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Prevalence Of Cognitive Dysfunction Syndrome In Dogs In Araucanía, Chile

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Abstract:
The objective of the study was to determine the prevalence of Cognitive Dysfunction Syndrome in Dogs (CDS) whose owners were surveyed between January and April 2024 in Chile's Araucanía region. Previous studies indicate that the prevalence of CDS is approximately 48% in older dogs, which demonstrates an underdiagnosed pathology (Neilson, Hart, Cliff & Ruehl, 2001). Our findings highlight the high prevalence of CDS in geriatric dogs and the importance of early diagnosis. Early detection can allow interventions that delay the progression of the disease and improve the quality of life for affected dogs. The relationship between dog size and the severity of CDS remains a debated area that requires further research. The high prevalence of CDS in geriatric dogs underscores the need to increase awareness of this condition among pet owners and veterinarians. Ongoing research and education about CDS are essential for developing and implementing effective strategies that promote the health and well-being of aging dogs.

INTRODUCTION

Human history has been deeply intertwined with certain animal species, particularly the dog. This enduring relationship has led to the dog being considered the domestic species most closely associated with humans. Today, dogs are not only pets but integral members of many families, performing tasks that aid or simplify human life. This close bond with humans has resulted in significant improvements in the care provided to dogs, which translates into a notable increase in their life expectancy and age-related pathologies (Sanabria, 2013). One such pathology is Cognitive Dysfunction Syndrome (CDS), a neurodegenerative disease that affects older dogs. It is characterized by the progressive loss of brain functions such as memory and learning ability. In Chile, there is growing interest in studying this pathology due to the increased life expectancy of dogs and concerns about the quality of life of animals. The objective of this work is to analyze the prevalence of CDS in dogs in the Araucanía region of Chile and to determine the risk factors associated with this disease. As dogs age, they develop a form of neurodegenerative disease that has many similarities with age-related cognitive decline and Alzheimer's disease in humans. A decrease in learning and memory can be demonstrated in dogs from the age of 7 through various neuropsychological tests (Landsberg, 2005). Thus, older dogs spontaneously develop progressive cognitive and behavioral dysfunction, along with neuropathological changes that collectively parallel several aspects of human aging and the progression of Alzheimer's disease, likely contributing to the development of canine cognitive dysfunction syndrome. Latency in response and memory tests increases significantly in older dogs in both initial and reversal learning tasks, but not in retention tasks, suggesting that processing speed is affected by increasing age during the acquisition of novel spatial information but not during the execution of previously learned tasks (Mongillo, 2013). Our study on canine cognitive dysfunction syndrome (CDS) is a disease similar to Alzheimer's in humans. This progressive neurodegenerative disease affects older dogs, causing many behavioral changes and diminishing the well-being of both the dog and the owner. Despite its high impact, many studies have shown that CDS is underdiagnosed. To address this, our study employed rigorous methodology. We randomly recruited 622 older dogs (aged seven years or older). After an initial interview, 389 dogs were excluded from the study due to clinical and sensory impairment. The owners of the remaining 233 dogs completed a questionnaire listing behavior related to CDS. The behavior was grouped into categories: disorientation, interaction, sleep-wake cycle, activity, and house soiling. Studies conducted in Thailand with 233 dogs through a survey concluded that 122 dogs (52.4%)

showed signs compatible with CDS. The percentage of dogs with CDS signs increased significantly with age. Sex and weight/body size did not significantly correlate with cognitive decline. The study also revealed that the sleep-wake cycle and activity were the most deteriorated behavioral categories (Benjanirut, 2018). Due to the fact that the canine population reaches older ages every day as a result of advancements in veterinary medical practice and various diagnostics, it is deemed necessary to identify the prevalence of these pathologies to alert clinicians to the importance of early diagnosis. A study conducted in Brazil indicates that the prevalence of behavioral changes in the geriatric canine population was 90.7% of dogs, with at least one of these behavioral changes, 22.3% with at least six changes, and changes in physical activity (58.5%) and loss of acquired training (30.2%) being the most reported by owners (Svicero, 2016).

MATERIALS AND METHODS

The Canine Dementia Scale (CADES) survey (Madari, 2015), which is the only validated instrument for this purpose, was used. This survey was applied to 250 owners from January to April 2024 and analyzed through SPSS. It was classified according to the authors' definitions by score: a score of 4-15 is consistent with mild CDS, 16-33 is moderate, and >33 is severe. All owners with dogs older than 8 years were asked to complete the survey. The ages of these animals ranged from 7 to 19 years (mean age of 10.5 years), of different breeds and sexes. Small dogs (<9.0 kg) were considered elderly at 11.48±1.86 years; medium dogs (9.0-23.0 kg) at 10.19±1.56 years; large dogs (23.1-36.0 kg) at 8.85 ± 1.38 years; and giant dogs (>36.0 kg) at 7.46 ± 1.27 years (Goldston, 1989). Incomplete surveys were eliminated (11 surveys). The questionnaire (Figure 1) focused on: disorientation, changes in social interaction, loss of training (house soiling), changes in the sleep-wake cycle, physical activity, memory, learning, awareness, and perception (Ruehl & Hart, 1998).

RESULTS

The distribution of evaluation scores within each breed size highlights that most small breed dogs were evaluated as healthy (21.3%), followed by those with mild signs (32.5%). Conversely, in the medium breed category, the majority were also evaluated as healthy (68.1%), with a smaller percentage showing mild signs (49.2%). In the case of large breed dogs, the proportion of healthy dogs was even lower (10.6%), while those with mild signs represented the highest percentage (18.3%). Analyzing the distribution of evaluation scores in relation to the size of the dogs shows that most dogs classified as healthy belong to the medium breed category (54.4%), followed by small breeds (31.4%). However, the proportion of large breed dogs evaluated as healthy is significantly lower (14.2%). Regarding the severity of signs presented by the dogs, most cases of moderate signs are found in medium breed dogs (56.6%), followed by small breeds (30.2%). On the other hand, large breed dogs show the lowest proportion of moderate signs (13.2%). Regarding severe signs, the sample presents a limited number of cases, being more common in small breed dogs (4.2%) and medium breeds (3.8%), while no cases of severe signs were recorded in large breed dogs. All these results are consistent with the literature.

Distribution of Evaluation Scores by Dog Size

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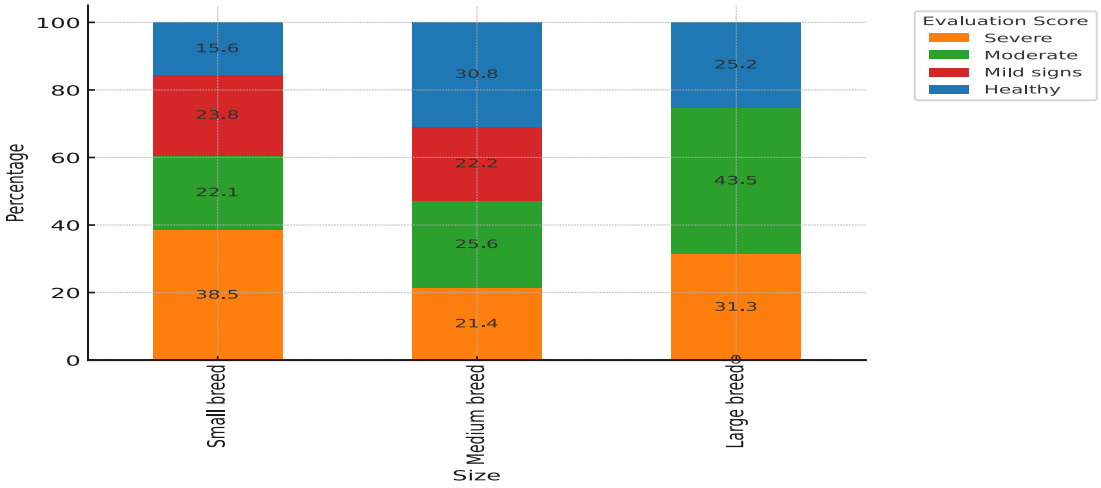

Analysis of Association Tests between Score and Size in Evaluated Dogs

Chi-square tests:

Test	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	11.368a	6	0.078
Likelihood Ratio	13.629	6	0.034
Linear-by-Linear Association	3.763	1	0.052
N of Valid Cases	239		

a. 1 cell (8.3%) has an expected count less than 5. The minimum expected count is 2.70.

Pearson's Chi-square indicates an association between score and size; however, its level of significance (0.078) does not reach the conventionally accepted threshold of 0.05, suggesting that the association might be due to chance. In contrast, the Likelihood Ratio shows a significantly lower value (13.629) and a higher significance (0.034), suggesting a more robust association between score and size. This test is particularly suitable when there are low expected counts in the cross-tabulation, enhancing its reliability in this specific situation. Based on these results, it is suggested to give greater weight to the Likelihood Ratio results when interpreting the relationship between score and size in the sample of evaluated dogs. The following 100% stacked bar chart provides a visualization of the distribution of dog sizes according to their evaluation classification. Each bar represents the total dogs evaluated in each size category (small, medium, and large breed), divided by their evaluation classification (healthy, mild signs, moderate signs, and severe signs). This graphical representation allows comparison of how different evaluation classifications are distributed within each size category.

The analysis of the correlation test between evaluation scores and the age of the dogs reveals a significant and positive correlation between these two variables. The Pearson correlation between evaluation scores and the age of the dogs is 0.485. This indicates a moderately strong relationship between these variables. Furthermore, the 2-sided significance value is 0.000, indicating that the correlation is significant at a 99% confidence level. In other words, there is a very low probability that this correlation is due to chance.

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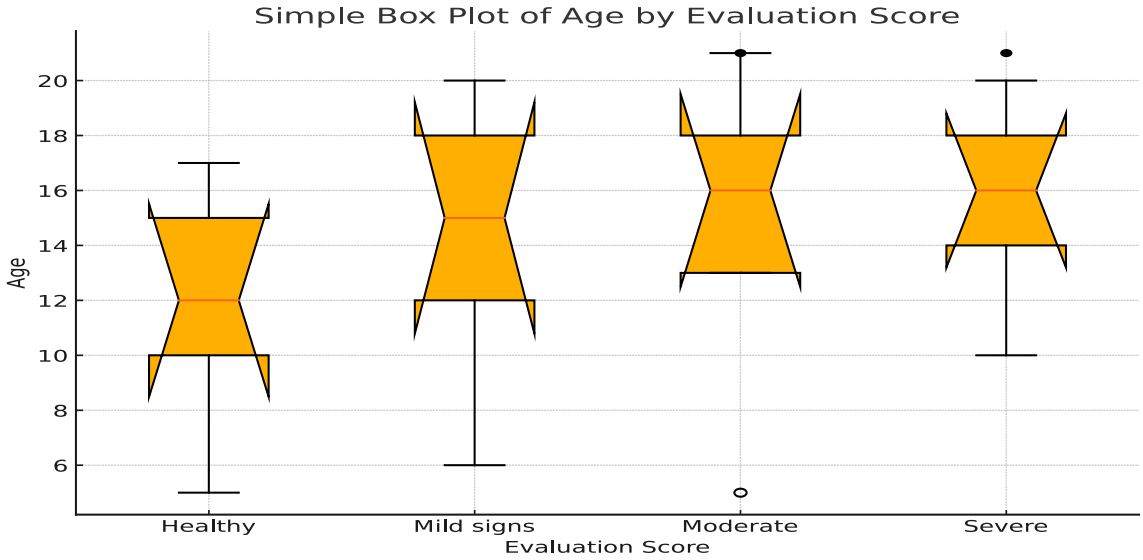
Correlations	Score	Age
Score	Pearson Correlation	1
	Sig. (2-tailed)	
	N	239
Age	Pearson Cor	

This finding suggests that, in general, as the age of the dogs increases, their evaluation scores also tend to increase. This could be interpreted in several ways: for example, older dogs may be more prone to developing certain health problems that are reflected in higher evaluation scores. Alternatively, it could indicate that older dogs have more time to accumulate signs of aging that are reflected in the evaluation scores.

The following graphical representation, using a simple box plot, shows the distribution of the ages of the dogs, segmented by diagnostic classifications derived from the evaluation scores. Each box in the diagram represents the distribution of ages within a specific diagnostic classification, showing the median, interquartile range, and outliers where applicable.



An additional analysis was conducted on the relationship between the ages of the dogs and their diagnostic classifications derived from the evaluation scores. The ages were recoded based on ranges established in the literature, dividing the dogs into three groups: Younger (1-7 years), Middle-aged (8-12 years), and Older (13 years and above).

Cross Tabulation Ages * Evaluation Score							
			Evaluation Score				Total
			Healthy	Mild Signs	Moderate Signs	Severe	
Ages	**Younger**	Count	1	7	3	1	12
		% within Ages	8,3%	58,3%	25,0%	8,3%	100,0%
		% within Evaluation Score	2,1%	5,8%	5,6%	5,3%	5,0%
		% of Total	0,4%	2,9%	1,2%	0,4%	5,0%
	Middle-aged	Count	40	76	19	1	136
		% within Ages	29,4%	55,9%	14,0%	0,7%	100,0%

		% within Evaluation Score	85,1%	62,8%	35,2%	5,3%	56,4%
		% of Total	16,6%	31,5%	7,9%	0,4%	56,4%
	Older	Count	6	38	32	17	93
		% within Ages	6,5%	40,9%	34,4%	18,3%	100,0%
		% within Evaluation Score	12,8%	31,4%	59,3%	89,5%	38,6%
		% of Total	2,5%	15,8%	13,3%	7,1%	38,6%
Total		Count	47	121	54	19	241
		% within Ages	19,5%	50,2%	22,4%	7,9%	100,0%
		% within Evaluation Score	100,0%	100,0%	100,0%	100,0%	100,0%
		% of Total	19,5%	50,2%	22,4%	7,9%	100,0%

The resulting cross-tabulation reveals interesting patterns in the distribution of diagnostic classifications within each age group. In the Younger group, most dogs were diagnosed with mild signs (58.3%) and moderate signs (25.0%), while in the Middle-aged group, the prevalence of mild signs (55.9%) was higher, followed by moderate signs (14.0%). On the other hand, in the Older group, there is a higher prevalence of moderate signs (34.4%) and severe signs (18.3%).

Applying statistical tests to evaluate the association between recoded ages and diagnostic classifications yielded significant results. Both Pearson's Chi-square and the Likelihood Ratio showed high values (50.287 and 54.734 respectively), with an asymptotic significance of 0.000. This indicates a highly significant association between recoded ages and diagnostic classifications. Additionally, the Linear-by-Linear Association test also indicated a significant association, with a value of 30.580 and a significance of 0.000. This suggests a linear trend in the association between recoded ages and diagnostic classifications.

DISCUSSION

Describing a precise epidemiological profile of Cognitive Dysfunction Syndrome (CDS) in dogs poses significant challenges. As highlighted by Landsberg and Malamed (2017), the reporting rate by owners can introduce biases in the prevalence of the disease and its clinical signs. In most cases of CDS, dogs are over 8 years old and exhibit progressive cognitive decline over several months, as shown by our sample. Current information on predisposition and risk factors is controversial. While some studies suggest a correlation between CDS and smaller size, others refute this association, which aligns with our study's results.

The prevalence of CDS in geriatric dogs varies considerably across studies. Neilson et al. (2001) reported a prevalence close to 48% in older dogs, indicating that this pathology is significantly underdiagnosed. Our research found that the prevalence of signs compatible with CDS was 52.4%, suggesting a high incidence of this condition in older dogs and reinforcing the need for more precise and early diagnoses. The study conducted in Thailand by Benjanirut (2018) with 233 dogs through a survey concluded that 52.4% showed signs compatible with CDS. The percentage of dogs with CDS signs increased significantly with age, similar to the findings of our study. However, no significant correlation was found between cognitive decline and sex or body weight/size, which also aligns with our results.

In Brazil, Svicero (2016) indicated a prevalence of 90.7% of behavioral changes in the geriatric canine population, with 22.3% presenting at least six changes. Changes in physical activity (58.5%) and loss of acquired training (30.2%) were the most reported by owners. These results underscore the high prevalence of CDS and the need for early intervention strategies.

Our study on CDS used the Canine Dementia Scale (CADES) survey, a validated instrument that allows for classifying the degree of cognitive dysfunction in dogs. The results showed a varied distribution of the disease according to the size of the dog. Small dogs showed a higher proportion of mild signs (32.5%), while medium and large breed dogs showed a higher proportion of moderate and

severe signs. This finding could be due to differences in owners' perception or variability in disease progression according to dog size.

Statistical analysis revealed a significant and positive correlation between evaluation scores and the age of the dogs (Pearson correlation of 0.485, $p < 0.001$), indicating that as dogs age, the likelihood of developing CDS increases. This finding is consistent with previous studies showing a higher incidence of CDS in older dogs (Landsberg, 2005).

Additionally, the analysis of the association test between evaluation scores and dog size indicated a significant association (Likelihood Ratio = 13.629, $p < 0.05$). However, Pearson's Chi-square did not reach the conventionally accepted threshold of significance ($p = 0.078$), suggesting that the association could be weak or influenced by other factors not considered in this study.

The study has allowed for determining the prevalence of Cognitive Dysfunction Syndrome (CDS) in geriatric dogs in Chile's Araucanía region using the Canine Dementia Scale (CADES) survey. The following are the most relevant conclusions:

- High Prevalence of CDS: The prevalence of signs compatible with CDS in dogs over 8 years old is significant, with 52.4% of the dogs showing symptoms of the disease. This finding is in line with previous studies reporting prevalences close to 48% in geriatric dogs (Neilson et al., 2001).
- Impact of Aging: There is a significant and positive correlation between the age of the dogs and the CDS evaluation scores (Pearson correlation of 0.485, $p < 0.001$). This indicates that as dogs age, the probability of developing CDS increases, highlighting the importance of vigilance and early diagnosis in older dogs.
- Distribution by Size and Breed: The distribution of CDS varies according to dog size. Small dogs showed a higher proportion of mild signs (32.5%), while medium and large breed dogs showed a higher proportion of moderate and severe signs. Although a significant association was observed between dog size and CDS scores (Likelihood Ratio = 13.629, $p < 0.05$), this relationship is complex and may be influenced by multiple factors.
- Importance of Early Diagnosis: The high prevalence of CDS and its progression with age emphasize the need for early diagnoses and the implementation of early intervention strategies. Early detection can significantly improve the quality of life of affected dogs and their owners.
- Need for Further Research: The relationship between dog size and the severity of CDS remains a debated area. While some studies suggest a higher prevalence in small dogs, others, including our results, do not find a significant correlation. More research is needed to better understand the risk factors and disease progression.

Veterinarians should be alert to the signs of CDS in geriatric dogs and consider using validated evaluation tools like CADES for diagnosis. Educating owners about the signs and symptoms of CDS is also crucial to improving early detection and disease management.

In conclusion, the study provides a comprehensive view of the prevalence of CDS in geriatric dogs in Chile and underscores the importance of continuous vigilance, early diagnosis, and timely intervention to improve the quality of life of affected dogs and their owners.

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Statement of Animal Ethics

All procedures involving animals were conducted in accordance with the ethical standards of the institution and the relevant national guidelines. The study did not involve the direct participation of animals. A survey was conducted with the guardians, who signed and approved an informed consent regarding the use of data and the confidentiality of information.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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