

## Prevalance of Behavioral Changes Associated with Age-Related Cognitive Impairment in Geriatric Dogs, Bursa, Turkey

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**Abstract:** The aim of this study was to investigate the prevalence of behavioral changes associated with age in dogs and their relationship to sex, reproductive status, weight, housing and feeding. About 134 dogs older than 7 years were included in this study. Owners of dogs were interviewed and gather information about signs: sleep/wake cycle, social interaction, learning and house training and disorientation. Forty seven dogs (35.07%) were found to have shown behavioural changes associated with age-related cognitive impairment. Prevalance increased with age. There were no significant effects of sex, weight, housing (inside/outside) and feeding (dry food/home made) on behavioral changes. According to categories, 20 dogs had alterations in one category, 7 dogs had two categories, 12 dogs with three categories and 7 dogs had four categories. The most impaired behavioral categories were changes in sleep/wake cycles (32%) and social interaction (30%) followed by disorientation (20%) and learning and house training (18%). The results of this study suggest that estimates of the prevalence of various degrees of age-related behavioral changes. Veterinarian and dog owner should be aware of this problem.

**Key words:** Cognitive impairment, age-related, geriatric dogs, behavior, Alzheimer-likediseases, canine cognitive dysfunction

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### INTRODUCTON

Improved veterinary care, nutrition and safer home environments are allowing dogs to live well into their senior years (Hart, 2001). In dogs, this aging period may start as early as 7 years old (Geer *et al.*, 2007). A longer life span brings with it age-related degenerative changes in a number of organ systems and it was suggested that the accumulation of amyloid protein in the brain, might lead to these impaired cognitive abilities (Heath *et al.*, 2007; Lansberg *et al.*, 2003; Siso *et al.*, 2006). The dogs represent a suitable animal model to study cognitive impairment observed in human ageing (Cummings *et al.*, 1993; Overall, 2000).

A serious impairment of cognitive processes must be distinguished from a simple and mild decrease in psychomotor activity and may be considered pathological ageing (Ruehl and Hart, 1998). The term Canine Cognitive Dysfunction (CCD) Syndrome is used in the veterinary literature to describe the progressive neurodegenerative disorder of senior dogs that is characterized by a gradual decline in cognitive function (learning, memory, perception and awareness) (Milgram *et al.*, 1994; Cummings *et al.*, 1996; Frank, 2002; Landsberg, 2005). Age

related behavioral changes may be useful indicators for early diagnosis and treatment of CCD (Osella *et al.*, 2007). Dogs with CCD is the extensive  $\beta$ -amyloid peptide deposition within the neurones and the synaptic regions of the brain (Borras *et al.*, 1999). CCD shares some analogies with Alzheimer's Disease (AD) in humans and is characterized by brain pathology that negatively affects the interaction of dogs with their own environment (Cummings *et al.*, 1996). As in dogs with cognitive impairment, changes in humans with Alzheimer's disease are progressive (Jack *et al.*, 1999; Bain *et al.*, 2001).

Behavioral changes associated with age-related cognitive impairment fall mostly into four categories, namely altered social interaction, loss of house training, disorientation and disturbance of the sleep-wake cycle (Siwak *et al.*, 2002; Heath *et al.*, 2007). Prevalance and severity increased with age (Azkona *et al.*, 2009). Neilson *et al.* (2001) showed that 28% of 11-12 years old dogs and 68% of 15-16 years old dogs presented impairment in one or more CCD-associated behavioural categories. Osella *et al.* (2007) found that 75 geriatric dogs of 124 tested animals had clinical signs consistent with CCD. The impact of sexual status on CCD prevalence is important. Females and neutered dogs were significantly

more affected than males and entire dogs, respectively (Azkona *et al.*, 2009). The aim of the study was to determine the prevalence of clinical signs of cognitive impairment in randomly selected population of geriatric dogs in Turkey. In addition, data was collected about sex, reproduction status, weight, housing and feeding of age-related problems in dogs.

**MATERIALS AND METHODS**

The study was designed as a cross-sectional study. Records from Uludag University, Faculty of Veterinary Medicine, Animal Teaching Hospital and four private veterinary clinics of small animals were searched to identify dogs 7-18 years old. A total of 1250 dogs were identified, of which 134 (10.72%) were older than 7 years old. Dogs not referred for behavioural consultations were used for the initial study. Inclusive criteria were the age (>7 years old), absence of any obvious medical disease, not receiving any drugs or medications that might alter cognitive or behavioral responses.

Dogs were divided into 3 age groups (7-10, 11-15 and 16-18 years). Dogs were classified based on weights as small size (<10 kg), medium size (10-20 kg) and large size (>20 kg). Dogs were divided sex and castration status and determined housing (inside/outside) and feeding status (dry food/home made). A phone interview adapted from Neilson *et al.* (2001) was used for the present study.

It included a questionnaire related four behavioral categories (Table 1). Categories were considered impaired if more than one sign within a category was affected. According to the number of impaired categories, cognitive impairment was further classified into mild (one category), moderate (two categories) or severe (three or four categories) as similar Azkona *et al.* (2009).

Table 1: Signs of the four behavioural categories that addressed cognitive dysfunction

Category	Behavioural signs
Sleep/Wake cycles	Walks or barks at night Changes in sleeping time Altered activity level
Social interaction	Decreases greeting behaviour Does not recognise familiar people Does not play with owner or other animals Decreases responsiveness to stimuli
Learning and house training	House soiling Forgets known commands or tricks
Disorientation	Deficits in learning and memory Gets lost in familiar locations Does not know to go out of narrow places Goes to wrong side of door Eyes fixed on the horizon

**Statistical analysis:** Statistical analysis was carried out using the statistical program SPSS 12.0 for Windows (SPSS Inc.). The prevalence of age-related cognitive impairment was calculated within the sample population according to age, sex, reproduction status, weight, housing and feeding status. Unvariable logistic regression analysis was applied between cognitive impairment as dependent variable (criterion variable) and age, sex, reproduction status, weight, housing and feeding status as independent variables (predictor variables) individually.

**RESULTS AND DISCUSSION**

In this study, a total of 134 geriatric dogs were included. Age, sex and reproduction status of geriatric dogs are shown in Table 2 and weight, housing and feeding status are shown in Table 3. The results of the statistical analysis revealed that 47 dogs (35.07%) of the geriatric dog population detected impairment of one or more behavioral categories. According to multivariable logistic analysis, age ( $p < 0.001$ ) found as significant predictor variables for cognitive impairment. The sex distribution of dogs were balanced: 25 (53.2%) female, 22 (46.8%) male and only 8 (17%) neutered. CCD with dogs according to age and weight shown in Table 4. In this study, 39 (83%) dogs live inside and 8 dogs (17%) live outside. The studied dog population was balanced according to feeding (51% dry food, 49% home-made). Housing and feeding status shown in Table 5.

Twenty dogs had alterations in one category, 7 dogs had two categories, 12 dogs with three categories and 7 dogs had four categories. The most impaired behavioral categories were changes in sleep/wake cycles (32%) and social interaction (30%) followed by disorientation (20%) and learning and house training (18%). There were no significant effects of sex, weight, housing and feeding status on behavioral changes. A survey of the owners of 180 healthy dogs aged 11-16 years was conducted to determine the incidence of the following behaviors: alterations in social interaction with owners, sleep-wake cycles or activity levels, house soiling or disorientation (Neilson *et al.*, 2001; Cummings *et al.*, 1996; Bain *et al.*, 2001). Neilson *et al.* (2001) reported an age-related increase in the incidence of one or more of these behaviors with 28% of the dogs reported to be affected at 11-12 years and 68% affected at 15-16 years of age. Holm-Cristensen (2008) found the prevalence was significantly higher in group 14 years compared to group 8-9 years in Denmark and there was a tendency towards higher prevalence with higher age. Akita and

**Table 2: Age, sex and reproduction status of geriatric dogs**

Parameters	Values (%)
<b>Age (years)</b>	
7-10	81 (60.4)
11-15	42 (31.3)
16-18	11 (8.3)
<b>Sex</b>	
Male	70 (52.2)
Female	64 (47.8)
<b>Reproduction status</b>	
Neutered	26 (19.4)
Intact	108 (80.6)

**Table 3: Weight, housing and feeding of geriatric dogs**

Status	Values (%)
<b>Weight (kg)</b>	
<10	49 (36.6)
10-20	28 (20.9)
>20	57 (42.5)
<b>Housing</b>	
Inside	104 (77.6)
Outside	30 (22.4)
<b>Feeding</b>	
Dry food	68 (51.0)
Home made	66 (49.0)

**Table 4: Canine cognitive dysfunction with dogs according to age and weight of geriatric dogs**

Category	Age (years)			Total
	7-10	11-15	16-18	
Small (<10 kg)	7/19	15/24	5/7	27/50
Medium (10-20 kg)	0/15	4/10	2/3	6/28
Large (>20 kg)	9/47	5/8	0/1	14/56
Total	16/81	24/42	7/11	47/134

**Table 5: Canine cognitive dysfunction with dogs according to housing and feeding status**

Status	Values (%)
<b>Housing</b>	
Inside	39 (83)
Outside	8 (17)
<b>Feeding</b>	
Dry food	24 (51)
Home made	23 (49)

Uchida (2007) reported 44.4% were found to have shown some behavioural changes which were present in canine cognitive dysfunction cases. In this study, cognitive impairment showed a prevalence of 35.07% (47 dogs) of the geriatric dog population detected impairment of one or more behavioral categories. Data on the prevalence of CCD suggest that the phenomenon is underestimated in veterinary medicine (Osella *et al.*, 2007). The most recent retrospective study (Neilson *et al.*, 2001) looked at 180 dogs (83 castrated males and 97 spayed females) representing 3 age groups, namely, dogs aged 11-12 (n = 80), 13-14 (n = 66) and 15-16 years old (n = 34). The percentage of 11-12 years old dogs with minor impairment was 17.5% and severe impairment was 10% total number of dogs. The percentage of 15-16 years old dogs were 32 and 35% for mild and severe impairment, respectively (total number of dogs affected

67%). Age related behavioral changes are progressive in dogs (Bain *et al.*, 2001) and especially detected up to 12 years (Studzinski *et al.*, 2005).

The neuroprotective role of testosterone has been also suggested in human beings (Wolf and Kirschbaum, 2002) and animals (Hart, 2001). Hart (2001) detected presence of circulating testosterone in aging sexually intact male dogs may slow the progression of cognitive impairment, at least among dogs that already have signs of mild impairment. Also another study (Luine *et al.*, 1998) suggests estrogen potentiates memory and learning in rodents and ovariectomy results in a decline in learning ability and memory. Both estrogen (Xu *et al.*, 1998) and testosterone (Gouras *et al.*, 2000) reduce accumulation of the  $\beta$ -amyloid material that comprises the neural plaques associated with cognitive impairment in humans and dogs. In this study only 8 dogs (17%) neutered. The rate is so low because of aspect to the castration in the country. Although the present results indicate that small size dogs had significantly greater prevalence of age-related behavioral changes than medium and large size dogs, weight can not be considered as a predictor variable for CCD. This results showed parallelism as Azkona *et al.* (2009)'s results. It is known that small dogs live longer than medium and large size dogs (Neilson *et al.*, 2001).

The relationship cannot be known between housing and CCD. Thirty-nine (83%) dogs live inside and 8 dogs (17%) live outside. Prevalance of age-related cognitive impairment in dogs live inside is remarkable higher than live outside. Dogs were kept outside may be exposure to more social stimuli than kept inside.

In future, more studies should be done about this topic. A variety of studies (Martin *et al.*, 2000; Youdim *et al.*, 2000) have shown that high intakes of fruits and vegetables might also decrease the risk for age related cognitive decline through their antioxidant and anti-inflammatory properties.

The studied dog population was balanced according to feeding (51% dry food, 49% home made). Osella *et al.* (2007) found that Senilife (phosphatidy-lserine), a standardized extract of Ginkgo biloba, dalpha-tocopherol and pyridoxine) showed a marked improvement of CCD related signs.

In this study, there were no significant effects of feeding status and CCD. According to categories, 20 dogs had alterations in one category, 7 dogs had two categories, 12 dogs with three categories and 7 dogs had four categories. The most impaired behavioral categories were changes in sleep/wake cycles (32%) and social interaction (30%) followed by disorientation (20%) and learning and house training (18%).

## CONCLUSION

The results of this study suggest that estimates of the prevalence of various degrees of age-related behavioral changes. Veterinarian and dog owner should be aware of this problem. Owners should identify any signs of cognitive impairment as early as possible and veterinarians should take into account age-related cognitive impairments.

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