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**Environmental and behavioral variables associated with lower urinary tract diseases in domestic cats**Nevra Keskin Yılmaz¹ ¹ Department of Internal Medicine, Faculty of Veterinary Medicine, Ankara University, Ankara, Türkiye

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ABSTRACT

Objectives: Feline lower urinary tract disease (LUTD) is a frequently seen disease with multiple etiologies. Since it is a complex condition, the aim of this study is to evaluate the factors that may affect the development of the disease.

Materials and Methods: Demographic, clinical, behavioral and environmental parameters of 30 cats diagnosed with lower urinary tract disease and 15 aged-matched healthy cats presented to Ankara University Small Animal Hospital were evaluated.

Results: In the diseased group, the male population was higher, and the cats were overweight. The number of food, water and litter boxes and litter material were found to differ significantly between groups. Daily habits such as playing with a scratching board and self-grooming differed between the groups. Inappropriate behaviors observed by the owners of the cats in the first group were listed as urinating/defecating outside the litter box and showing aggression towards the owner, guests, and/or other animals.

Conclusions: The results of this study show that the detailed evaluation and regulation of the daily needs of cats is important for the emergence or recurrence of the disease and therefore may contribute to the correct management of the treatment process in cats with LUTD.

Keywords: Behavioral factors, Environmental factors, FLUTD, Lower urinary tract.

INTRODUCTION

Feline lower urinary system disease (LUTD), which is one of the most common reasons for referral to veterinary clinics, is a general term used to describe diseases affecting the bladder and urethra in cats (Hostutler et al., 2005; Lew-Kojrys et al., 2017). LUTD has multifactorial etiology such as functional and structural disorders of lower urinary system organs, as like crystalluria, urethral plaque formation, urolithiasis, urinary tract infections (UTI), neoplasia, trauma, neurological disorders, behavioral problems and feline idiopathic cystitis (FIC). Each of these diseases causes serious clinical symptoms and intense pain

in patients that significantly affects animal welfare (Gunn-Moore, 2003).

In cats, LUTD may cause complete or partial urethral obstruction and obstructive disease may cause varying degrees of clinical manifestations related with the severity of the obstruction. The signs include localized lower urinary tract symptoms such as dysuria, hematuria, frequent and repeated visits to the litter box, increased vocalization and pain may be seen clinically as well as systemic manifestations such as electrolyte disturbances and uremia, anorexia, lethargy, and vomiting (Segev et al., 2011).

Given the widespread prevalence and severity of LUTD in feline populations, there is a pressing need to identify the key factors contributing to the onset of this condition. Beyond the conventional exploration of demographic and clinical parameters, it is imperative to broaden the research to include variables that impact animal welfare, such as environmental and sociological structures. The intricate nature of LUTD implies significant gaps in our current understanding of its pathogenesis. This study is designed to bridge these gaps through a comprehensive analysis, aiming to unveil potential associations between LUTD in domestic cats and a spectrum of demographic, environmental, and behavioral variables. By doing so, our research seeks to amplify comprehension of the intricate complexities that contribute to the widespread prevalence of LUTD in feline populations.

MATERIALS and METHODS

Study population

The study included 45 cats presented to Ankara University Veterinary Faculty Small Animal Clinics. Patient records were reviewed retrospectively by using the hospital software system. The cats were categorically assigned into two groups; the first group included cats diagnosed with LUTD, and the second consisted of healthy cats. Exclusion criteria ensured the omission of cats with endocrine and/or metabolic disorders, as well as those facing joint problems. This study has been reviewed and approved by the Local Animal Ethics Committee (Decision number: 2022-14-131) and the Ethics Committee for Non-Clinical Human Research (Decision number: 17/157) of Ankara University.

The first group consisted of 30 cats that presented to the clinic with the signs of LUTD including anuria/oliguria, stranguria, hematuria, vomiting, lethargy, etc. In these cases, the diagnosis was made after a complete physical examination, radiographic imaging and abdominal ultrasonography of the urinary tract, urine analysis, bacteriologic culture of the urine, and additional testing of blood parameters was performed in some cases if needed. According to the results obtained, cats were classified based on the cause of the disease. The control group included 15 healthy aged-matched cats brought to our clinics for yearly routine examinations. In addition to the applied exclusion criteria in all cats

in this group, cats with history of LUTD were also excluded from the study.

Assessment of environmental and behavioral variables

To assess environmental and behavioral variables, the anamnesis obtained from each patient owner was compiled in detail. The data included a standard question set routinely used in our clinics were adapted from the open-access BSAVA Client Information Leaflet Feline Behavior Questionnaire (Horwitz and Mills, 2009). This set of questions has been incorporated into our anamnesis forms, playing a pivotal role in conducting standardized behavioral assessments consistently in our clinics. The clinical findings and the information obtained from the patient's owner were examined under 6 sub-headings. i) demographics, ii) physical environment and housing, iii) social interaction (hiding, interaction with the owner, guests, and foreigners), iv) daily routine (eating and drinking, sleep and wake routines), v) playing and investigative behaviors, and vi) the problem behavior (inappropriate urination, etc.). The following information was obtained from the patient owners in detail: the type of elimination, covering of elimination in the litter box, the type of the litter box and/or litter tray, the number and localization of the food bowl, water bowl, cat litter box and whether she/he used a scratching board.

Statistical analysis

The relationship between categorical variables was evaluated using either the Chi-square test or the Fisher exact test. Chi-square test was employed to analyse the correlation among numeric variables, while the Chi-squared test of association was utilized to assess relationships between categorical variables. For binary variables, summary statistics such as means, medians, and standard deviations were computed. To compare continuous parameters between the study and control groups, as well as between the two groups, either Student's t-test or the Mann-Whitney U test was employed based on the distribution of the data. The analyses were performed in SPSS 22.0 for Windows, SPSS Inc, Chicago, IL, USA, and the significant effect was defined at a value of $p < 0.05$.

RESULTS

Demographic characteristics of the study population

The demographic characteristics of the cats in both groups were examined in detail. In the first group,

18 of the cats were mixed breed while the rest were Scottish fold (n=5), British shorthair (n=3), Angora (n=2), and Sphinx (n=1). The male (n=25) cat population was higher than the female (n=5) cats. Fifteen of the males and 3 of the female cats were neutered. The age of cats ranged from 6 months to 8 years of age (mean 3.7 ± 2.07 years) and they were weighing between 2 to 8.5 kg (mean $4.8\text{ kg}\pm 1.34$ kg). The second group consisted of healthy cats, the majority of the cats were mixed breed (n=12), followed by British shorthair (n=2) and Persian (n=1) cats. There were 8 female-spayed and 7 male-castrated cats in this group. The age of the cats ranged from 1 year to 9 years (mean 3.96 ± 2.32 years) and they were weighing between 3 to 5 kg (mean 4.12 ± 0.52 kg). The cats in the first group were found to be weighted higher than those in the second group ($p=0.036$). Although no statistical analysis was applied because the second group was selected with a balanced age and gender distribution, male cats were clearly dominant in the first group.

The most common diagnosis in the first group was struvite crystalluria (n=12), and it was followed by struvite crystalluria and UTI (n=4), urolithiasis (n=6; 4 struvite and 2 CaOx uroliths), FIC (n=6), and UTI (n=2). Identified pathogens for bacterial LUTD were, *Streptococcus* spp. (n=2), *E. coli* (n=1), *Staphylococcus* spp. (n=1) for the Struvite crystalluria and UTI cases and *E. coli* (n=1), *Proteus* spp. (n=1) for UTI cases.

Physical environment and housing

The majority of the cats diagnosed with LUTD were housed in an apartment (n=29) and the owners described their home environments as *calm* or *active* equally. In 14 of the houses, there were multiple pets and, in 13 of these, the second pet was also a cat. All but 5 of the cats in the study group had access to the entire house. These remaining 5 cats were restricted from entering the kitchen and/or living room. Twenty-five of the cats in the first group were indoors only while the rest was allowed to leave the house in a controlled manner for maximum of 2 hours a day. Among those cats, 3 were male (2 were castrated and 1 was active) and 2 were female (1 spayed and 1 active).

As in the first group, most of the cats (n=14) were housed in an apartment in the second group. Three of the owners describe their home environment as *active*, while the remaining 12 describe their home as *calm*. Only 3 of the owners owned one cat, and the rest had more than one in their homes. Cats in

this group were allowed access to the entire house. One female and one male cat were allowed to leave the house in a controlled manner.

Since the dominant majority in both groups were indoor cats, information about whether they saw cats/other animals on the street through the window were also evaluated within the scope of this study. In both groups, it was determined that about half of the cats can see other animals through the windows, while the other half did not ($p>0.05$).

In both groups, the cats were fed with commercial food only. While there were as many or fewer food bowls as the number of cats in the first group, there was one more bowl than the number of cats in all the houses in the second group ($p<0.001$).

Table 1. Details about litter boxes of cats.

	Groups		P value
	1	2	
Box size (n)			
<i>Medium</i>	18	10	NSD
<i>Large</i>	12	5	
Box type (n)			
<i>Closed</i>	13	19	NSD
<i>Open</i>	17	5	
Litter brand routine (n)			
<i>Same brand</i>	15	6	NSD
<i>Different brands</i>	15	9	
Litter types (n)			
<i>Bentonite (clumping)</i>	15	14	0.016
<i>Silica</i>	12	1	
<i>Active Carbon</i>	3	-	
Litter fragrance (n)			
<i>Scented</i>	22	7	NSD
<i>Unscented</i>	8	8	
Cleaning regime (n)			
<i>Every day</i>	18	15	0.001
<i>Every 2 days</i>	12	-	
Cleaning the entire litter box (n)			
<i><7 days</i>	3	4	NSD
<i>7-15 days</i>	12	6	
<i>>7 days</i>	15	5	

NSD: No significant difference, (-) = Not applicable.

The data regarding the litter boxes were also analyzed (Table 1). It was determined that there were as many or fewer litter boxes as the number of cats in the houses in the first group. In the second group, while the litter box was more than the number of cats in only one house, it was either as many or less than the number of cats in other houses ($p<0.001$). Litter box size did not differ

between the two groups ($p > 0.05$). While the litter material was found to be statistically significantly different between the groups ($p = 0.016$); the scent of the litter material was not differed.

In the first group, an equal number of owners stated that they always used the same brand or changed brands while 9 of the owners in the second group stated that they change the brand occasionally and the remaining 6 always use the same brand which does not differ significantly from the first group. The cleaning habits were changing regarding the cleaning regimens of the litter box between both groups. While all the litter boxes are reported to be cleaned every day by the owners in the 2nd group ($p = 0.001$), there was not a significant difference between the groups when the entire litter box cleaning habits were evaluated.

The number of scratching boards was also differed between the groups. While 20 cats had a scratching board in the first group, all the cats had it in the second group ($p = 0.019$).

The daily routine of the cat

Eating habits were evaluated in both groups and it was noted that while 23 of the first group ate slowly and the remaining 7 ate fast and in the second group, 10 ate slowly and the rest ate fast ($p > 0.05$). In both groups, it was observed that cats mostly sleep with their owners and wake up between 6-9 am. All the cats in both groups use their litter boxes routinely. When the data on self-grooming behavior were examined, it was observed that the cat in the first group rarely groomed itself, while all the cats in the second group groomed themselves as a routine daily activity as stated by the owners ($p = 0.001$).

A review of data on whether there has been a recent change in home routine showed that 6 cat owners in the first group indicated a routine change due to a new job, new home, or travel. In the second group, it was learned that 3 cat owners had recently moved.

The data on the routine relationship between the guests and the cat showed that 21 animals in the first group were affectionate towards the guests, while 8 cats in the second group.

Playing and investigative behaviors

Owners of 26 cats in the first group described their cats as *playful* while all but 2 owners in the second group did ($p > 0.05$). In both groups the owners of the playful cats reported that they play the games their cats initiate every day. When the owners of

the cats in the first group were asked how long the play time was, 4 of them reported that they played less than 10 minutes while 9 of them played for 10-20 minutes and, 13 of them played more than 20 minutes while the daily routine playing time for the cats in the second group is more than 20 minutes ($p = 0.021$). All the owners in the first group noted that the toys were available for the cats during the day and the first-choice toys of the cats for playing were rope ($n = 11$), ball ($n = 9$), soft plush toy ($n = 6$), furry mice ($n = 2$) and laser ($n = 2$). The 4 cats who were stated to do not like to play, were noted as playing games initiated by their owners for less than 10 minutes and were all played with rope. In the second group, cats' favorite toys are listed as follows; balls ($n = 5$), rope ($n = 4$), soft plush toys ($n = 4$), and furry mice ($n = 1$). The cats who do not like to play are played the laser by the owners.

In the first group, it was noted that all but 3 of the cats were prone to discovery. Eleven of all the cats in this group tended to defend their territory. Moreover, while 16 of the cats hunted (bugs, butterflies, etc.) frequently, the rest did not. In the second group, all 15 cats were prone to explore. Except for 2 cats, it was stated that the cats in this group protect their territory. Eleven cats are hunted frequently, while 4 cats are not ($p > 0.05$).

The problematic behavior

When the data is examined on whether the patient owners observed inappropriate behavior in their cats, a total of 14 cat owners in the first group reported that their cat engaged inappropriate urination/defecation problems occasionally as they urinated/defecated outside the litter box while only one cat in the second noted to urinate outside the litter box when the box was not cleaned that day ($p = 0.003$). Half of the 14 cats in the first group who urinated/defecated outside the litter box were seen squatting and the other half were in the standing position. The location of periuria or inappropriate defecation was stated as the floor nearby the litter box. The second most common undesirable behavior was aggression ($n = 13$) toward the owner, guests, and/or other animals (hissing, biting, attacking) ($p = 0.002$).

DISCUSSION

Demographic data findings obtained from the presented study were compatible with the previous studies. Cats included in the first group were aged between 6 months to 8 years and the majority of the cats were male castrated with

increased average body weight (Lekcharoensuk et al., 2001; Piyarungsri et al., 2020). It is estimated that overweight indoor cats are less active as their environments are generally predictable and unchanging (Rochlitz, 2005). Therefore, they are likely to urinate less and drink less water. In addition, obesity may lead to urethral compression with the accumulation of fat around the urethra and penis (Piyarungsri et al., 2020). Hence, it is important to control the weight as a part of the treatment in cats with LUTD.

In the presented study, almost half of the cats in the first and 80% of the cats in the second group were reported to live in a multi-cat household. However, the number of food bowls and litter boxes was significantly less in the first group than in the second group. Hence, upon evaluating these data, it becomes evident that resource distribution plays a significant role in the development of LUTD in cats. As indicated in this study and supported by previous reports, adhering to the standard rule of providing one additional resource beyond the number of cats can mitigate the development of various issues (Forrester and Towel, 2015). The social structure of domestic cats is primarily shaped by food availability, while environmental factors within households, including human relationships and resource availability, emerge as crucial contributors to feline stress levels (Wojtaś, 2023). Consequently, making simple adjustments to environmental enrichment has the potential to enhance inter-cat relationships and alleviate stress in multi-cat households, thereby promoting the health and well-being of cats.

In line with the previous findings this study revealed that the size and type of litter box, the scented or unscented litter material, or the change in the brand of litter do not seem to contribute to the development of the LUTD (Sung and Crowell-Davis, 2006). Conversely, the material utilized in the litter box emerges as a crucial factor, constituting a risk element in LUTD development. Cats' preferences for litter material likely stem from the domestication process. As far as is known, the desert-dwelling African wildcat used desert sand as its litter, creating a material preference that is thought to have persisted throughout the domestication process (Neilson, 2001; Neilson, 2009). In this study, the preference for clumping bentonite litter in the healthy group may be associated with the preference of the cats for sand-like material that clumped when wet.

In a majority of cases, LUTD is closely linked to issues in litter box management. Inadequate cleaning of the litter box can precipitate the development of inappropriate elimination behavior and/or LUTD in certain cats. This is particularly noteworthy in multi-cat households, where the unfamiliar odors of urine and feces may render a cat vulnerable, especially if it harbors fear of other cats in the same environment. Consequently, this vulnerability may manifest as a reduction in the frequency of elimination or the selection of an inappropriate toileting location (Overall, 1997; Neilson, 2009). The diminished frequency of urine elimination heightens the risk of urinary tract diseases by prolonging the contact time of high-concentration urine with uroepithelial tissue (Forrester and Towell, 2015). Hence, in accordance with the findings of the present study, consistent daily maintenance proves beneficial in preventing LUTD, even when the entire litter box is not thoroughly cleaned.

There are some species-specific behaviors, and the fact that cats mostly live indoors may prevent them from exhibiting these natural behaviors, as they spend most of their time hunting and exploring their territory when living outside (Amat et al., 2016). Therefore, environmental enrichment strategies should be designed by targeting the needs of cats in mind. One of the elements that should be included in these regulations and that supports the natural behavior of cats is the scratching boards. Scratching is one of the natural cat behaviors and plays an important role in leaving both visual and pheromonal regional marks while helping to maintain claw health (Stella and Crony, 2016). This study presents evidence to suggest that healthy cats are strongly motivated to scratch, and this behavior has positive aspects on their well-being, probably by reducing stress and meeting their daily needs.

Grooming is a normal behavior in cats, and they spend about 8% of their active time self-grooming (Eckstein and Hart, 2000). The grooming behavior in cats can serve different purposes such as hair arrangements, removal of foreign bodies, dirt, and parasites, and sensory stimulation of the skin. Many factors that affect the well-being of cats can cause cats to be stressed and unable to express species-specific behaviors, including self-grooming (Stella and Crony, 2016). In the presented study, grooming behavior was significantly reduced in the first group compared to the second group. This

suggests that the absence or decrease of normal cat behaviors may increase the susceptibility to LUTD. Cats are natural hunters. Hunting behavior is mostly triggered by the seeking system and thus is not directly related to hunger. Solitary play behavior is a manifestation of hunting in cats, which has a critical value in survival (Bradshaw et al, 2012). Cats, with their biology intricately linked to hunting, thrive when given regular opportunities to practice and hone their natural hunting instincts. The absence of play and hunting outlets can lead to considerable stress in domestic cats (Zhang et al., 2022).

The current study indicates that cats in the first group engage in play for a shorter duration compared to those in the second group. Research suggests that solitary-living cats exhibit improved communication with their owners and tend to engage in longer play sessions (Mertens, 1991). The full extent of the impact of early experiences, essential for fostering social bonding in cats with their environment, on their socialization and play behaviors remains incompletely understood (Rochlitz, 2005). Nevertheless, positive effects can be achieved by optimizing environmental arrangements to encourage cat play. The constant availability of many and varied toys providing opportunities to meet hunting and exercise needs can help reduce stress levels. However, it is noteworthy that in this study, the toys provided in both groups were found to satisfy only a limited range of instinctive skills. A study addressing common behavioral problems in cats has demonstrated an association between playtime and behavior issues, highlighting the inadequacy of typical commercially available toys in meeting the complex needs of house cats (Strickler and Shull, 2014). An interesting finding from the current study is that cats in the healthy group engaged in play involving lasers. Although playing cats with lasers constantly triggers the frustration system here it can be inferred that even playing with a laser would be better than not playing at all (Kogan and Grigg, 2021).

Individual differences in the expression of their behavior may stem from a variety of causes. The most common undesirable behaviors are aggression among cats or towards humans, along with inappropriate elimination behavior (Curtis, 2008). Medical problems can change behavior directly or indirectly. Therefore, when monitoring these behavioral changes, the cat's general health status should be examined as well as their pain

assessments, and arrangements for their individual needs should be evaluated (Camps et al., 2019). In the present study, it was determined that the cats in the first group showed markedly inappropriate elimination behavior and were aggressive. However, within the scope of the presented study, it is not known whether these behavioral changes are caused by pain or environmental stress. Evaluation of these changes in future studies involving larger numbers of cats will have important implications.

CONCLUSION

This research underscores the critical role of environmental and behavioral factors in LUTD. To evaluate the effectiveness of these factors, it is imperative to collect comprehensive information from owners of affected patients. This includes demographic details, clinical examination findings, and information about the patient's environment. It should be considered that ensuring that the basic daily needs and species-specific social needs of cats are adequately met will play a very important role in preventing the onset or recurrence of the disease, and patient owners should be informed about making the necessary changes.

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