the strength of the association between categorical variables, Cramer's V was used, with values indicating the statistical significance of the association between age group and the diagnosis of glaucoma and cataracts, interpreted according to the following scale: (a) 0 to 0.1: negligible association; (b) 0.1 to 0.3: small association; (c) 0.3 to 0.5: medium association; (d) > 0.5: large association.

3. Results

In total, 770 records were analyzed, with 196 incomplete records excluded, resulting in the inclusion of 574 records and the analysis of 1,724 diagnoses. Regarding sex, 50% (287/574) were female and 50% (287/574) were male. There was no statistically significant difference in the occurrence of diagnoses based on sex ($p = 0.158$). Table 1 shows the distribution of

the Shih Tzu population evaluated in relation to sex and their respective diagnoses, divided according to anatomical location.

Table 1. Distribution of the Shih Tzu population under treatment at the Ophthalmology Sector of the Governador Laudo Natel's Veterinary Hospital according to sex and their respective diagnostic groups. Diagnostic group 1 corresponds to conditions affecting the lacrimal system, eyelids, and adnexa, group 2 the anterior segment, group 3 the posterior segment, and group 4 the eyeball.

		SEX		Total
		Female	Male	
Dog number		287	287	574
Diagnosis group	**Group 1**	500	445	945
	Group 2	330	353	683
	Group 3	15	8	23
	Group 4	37	36	73
p= 0.158	**Total**	882	842	1724

Group 1 – lacrimal system, eyelids, and adnexa; Group 2 – anterior segment; Group 3 – posterior segment; and Group 4 – ocular bulb.

Conditions were classified based on anatomical location. Diagnoses in group 1 (lacrimal system, eyelids, and adnexa) were the most significant, accounting for 55% (945/1,724), followed by group 2 (anterior segment) with 40% (683/1,724), group 4 (ocular globe) with 4% (73/1,724), and group 3 (posterior segment) with 1% (23/1,724) (Figure 1).

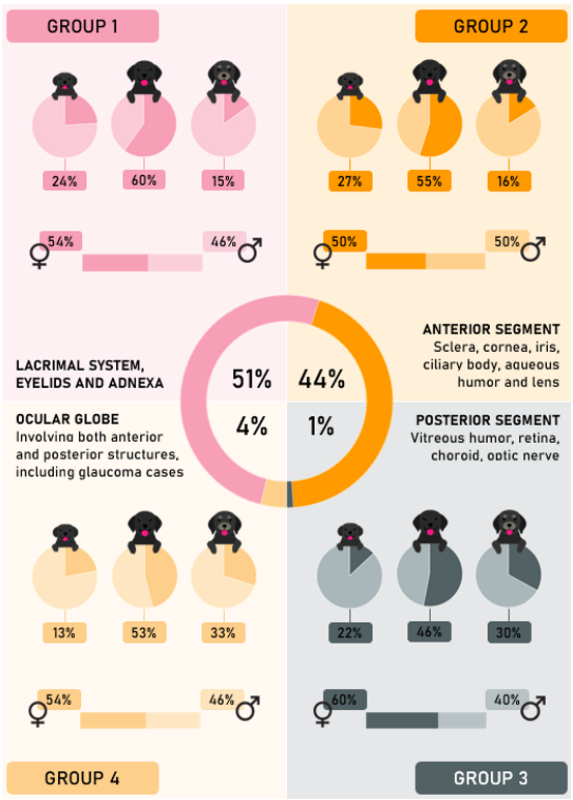

Figure 1. Distribution of ophthalmic diagnoses in Shih Tzu dogs into groups: lacrimal system, eyelids, and adnexa (Group 1), anterior segment (Group 2), posterior segment (Group 3), ocular globe (Group 4), according to their age (young, adult, and elderly) and sex (male and female), at the Ophthalmology Sector of the Governador Laudo Natel's Veterinary Hospital, São Paulo State University Júlio de Mesquita Filho, Jaboticabal, São Paulo State, Brazil.

Adult dogs predominated, accounting for 55% (317/574), followed by young dogs at 25% (145/574) and elderly dogs at 20% (112/574). Table 2 presents the classification of the absolute number of diagnoses and Shih Tzu dogs characterized by age and their respective ophthalmic groups.

Table 2. Absolute number of dogs per diagnosis group according to age class and sex. Group 1 (conditions affecting the lacrimal system, eyelids, and adnexa), group 2 (anterior segment), group 3 (posterior segment), and group 4 (eyeball), at the Ophthalmology Sector of the Governador Laudo Natel's Veterinary Hospital, São Paulo State University Júlio de Mesquita Filho, Jaboticabal-SP, Brazil

		AGE CLASS						Total
		Young		Adult		Elderly		
		♂	♀	♂	♀	♂	♀	
Dog number		75	70	164	153	48	64	574
Diagnosis group	**Group 1**	91	120	288	280	66	100	945
	Group 2	96	62	202	169	55	99	683
	Group 3	1	3	4	6	3	6	23
	Group 4	7	8	18	12	11	17	73
	Total	195	193	512	467	135	222	1724

Group 1 – lacrimal system, eyelids, and adnexa; group 2 – anterior segment; group 3 – posterior segment and group 4 – ocular bulb.

The average age at diagnosis of ophthalmic changes was 5.2 years. According to the Chi-Square test, there was a statistical difference ($p = 0.000$) when ophthalmic diseases were associated with age group and compared between groups. In adults, there was a statistically significant difference ($p<0.05$) for diagnoses 1 and 4, as well as in the elderly for diagnoses 1, 3, and 4. There was no statistically significant difference between the diagnoses in young dogs.

When exploring the likelihood of an animal developing the most prevalent diagnosis in group 4, glaucoma, concerning age, we found that the probability of an elderly Shih Tzu (18/94) developing glaucoma is 6.7 times higher compared to young dogs (4/141). Regarding Cramer's V, the association between categorical variables showed a small association (0.236). When compared to adults (16/301), elderly dogs are 3.6 times more likely to develop glaucoma, with a small association (0.179). Adult dogs were 1.8 times more likely to have glaucoma than young dogs, with no statistically significant difference concerning Cramer's V (0.052).

The probability of an elderly Shih Tzu (20/92) developing cataracts is 10.2 times greater than that of a young dog (3/142) and 2.0 times greater than that of an adult, with Cramer's V being significant for both (0.274) and (0.115). Adult Shih Tzus (30/287) were 4.9 times more likely to develop cataracts than young dogs, with a significant Cramer's V (0.133).

The investigation of the five most diagnosed conditions among all groups showed that ulcerative keratitis was the most recurrent, with 15.2% (262/1,724), followed by keratoconjunctivitis sicca (KCS) (15%; 259/1,724), distichiasis (9.1%; 157/1,724), entropion (6.7%; 115/1,724), and cataracts (4.6%; 79/1,724). Among these, sex influenced the appearance

of distichiasis (z=2.6), with females being the most affected. The respective illnesses and their prevalence concerning age were elucidated in Figure 2.

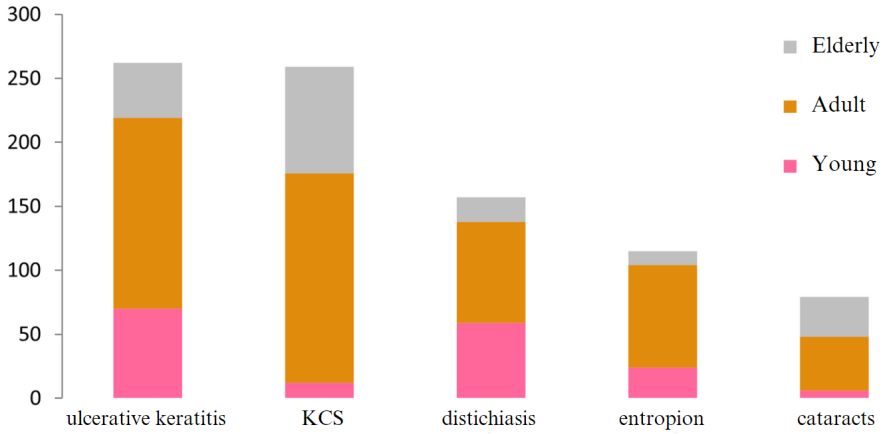

Figure 2. Number of dogs for the five ophthalmic conditions (of the 1,724 dogs) most prevalent in Shih Tzu dogs under treatment at the Ophthalmology Sector of the Governador Laudo Natel's Veterinary Hospital, São Paulo State University Júlio de Mesquita Filho, Jaboticabal-SP, Brazil.

Age influenced the occurrence of cataracts, distichiasis, KCS, and ulcerative keratitis, with these conditions being more prevalent in adult dogs compared to young dogs. When comparing adult and elderly animals, adults showed higher incidences of cataracts, distichiasis, entropion, and KCS. Comparing elderly and young dogs, cataracts and KCS were more prevalent in elderly dogs, while distichiasis, entropion, and ulcerative keratitis were more common in young dogs.

4. Discussion

Shih Tzu dogs frequently suffer from ophthalmic disorders, as seen in veterinary practice [5,10]. This breed has been among the most frequent in the ophthalmology service of the Veterinary Hospital of the Federal University of Bahia, in Brazil, as well as in reference centers in Japan, the United States, and South Korea [10,11]. We observed no significant difference between sexes for all diagnosis groups, which is consistent with recent research findings [10]. The high percentage of diagnoses in adulthood, with 55% (317/574) of dogs in this age group, suggests that Shih Tzus are prone to acquired and chronic conditions [10]. These conditions often require continuous monitoring and control, such as immune-mediated keratoconjunctivitis sicca.

Surface conditions were the most common in this study. Ulcerative keratitis ranked first, accounting for 15.2% (262/1,724) of diagnoses, with the main clinical signs being tearing, photophobia, blepharospasm, corneal edema, miosis, and conjunctival hyperemia. This can be explained by conformational changes in Shih Tzu dogs, such as lagophthalmos (incomplete eyelid closure), which increases the likelihood of ocular surface disorders, ranging from subclinical irritations to serious conditions that threaten the eyeball and vision [12,13]. Additionally, macroblepharon, characterized by an excessively large palpebral fissure, leads to inadequate protection of the ocular surface [11].

James-Jenks et al. [14] investigated the incidence of simple and complex ulcerative keratitis and indolent ulcers. They concluded that, except for chronic spontaneous epithelial defect, which mostly affected Boxer dogs, Shih Tzus had the highest diagnosis rates for all other types of ulcers. O'Neill et al. [5] observed that brachycephalic dogs were 11.8 times more likely to develop corneal ulcers compared to mixed-breed dogs, with Shih Tzus having the highest prevalence.

Reduced corneal sensitivity in brachycephalic patients may contribute to an increased incidence of ulcerative keratitis, as it diminishes the blink reflex, tear production reflex, and production of trophic factors (important for epithelial turnover), leading to corneal injuries due to trauma [5,15,16]. Furthermore, tear film disorders, such as keratoconjunctivitis sicca, can exacerbate ocular surface conditions [17]. The severity of corneal ulcers can lead to profound consequences like endophthalmitis, phthisis bulbi, and glaucoma, which pose risks to the eyeball and vision [18].

Keratoconjunctivitis sicca (KCS) was the second most common condition, with 15% (259/1,724) of diagnoses. It presents with signs such as conjunctival hyperemia, ocular secretion (mucoid or mucopurulent), and itching. This can be attributed to reduced corneal sensitivity in brachycephalic dogs, due to less innervation of the trigeminal nerve (V cranial nerve pair), which negatively affects the afferent pathway of tear production. Research has shown that the Schirmer tear test 1 (STT1) results were approximately 14% lower in brachycephalic dogs compared to non-brachycephalic dogs [19].

The abnormal airflow in the nasal cavity of brachycephalic dogs may also contribute to the higher incidence of keratoconjunctivitis sicca, similar to findings in humans where nasal mucosa stimulation accounts for a sizeable portion of aqueous tear production [2,20]. In Shih Tzu dogs, stimulation of the nasal mucosa increased tear secretion by 9.5% in anesthetized eyes and 10% in non-anesthetized eyes [11].

O'Neill et al. [6] found that brachycephalic dogs were 3.63 times more likely to develop keratoconjunctivitis sicca compared to mesocephalic dogs, with a positive association with senility and Shih Tzus, which were among the breeds with high predisposition rates. In the present study, adult dogs predominated, similar to the findings of O'Neill et al. [6].

In humans, it is well established that ocular surface homeostasis deteriorates with age, adversely affecting tear composition [21]. Similarly, in Shih Tzu dogs, age correlates with a shorter tear film breakup time, with disorders of the meibomian glands, lower goblet cell density, and changes in blinking potentially contributing to this condition [10,11,22,23]. Future studies could further characterize the changes in the ocular surface and tear components of elderly brachycephalic dogs.

Distichiasis is commonly found in brachycephalic dogs and can be asymptomatic [10,11]. In the present study, it was the third most common condition, with 157 diagnoses. Affected dogs exhibited tearing, blepharospasm, epiphora, and pruritus. Brachycephalic dogs showed higher prevalence rates of distichiasis compared to non-brachycephalic dogs; however, Shih Tzus

were not among the most affected breeds, possibly due to their coat type, as dogs with shorter coats were diagnosed more frequently than those with longer coats (Jondeau et al., 2023).

Recent studies have indicated that distichiasis has a low clinical impact, with 85% of the studied population showing no clinical signs. However, brachycephalic dogs exhibited more clinical signs than non-brachycephalic dogs [24]. In the present study, distichiasis was diagnosed primarily in adult dogs, highlighting the challenges of diagnosing this condition before the patient arrived at a reference ophthalmology service, as magnification tools and practice are essential for recognition [24]. Future studies may clarify specific characteristics of distichiasis, such as stiffness, width, and length, in different breeds.

Entropion was the fourth most common condition, with 115 diagnoses. Affected dogs showed tearing, mucopurulent secretion, blepharospasms, and signs of eye irritation. Medial corner entropion is notably prevalent in brachycephalic dogs, including Shih Tzus [11]. Research has shown that 71% of evaluated Shih Tzus exhibited medial corner entropion, contributing to surface conditions [8]. Brachycephalic conformation predisposes these dogs to entropion, as skull shortening causes excessive tension in the medial palpebral ligament and consequent narrowing [25]. One consequence of entropion is obstruction of the inferior nasolacrimal puncta, leading to inadequate tear drainage, epiphora, chromodacryorrhea, and ventral moist dermatitis [23, 25].

Cataracts were the fifth most common diagnosis, with 79 cases, predominantly affecting adult dogs. Common signs included lens opacity, visual deficit/loss, ocular secretion, and uveitis. Shih Tzus are among the breeds most affected by cataracts [10,26]. Park et al. (26) found that the average age of cataract diagnosis was 8.3 ± 3.9 years, but in Shih Tzus, the onset was earlier, around 6.5 years. This contrasts with other research where Shih Tzus and Toy Poodles were diagnosed later, at around 10 years of age [27].

In this research, the probability of an elderly Shih Tzu dog (20/92) developing cataracts was 10.2 times greater than that of a young dog (3/142) and 2.0 times greater than an adult (30/287). Adult Shih Tzus were 4.9 times more likely to develop cataracts compared to young dogs. The likelihood of developing immature cataracts increased by 1.1 times each year since the first treatment of brachycephalic dogs [10].

Age and breed predisposition are proposed etiologies for cataract formation [26], aligning with the results of this investigation. Additionally, it is well understood that Shih Tzus are predisposed to retinal detachment, vitreous degeneration, and progressive retinal atrophy, conditions associated with cataract formation [29]. However, this study did not explore the plausible causes of cataracts in these dogs, which could be addressed in future research.

Regarding glaucoma, the study found that the probability of an elderly Shih Tzu (18/94) developing glaucoma was 6.7 times greater than that of a young dog (4/141) and 3.6 times higher compared to adults (16/301). Adult dogs were 1.8 times more likely to develop glaucoma than young dogs. The Shih Tzu breed is predisposed to primary glaucoma due to abnormalities in the iridocorneal angle and dysplasia of the pectinate ligaments. Additionally, the SRBD1 gene polymorphism plays a significant role in the emergence of glaucoma in Shih Tzus, Shiba Inus, and humans [30]. This study did not classify glaucoma into congenital, primary,

or secondary types. The most commonly observed clinical signs were increased intraocular pressure, mydriasis, episcleral congestion, buphthalmos, presence of Haab's striae, variable changes in the optic nerve, and vision loss.

Age is an important risk factor for glaucoma, especially in pure breeds, where the majority of cases appear at an average age of six years [28]. The breakdown of the blood-aqueous barrier, resulting in proteins and cells in the aqueous humor (aqueous *flare*), has been described in humans and animals, leading to serious conditions such as cataracts, vitreous opacities, blindness, glaucoma, and eventually *phthisis bulbi* [31]. It is understood that in humans, aqueous *flare* increases with age (32, 33), which may support the presence of glaucoma in older ages and the possibility of sequelae due to anterior segment changes.

However, studies focusing on this topic in dogs are still limited. Despite the high prevalence, there is a lack of investigation into the genetic etiologies and specificities in Shih Tzus. An in-depth understanding of the pathogenesis is essential for effective management and preservation of vision. Moreover, it is presumed that each breed may exhibit different manifestations of glaucoma [15], making treatment even more challenging.

In these dogs, the heritability of certain conditions, such as keratoconjunctivitis sicca, glaucoma, cataracts, progressive retinal atrophy, optic nerve hypoplasia, and retinal degeneration, has led the Genetics Committee of the American College of Veterinary Ophthalmologists to discourage breeding Shih Tzus with such diagnoses [34]. Additionally, in Brazil, it is challenging to describe breed patterns accurately due to widespread domestic, improper, and unregulated crossbreeding, which can negatively affect the description of morphological and genetic characteristics.

Like many retrospective studies, we acknowledge weaknesses in the present study, such as the exclusion of some clinical records due to incomplete data and geographical influence that may affect the prevalence of certain breeds and ophthalmic conditions. However, our results provide invaluable information that can contribute to more individualized decisions for Shih Tzus, as this breed has become increasingly popular in Brazil. The findings clarify routine conditions, allowing for more efficient, assertive, and early intervention.

5. Conclusion

The most commonly diagnosed conditions among Shih Tzu dogs were ulcerative keratitis, keratoconjunctivitis sicca, distichiasis, entropion, and cataracts. Adult dogs were the most represented among these conditions, with no statistically significant difference between sexes in the occurrence of these diagnoses.

Declaration of conflict of interest

The authors declare no conflict of interest.

Author contributions

Conceptualization: L.R., Marchini and F.A., Fachini. *Investigation*: L.R., Marchini. *Formal analysis*: I.P., Rabelo. *Supervision*: P.C., Moraes.

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