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RESEARCH ARTICLE

A Retrospective Analysis of High Rise Syndrome in Cats in Istanbul: 160 Cases (2016-2017)

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A B S T R A C T

Within the scope of the study, a total of 160 cats, 96 males and 64 females, who fell from height between August 2016 and August 2017, were retrospectively evaluated. In addition to the age, gender, breed, neutering status, clinical and radiographic findings of the cats, the answers given to the questions asked to the cat owners about the changes in the house they lived in, pre-existing diseases, and the presence of medication they were constantly using were evaluated to obtain new data on the etiology. The average age of the cats was 15.8 months. 65.6% of the cats were 12 months and younger. It was observed that 109 (68%) of the cats fell from height between April and July, and July was the month with the highest number of falls from height with 40 patients. Injury scores increased in direct proportion to the height of the fall. There was a linear correlation between falls from height and increased daytime hours. The survival rate of the cats was 93.4%. In conclusion, future studies on high-rise syndrome in cats should focus more on the effect of sex hormones, and that screening for parasitic and some bacterial agents such as *Toxoplasma gondii*, which is known to increase suicidal tendency in humans, may yield important results. In addition, it was seen that evaluating the ratio of unspayed female cats in countries with temperate climates where doors and windows can be left open for a long period of the year could make an important contribution to the etiology of this syndrome.

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INTRODUCTION

Feline high-rise syndrome, also known as High Flyer Syndrome or Jumper's syndrome, is a definition used to refer to traumatic injuries caused by cats kept in urban settlements falling or jumping from 2 or more high-rise buildings (Papazoglu *et al.,* 2001; Vnuk *et al.,* 2004; Bonner *et al.,* 2011). To date, the relationship between trauma scoring, sex distribution, sterilization status, day or night jumping, and seasonal variations have been significantly examined in many previous studies (Papazoglu *et al.,* 2001; Vnuk *et al.,* 2004; Bonner *et al.,* 2011; Uzun *et al.,* 2023).

Although the clinical findings evaluated in the early days were limited to epistaxis, cleft palate, and pneumothorax (Robinson, 1976); recently, this triad has been replaced by studies evaluating facial, thoracic, and orthopedic clinical findings (Whitney and Mehllhaff, 1987; Papazoğlu 2001; Pratschke and Kirbey, 2002). Orofacial lesions include epistaxis, jaw fractures, symphysial separation, hard palate fractures, tooth fractures, and temporomandibular joint dislocation (Bonner *et al.,* 2011). Traumatic lesions of the maxillofacial region and mandible in cats can cause significant impairments and these impairments can be life-threatening. Nowadays, the increasing number of multi-story buildings and the risk of cats jumping from heights due to various reasons causes more encounters with high-rise syndrome in cats (Tüzün and Sağlam, 2009).

Although the natural physical results of falling from a height are called trauma, psychological factors such as depression and anxiety disorders that push cats to fall from heights are also accepted as trauma nowadays (Ozaydin and Erdikmen, 2023). Stress factors in domestic animals are also evaluated separately as physical and social stress factors (Amat *et al.,* 2016). It is also known

that psychological traumas that may pose a threat to cats are stronger stress stimuli than physical factors such as infection (Zhang *et al*., 2022). Especially effects of stress induced physicological trauma towards cats falling from height should be more detaily examined according to our prediction and we tried to evaluate and discuss.

In our study, we retrospectively evaluated the cases brought to the surgery and emergency clinics of our hospital with a history of falling from a height. In addition to weather temperature, some parameters that have not been evaluated before to the best of our knowledge, such as the relationship between seasonal sunbathing times and neutering status, were also examined.

In addition, it was aimed to generate new hypotheses by questioning the reasons that may cause stress in cats. Although it has not been proven, the possible correlation between the presence of suicide and high-rise syndrome in cats was opened to discussion and new parameter suggestions were made to be evaluated in new studies to be carried out.

MATERIALS AND METHODS

The material of our study consisted of 160 cats of different breeds, ages and gender who were brought to our clinic between August 15, 2016 and August 15, 2017, with a history of falling from a height. Our study was approved by the Istanbul University-Cerrahpasa Animal Experiments Local Ethics Committee on 03/06/2024 (Approval No: 2024/36).

After the clinical examination and first interventions of the patients, information on the age, breed, gender, neutering status and the height of the fall were requested from the owners and recorded. The owners were asked questions about whether there was another cat in the house, whether the cat had fallen from a height before, the time of the fall, the characteristics of the floor, and the presence of obstacles that the cat could get stuck in while falling. They were also asked whether the furniture in the house had been moved shortly before the fall, whether there were any other cats or guests in the house, whether the cat was sick, whether it was on any medication, whether it had been tranquilized and shaved in the few days before the fall, and whether any medication had been administered. They were also asked whether the cat had fallen while trying to catch birds or insects or had slipped from a window/balcony sill and the answers were recorded. Owners who had seen the moment of falling from a height were also asked 'Would you consider this as a suicide?' and 'Did the cat show a different behavior than usual at the moment of falling from a height?'

The scoring system preferred by Merbl *et al*. (2013) was modified and used for the scoring of injuries resulting from falls from height. In our study, injuries in patients with high-rise syndrome were classified into 9 categories. The lesions and associated clinical findings were subcategorized and evaluated (Table 1). Injury category score (ICS) and total injury score (TIS) were calculated for each cat that fell from a height. The ICS revealed how many of these 9 categories the cat had injuries and was evaluated by giving a score between 0 and 9. The TIS was calculated by examining 38 subcategories of these 9 categories and the number of injuries the cat had in each of these subcategories was scored from 0 to 38 (Table 1). Fall height was defined as floor height and recorded.

After 1 month, the owners were called by phone to find out whether their cats were alive and their general health status.

RESULTS

All of the cats in this study had fallen from buildings with 2 or more floors or a height of more than 4 meters. Of the patients with a history of falling from a height, 96 (60%) were male and 64 (40%) were female. When gender was not differentiated, 116 (73%) of the cats were intact and 44 (27%) were neutered. When the data were sex-disaggregated, 25 (16%) males were neutered and 71 (44%) were intact; 19 (11%) females were spayed and 45 (29%) were intact (Fig. 1).

Of the cats, 19 (18%) fell from the 2nd, 27 (17%) from the 3rd, 47 (29%) from the 4th, 30 (19%) from the 5th, 24 (15%) from the 6th, and 13 (8%) from the 7th or higher floors (Fig. 2). When the age distribution was analyzed, 105 cats were 12 months and younger, 26 cats were between 13-24 months, 14 cats were between 30-36 months, 8 cats were between 42-48 months and 7 cats were between 60-72 months (Fig. 3). Of the cats, 123 (77%) were mixed breeds, 14 (9%) Persian, 6 (4%) Scottish Fold, 5 (3%) British Shorthair, 4 Van, 3 Siamese, 3 Angora, 1 Himalayan, and 1 Exotic Shorthair.

Of the cats, 111 had fallen on concrete, 31 on soil, 7 on grass, 1 on the windshield, 1 on the fence, 1 on metal, and 1 on the table. Since 7 of the patients fell on different types of ground, the exact type of ground could not be specified. When the number of cats falling from height was analyzed by months, 109 (68%) of the cats fell between April and July. July was the most common month with 40 (25%) cases (Fig. 4). A total of 135 cats had clear information about the time of fall. 61 of the cats had fallen from a height during the daytime and 73 during the dark hours (Fig. 5).

Injury category score (ICS) and total injury score (TIS) were calculated for each patient according to the scale in Table 1. The mean ICS and TIS were 1.21 and 1.63 for those who fell from the second floor, respectively. ICS and TIS values for those who fell from the third, fourth, fifth, sixth, seventh and higher floors were 1.11 and 1.51, 1.46 and 2.21, 1.63 and 2.33, 1.37 and 2.0, and 1.83 and 2.58, respectively (Fig. 6).

It was learned that 71 of the cats tripped over an obstacle while falling, while 89 of them had no obstacle to trip over. To the question of whether there was a change in the environment where your cat lived, 33 of the owners answered yes, and 127 answered no. While 133 of the patient owners answered yes to one of the questions "Did your cat fall while trying to catch birds or insects" or "Did your cat slip and fall from a window or balcony sill", 27 patient owners answered no to both questions. These 27 owners stated that their cats exhibited different behaviors than usual at the time of the fall. Among these behaviors, 12 owners reported that their cats made unusual noises, and 7 reported that they were restless. Eight owners could not describe the abnormal situation.

Table 1: The chart which was used to categorized the injuries and the total injury numbers and signs belongs to different body systems.

Injury	Number of Cats
1. Forelimb Fractures	
1. Scapula Fractures	1
2. Humerus Fractures	9
3. Radius-Ulna Fractures	38
4. Carpal Fractures	7
2. Hindlimb Fractures	
5. Femur Fractures	24
6. Tibia-Fibula Fractures	20
7. Tarsal Fractures	1
8. Pelvis	24
9. Coxo-Femoral Luxations	3
3. Vertebral Fractures	
10. Contusions	2
11. Cervical Vertebrae Fractures	1
12. Thoracal Vertebrae Fractures	11
13. Lumbal Vertebrae Fractures	9
14. Sacro-Caudal Vertebrae Fractures	1
4. Shock Signs	
15. Pale Mucous Membranes	5
16. Hypothermia	3
17. Weak Femoral Pulse	2
18. Cold Extremity	4
5. Perineal Injuries	
19. Perineal Soft Tissue Injury	3
6. Abdominal Injury And Signs	
20. Abdominal Pain	12
21. Hematuria	1
22. Urinary Baladder Rupture	1
23. Hemoabdomen	-
7. Head Injuries	
24. Facial Wounds	9
25. Cleft Palate	9
26. Ocular Damage	1
27. Epistaxis	14
28. Mandibular Fractures	10
29. Broken Teeth	11
30. Tempero-Mandibular Joit Luxations	1
8. Respiratory Tract Signs	
31. Pneumothorax	3
32. Lung Contusions	15
33. Dyspnea	22
34. Abnormal Respiratory Sounds	9
35. Rib Fractures	-
36. Pleural Effusion	-
37. Emphysema	3
38. Pneumomediastinum	-
9. Soft Tissue Injury Induced Lameness	3

Thirty-six of the cats included in the study had previously high-rise experience. A few days before the fall, 4 of the cats were tranquilized and clipped their hair, 7 of the cats were relocated, and 14 of the cats had a new cat brought into their home. 44 of the cats were already sharing a home with one or more other cats. It was found that 7 of the cats were sick before the fall and only 4 of them were on medication.

'It was determined that, 10 (6.06%) cats died due to falling from a height in this study. It was learned through a phone call that, 5 cats whose intensive care expenses could not be afforded by their owners and taken away from hospital after first evaluation, died 12 (2 cats), 24 (1 cat) and 48 (2 cats) hours after falling from a height. Two cats were died after 1 and 2 weeks later because of

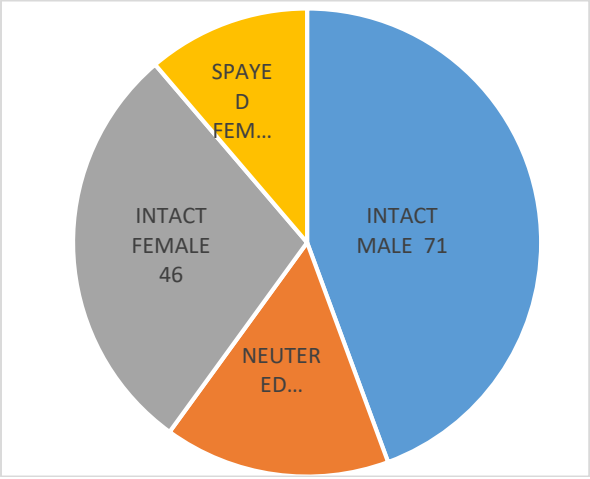

Fig. 1: Sex and neutering status of the cats.

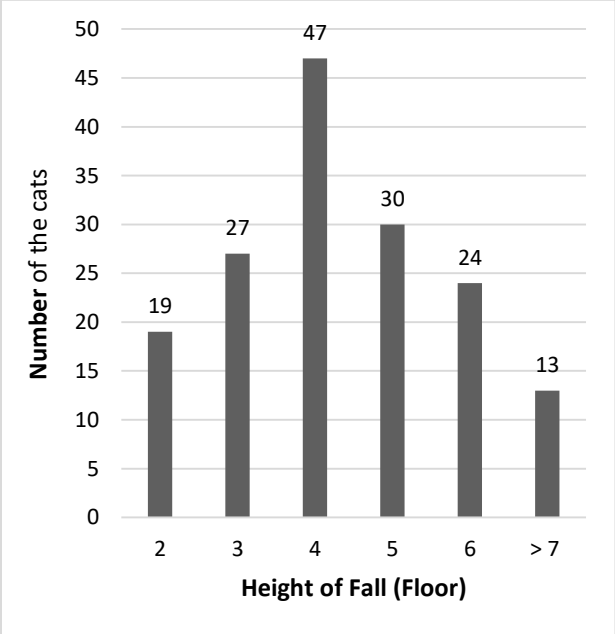

Fig. 2: Number of cats falling from different floors.

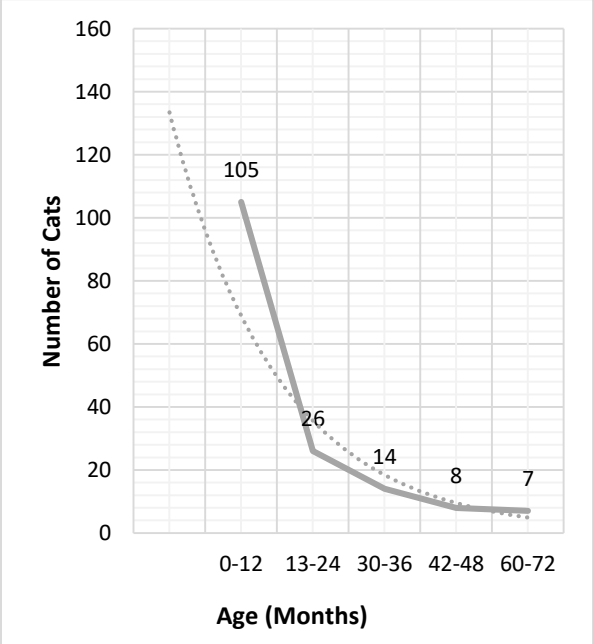

Fig. 3: Age distrubution of the cats.

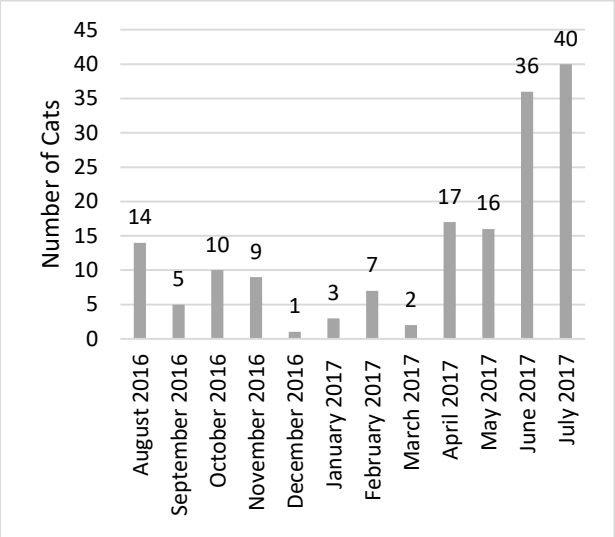

Fig. 4: Total number of the cats falling from height according to months between August 2016- July 2017.

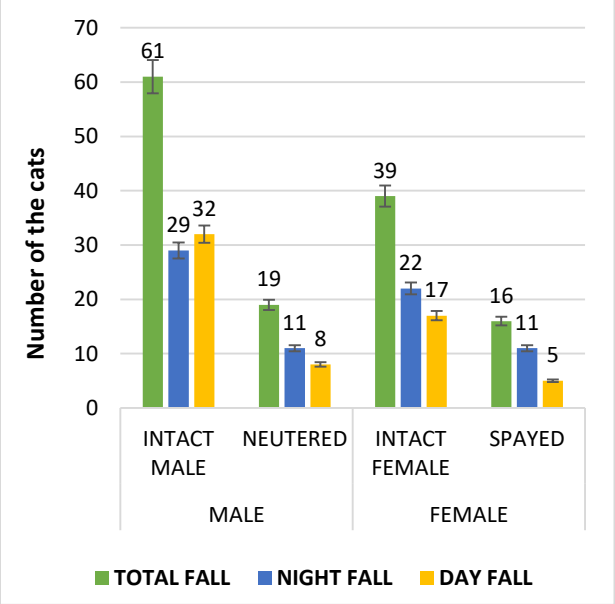

Fig. 5: Distribution of cats according to gender, sterilization status, and time (day/night) of fall from height.

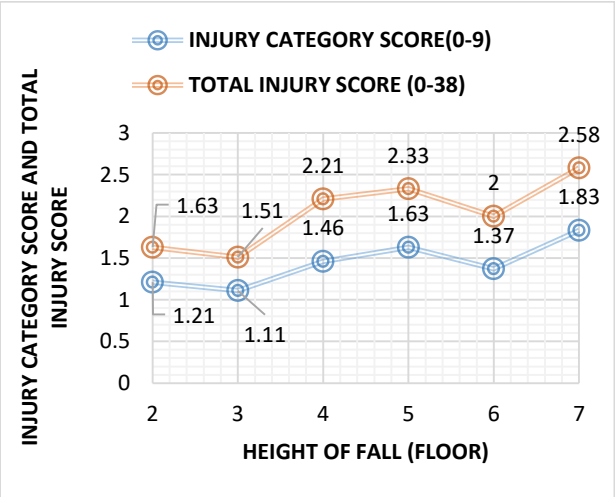

Fig. 6: Relationship with the injury category score/total injury score and height of fall.

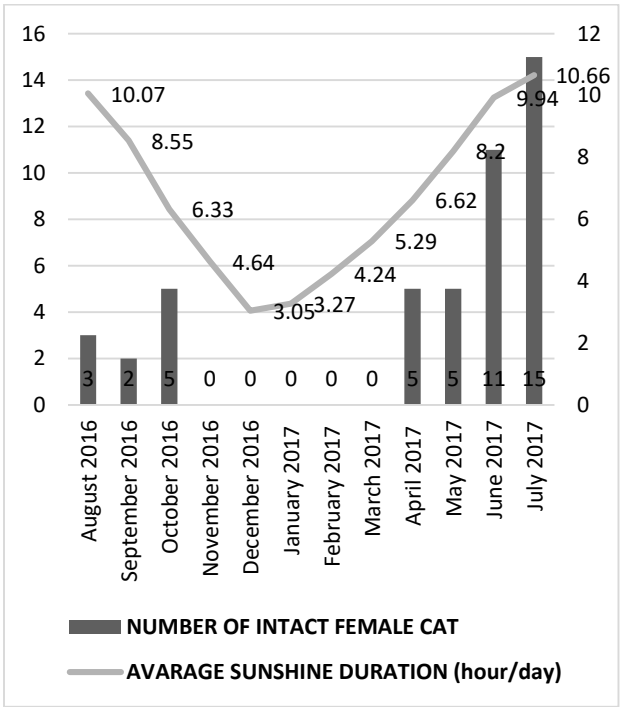

Fig. 7: Number of intact female cats falling from height according to months and relation with the average sunshine duration. (Average sunshine duration data: https://www.mgm.gov.tr/kurumici/turkiye-guneslenme-suresi.aspx)

undetermined causes. In addition, 1 cat who was operated on two days after falling from a height died following the operation, and 2 patients were euthanized one day later due to vertebral fractures.

DISCUSSION

The relationship between the number of injuries resulting from falls from height and the height of the floor from which the cats fall has been described as linear in some studies (Dupre *et al*., 1995) and curvilinear in others. Some studies reported that there was no linear relationship between the number of injuries and the increase in the height from which the cat fell, while another study reported that the number of injuries in the thorax increased as the height increased (Merbl *et al.*, 2013). In our study, it was found that the injury category score and total injury score increased as the height from which the cat fell increased (Fig. 6).

Although studies have reported that mostly young cats fall from heights, they have also reported mean ages in different ranges between 1.2-2.7 years (Vnuk *et al.*, 2004). In our study, the mean age of the cats was calculated as 15.8 months (1.3 years). Some authors state that high-rise syndrome is more common in cats younger than 3 years of age (Whitney and Mehlhaff, 1987; Papazoğlu *et al.*, 2001; Pratschke 2002). In our study, the rate of cats younger than 3 years of age was calculated as 80%. When the studies were analyzed in terms of average age, the closest results to our study are the studies conducted in Diyarbakır/Turkey and Thessaloniki/Greece, which are geographically close and the climatic conditions are relatively the most similar (Papazoglu *et al.*, 2001; Catalkaya *et al.*, 2022) with 1.11 and 1.2 years of age.

In our study, 27 owners answered no to the questions 'Did your cat fall while trying to catch birds or insects' or 'Did your cat slip and fall from a window or balcony sill'. These owners stated that their cats exhibited different behavioral patterns, although there was no change in the environment in which they lived. Although these owners claimed that their cats committed suicide, self-determined killing or suicide as a behavioral pattern in cats has not been detected as far as we know. In addition, animal models that have been attempted to investigate the mechanism leading to suicide in humans have not achieved significant success (Preti, 2011). However, since *Toxoplasma gondii* infection, which we know to cause a disease picture in cats, has been reported to increase suicidal tendencies in humans (Postolache *et al.,* 2021), it is thought that *Toxoplasma gondii* screening in cats in future high-rise syndrome studies may add an important perspective to the subject. Also, *Bartonella henselae* bacteria (Flegr and Hodný, 2016), which can be transmitted after cat scratching and increase depression score in humans, may also be useful to evaluate in this respect.

Another controversial issue is related to sex distribution/predisposition. The results obtained from some of the studies suggest that there is no sex predilection [Lefman and Prittie (2021); Uzun *et al.* (2023) 44%; Vnuk *et al.* (2004) 45.4%; Tüzün and Sağlam (2009) 48.8%; Papazoğlu *et al.* (2001) 52%)]. However, there are also studies reporting the male population as 76 and 61.9% (Collard, 2005; Bonner *et al*., 2011). In our study, male cats constituted 60% of the total population, regardless of sterilization status. Therefore, it seems useful to examine hunting and mating behaviors, which are considered among the causes of falls from height in males.

The most common causes of falling from height are roaming, mating and hunting (Lefman and Prittie, 2021). However, when the hunting behavior of domestic cats was examined, it was found that sex and age did not affect hunting behavior (Escobar-Aguirre *et al.,* 2019). In this context, it can be considered that looking for a relationship between hunting behavior and gender and age parameters when evaluating cat populations falling from heights will not produce meaningful results. At this point, the question arises whether the different sex distributions in different studies on cats falling from heights can be associated with mating behavior if they cannot be associated with hunting behavior. Although known that domestic cats have very good vision, large binocular field and good depth perception, they cannot see distances further than 6 meters is also known (Bishop 1962; Kaye 1981; Mayes 2015). The lack of good height perception could be the another reason of the high-rise syndrome of the cats.

Unspayed female cats are seasonal polyestric animals and it is known that they enter the anoestrus period and do not show estrous behaviors when the sunbathing period decreases to <8 hours/day (Johnson, 2022). When we examined the times when the 46 unspayed female cats in our study fell from height, considering the sunshine hours on a monthly basis, it was found that 10 (21.8%) unspayed female cats fell from height in months with <8 hours of sunshine and 36 (78.2%) unspayed female cats fell from height in months with >8 hours of sunshine (Fig. 7). When we evaluated the cats in the study without considering gender and neutering status, it was determined that 49 cats (31%) fell/jumped from heights in the months with <8 hours/day of sunshine and 111 (69%) cats fell/jumped from heights in the other months with >8 hours of sunshine.

It has been reported in many studies that there is a seasonal variation in the incidence of falls from heights, with more cats falling from heights in relatively better weather conditions due to owners leaving windows and balcony doors open (Vnuk *et al.,* 2004; Catalkaya *et al.,* 2022). These relatively better weather conditions coincide with months with >8 hours of sunshine. However, the higher rate of falls from height in unspayed female cats during these periods compared to the general population (78.2 to 69%) suggests that it may be related to sunbathing hours and the polyestric nature of cats. To clarify this situation, studies in countries where seasonal conditions are milder most of the year are needed. Only then will it be possible to differentiate whether the high-rise syndrome in cats is related to sunbathing hours and the polyestric nature of unspayed female cats or whether it is related to leaving windows and balcony doors open?

In a study by Merbl *et al.* (2013), it was reported that the effect of sex hormones was not considered an important predisposing factor for high-rise syndrome. In our study, 117 of 160 cats were intact and 43 were neutered, indicating that unneutered cats may be more prone to jumping from height.

Another controversial issue is whether cats fall/jump more during the day or at night. In their study, Uzun *et al*. (2023) found that cats fall from heights more at night and attributed this to the fact that they are nocturnal hunters. Whitney *et al.* (1987) also reported that cats mostly jumped from heights at night in their study, while this was the opposite in Papazoglu *et al.* (2001)'s study. In our study, 73 cats fell at night and 61 cats fell during the daytime. Only with a very small difference, it was found that unneutered male cats (32 during the day vs. 29 at night) fell from heights more often during the daytime, while all neutered males and females fell from heights more often at night.

The survival rate after a fall from height varies between 88 and 97.3% (Papazoglu *et al.,* 2001; Vnuk *et al.,* 2004; Merbl *et al.,* 2013). In our study, this rate was 93.94%.

Conclusions: In studies on high-rise syndrome in cats, it should be taken into account that there cannot be a correlation between hunting behavior and age and gender, and that the poor ability of cats to see far away may be an important factor in falling from a height, so this factor should be considered. In addition, cat owners should be informed about stress factors and the behavioral characteristics that may occur as a result of these. It is thought that screening cats for diseases such as toxoplasma, which causes depression and suicidal tendencies in humans, may contribute to the etiology of this syndrome and its inclusion in future studies may be beneficial.

Authors contribution: MK designed the study. BEE, EBB and ZNA collected the retrospective data and aided in interpreting the results. MK wrote the manuscript with support from CNGB, MTT and DAK. Both ZM and SU contributed to the final version of the manusicript. CNGB and MTT designed the figures and tables. All authors interpreted the data, critically revised the manuscript for important intellectual contents and approved the final version.

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