Praca oryginalna *Original paper*

Long bone ratios in the thoracic and pelvic limbs of domestic cats (*Felis catus*)

MEHMET KARTAL[1], ŞAMİL SEFERGİL[2], SEYYİD SAİD SABANCI[2], DOMINIK PORADOWSKI[3], OKTAY DÜZGÜN[4], ALEKSANDER CHRÓSZCZ[3], VEDAT ONAR[2]

[1]Faculty of Health Sciences, İstanbul Gelişim University, Avcılar, Istanbul, Türkiye
[2]Department of Anatomy, Milas Faculty of Veterinary Medicine, Muğla Sıtkı Koçman University, 48200, Milas, Muğla, Türkiye
[3]Department of Biostructure and Animal Physiology, Faculty of Veterinary Medicine, Wrocław University of Environmental and Life Sciences, Kożuchowska 1, 51-631 Wrocław, Poland
[4]Department of Surgery, Faculty of Veterinary Medicine, Istanbul University-Cerrahpaşa, Avcılar, Istanbul, Türkiye

Received 16.08.2025 *Accepted 27.11.2025*

Kartal M., Sefergil Ş., Sabanci S. S., Poradowski D., Düzgün O., Chrószcz A., Onar V.

Long bone ratios in the thoracic and pelvic limbs of domestic cats (*Felis catus*)

Summary

In this study, indices and ratio calculations were performed using osteometric measurements of the long bones (humerus, radius, femur, tibia) of the thoracic and pelvic limbs in domestic cats. For this purpose, the bones of a total of 55 adult animals, comprising 33 males and 22 females, were used. Sexual differences were observed in osteometric measurements at a level of significance of $p < 0.05$, while no gender-related differences were observed in index values. The intermembral and humerofemoral index values were determined to be 89.83 ± 3.22 and 94.42 ± 5.46, respectively, while the brachial and crural index values were determined to be 96.65 ± 3.54 and 106.55 ± 6.63, respectively. The intermembral and humerofemoral indices obtained showed that the pelvic limbs of domestic cats were longer than the thoracic limbs. In domestic cats, both the thoracic and pelvic limbs had different activities in hunting, movement, and habitat strategies. A low brachial index indicated hunting manipulation and climbing movements requiring strength, while a high crural index and low intermembral index supported jumping and agility capacities. The data obtained were believed to serve as a reference for veterinary practice and zooarchaeological approaches, in addition to understanding the habitat strategy of domestic cats in urban life.

Keywords: thoracic limb, pelvic limb, ratio, long bone, domestic cat

Body weight plays an important role in the mechanical requirements of movement and skeletal support (4, 5). Changes in body size manifest themselves either in the dynamic functions of organisms or in changes in the form or characteristics of skeletal structures. Locomotor differences between different mammalian species also bring about certain changes in the skeletal system. In bipedal (two-legged) or quadrupedal (four-legged) locomotion, changes in the stress load on the thoracic or pelvic limbs are observed (4). It has been reported that changes in skeletal bone size are accompanied by a large increase in body size, thereby safely supporting the increased power (5). The shape of the bones and the organisation of the muscles associated with this also affect the distribution of mechanical stresses on the skeleton. This gives rise to differences in locomotion among animals. For example, while some animals can be observed climbing trees (e.g., cats, squirrels), others (e.g., horses) lack this ability. This is because the skeletal system of animals must regularly resist the effects of pressure and force during locomotion (5). All above-mentioned remarks also include the morphology of cat's skeleton.

In Felidae species, the thoracic and pelvic limbs play an active role not only in locomotion but also in hunting strategies. The long ratios of modern felids have been widely used (2) to relate the locomotive ability of some extinct species (e.g., sabre-toothed cats) to behavioural and ecological strategies (14). To this end, knowledge of limb ratios and indices can determine whether extinct species employed running or ambush hunting strategies (2) and can also reflect their preference for open or closed habitats (2, 3). The brachial index has been particularly useful in determining habitat preferences, and it has been suggested that low values of this index indicate hunting strategies in closed habitats, while high values indicate hunting strategies in open habitats (3).

Not only domestic cats (*Felis catus*) but also other big cats (such as *Panthera leo*, *Panthera pardus*, *Panthera onca*) have significant thoracic and pelvic limb morphometry and proportions, which are crucial in determining the habitat use and hunting strategies of these felids (14). To this end, the effective roles of the thoracic and pelvic limb have been investigated.

In cats, the thoracic limbs are considered an important part of the apparatus for catching and killing prey. Therefore, linear morphometry of the thoracic limbs has been used to determine morphological differences according to different prey types (large, small and mixed prey) (24). When evaluating the relative length of the bones within the thoracic limbs across different animal species, such as hyenidae, graffidae, bovidae, and cervidae, a proportionally short humerus is noted (28). However, members of the Felidae family are considered hyper-carnivorous animals because they show very little variation in prey selection and prey size in their diet. Indeed, it has been reported that because members of this family use two different modules for hunting, namely the cranial and thoracic limb modules, it is likely that the morphology of both the skull and thoracic limbs reflects the size of the prey they kill (24). This can be documented by examining the morphology of long bone ratios within the thoracic limb module (13, 14, 32). However, the length or shortness of limbs is an effective factor in hunting strategy. Long limbs are less robust because they are less effective at holding prey. However, long limbs enable large felines to reach maximum speed over distance (22).

Differences in hunting strategies between large and small carnivores should have functional consequences on the morphology of the thoracic limbs. Large carnivores should exhibit greater thoracic limb robustness to cope with the increased stress of subduing prey and should have a shorter distal part of limbs to increase mechanical advantage. This has been associated with wider distal widths of the humerus and radius for greater muscle attachment and wider joint surfaces to distribute heavier loads (24). A supporting factor for the effect of thoracic limbs length morphology on prey capture is the length of the pelvic limbs. The positive relationship between these limbs and prey size (17) is of great importance for greater power and speed, parallel to that of the thoracic limbs (12). It is also known that the thoracic limbs play a more effective role than the pelvic limbs in carrying the animal's body weight (33). The pelvic limbs provide greater propulsive force than the thoracic limbs and therefore both reflect the requirements for acceleration in running and jumping (10, 30) and, unlike the thoracic limbs, also serve to stabilise the body (32).

When considering the relative lengths of the thoracic and pelvic limbs, it is reported that in cat species, the pelvic limbs are longer than the thoracic limbs, and that in most species, the radius is generally longer than the humerus, and similarly, the tibia is slightly longer than the femur (8). It is suggested that this general assessment varies among felids depending on habitat conditions. For example, it has been reported that species inhabiting closed habitats (forests), such as clouded leopards and jaguars, have shorter thoracic limbs than cheetahs and lions living in open habitats, which is attributed to their shorter radius relative to humerus length (22).

These relative changes observed between the thoracic and pelvic limbs can only be observed using the calculated index and ratio values. Although thoracic and pelvic limb indices are used extensively in primates, particularly in relation to locomotor models (1, 21, 29), they have also been of great importance in evaluating the hunting and ecological strategies of felids (2, 3, 14, 22). For this purpose, in our study, many calculations were made, such as the brachial, crural, intermembral and humerofemoral indices.

The intermembral index is a correlation between the relative length of the thoracic and pelvic limbs and the locomotor model. Particularly in primates, the ratio of the arms to the legs is determined by the intermembral index. More precisely, this index compares the length of the two bones of the arm (humerus and radius) with the length of the two bones of the limb (femur and tibia). If the index value is 100, the thoracic and pelvic limbs are of equal length (excluding the hands and feet). If the index is above 100, it indicates that the arms are longer than the limbs. If the index value is below 100, it indicates that the (back) limbs are longer. The value determined for humans is 70 (29).

Unlike these indices, brachial and crural indices have been calculated for primates by many anthropologists (1, 20, 21). The variation of these indices under different living conditions has been studied. For example, high brachial and crural index values related to temperature have been reported in human groups living in tropical conditions (20).

Index and ratio calculations for the thoracic and pelvic limbs have been widely used in primates, but these index and ratio relationships have remained extremely limited in quadrupedal (four-legged) animals. It has been suggested that measurements related to determining the ratio between individual bones in the limbs of domestic cats are generally neglected due to the limited number of available research materials (15). However, while this may be the case for domestic cats, it is not thought to apply to big cats (lions, jaguars, cougars, etc.). Therefore, unlike large felines, our study focuses on index and ratio calculations for the thoracic and pelvic limbs of domestic cats living in urban environments. The relative proportions of the limbs within the body conformation were evaluated in terms of their effectiveness in both hunting and movement strategies, and the limb ratios and indices of domestic cats were attempted to be determined. Furthermore, we believe that the indices and ratios obtained will also be useful in zooarchaeological/forensic science studies (7, 16, 31) for estimating skeletal integrity.

Materials and methods

In this study, a total of 55 adult (2-4 years old) animal bones were used, comprising 33 males and 22 females. The materials used in the study were obtained from the osteological collection of the Osteoarchaeology Practice and Research Centre at Istanbul University (2015-2018). In this context, all records pertaining to the individuals (sex, age, etc.) were taken from the existing information in the collections. The 'greatest length (GL)' measurements of the humerus (H-GL), radius (R-GL), femur (F-GL), and tibia (T-GL) bones from thoracic and pelviclimbswere taken using a digital caliper (9). Each measurement, a digital caliper with a precision 1 mm were used for measuring. All measurements were taken three times and the mean value was computed.

The following index calculations were performed using these osteometric measurements.

Standard indices to assess relative limb proportions (1, 21):

Intermembral index = (humerus greatest length + radius greatest length)/femur greatest length + tibia greatest length) ∗ 100

Humerofemoral index = (humerus greatest length/femur greatest length) ∗ 100

Brachial index = (radius greatest length/humerus greatest length) ∗ 100

Crural index = (tibia greatest length/femur greatest length) ∗ 100

To determine whether there was homotypic variation (asymmetry) in the osteometric data used in the study, a Student's t-test was performed between the right and left bones. The analysis revealed no asymmetry between the right and left homotypic bones, so only data from the left-side bones were used in the study.

The Student's t-test was applied to the obtained osteometric measurements and indices to check the significance of the difference between female and male individuals.

Results and discussion

Sexual differences significant at the $P < 0.05$ level were observed in the osteometric measurements of the cats used in our study (Tab. 1). Male individuals were observed to have longer structures in both their thoracic and pelvic limb bones compared to females.

Using these osteometric measurements, four different indices were calculated. These are presented in Table 2.

Unlike the absolute maximum length (GL) measurements of the humerus, radius, femur and tibia bones, no statistically significant difference was observed between the sexes in the index values calculated using these data. This indicated that there was no sexual dimorphism between the index values.

Tab. 1. Osteometric measurements of thoracic and pelvic limb long bones (mm)

Sex	Statistical	H-GL	R-GL	F-GL	T-GL
Male	Mean	111.23*	107.70*	118.54*	125.08*
	N	33	33	33	33
	SD	7.18	7.76	8.34	7.27
Female	Mean	104.85*	101.10*	110.60*	118.86*
	N	22	22	22	22
	SD	6.40	8.13	8.43	8.25
Total	Mean	108.68	105.06	115.37	122.59
	N	55	55	55	55
	SD	7.51	8.49	9.17	8.20

Explanations: * $P < 0.05$; H – humerus; R – radius; F – femur; T – tibia; GL – greatest length

Tab. 2. Index values of thoracic limb and pelvic limb long bones

Sex	Statistical	Brachial	Crural	IMI	HFI
Male	Mean	96.84^{NS}	105.79^{NS}	89.88^{NS}	94.03^{NS}
	N	33	33	33	33
	SD	3.64	6.50	3.40	5.81
Female	Mean	96.35^{NS}	107.70^{NS}	89.77^{NS}	95.00^{NS}
	N	22	22	22	22
	SD	3.44	6.80	2.99	4.95
Total	Mean	96.65	106.55	89.83	94.42
	N	55	55	55	55
	SD	3.54	6.63	3.22	5.46

The intermembral index value was determined to be 89.93. This value, which is below 100, indicated that the pelvic limbs were longer than the thoracic limbs. The humerofemoral index was determined to be 94.42. This index value confirmed that there was a difference between the lengths of the femur and humerus, and that the femur was longer than the humerus. Simultaneously, the brachial index was determined to be 96.65. This value indicated that the radius was slightly shorter than the humerus. Moreover, the crural index was determined to be 106.55. This revealed that the tibia was significantly longer than the femur.

When the coefficient of variation (CV) for osteometric measurements was calculated, it indicated a moderate level of variation (Fig. 1). The coefficients of variation ranged from 5.81 to 7.21 in males and from 6.10 to 8.04 in females. The coefficients of variation for the humerus in the thoracic limbs were found to be lower than those for the radius measurements. In the pelvic limbs, the tibia exhibited a lower coefficient of variation compared to the femur measurements.

The coefficients of variation for the indices were lower than those for osteometric measurements. The distribution of variation was observed to be significantly narrower than that for osteometric measure-

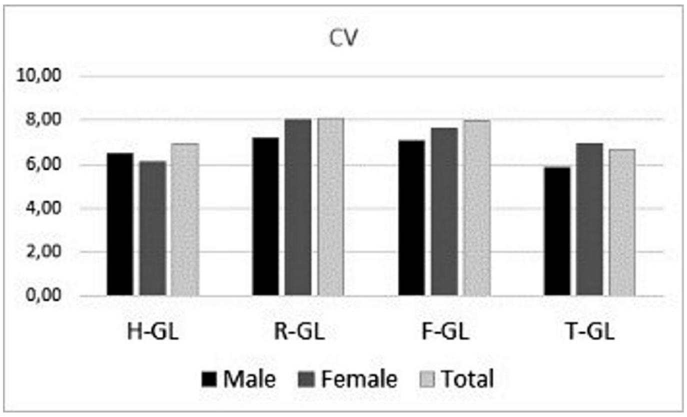

Fig. 1. Coefficients of variation (CV) for osteometric measurements
Explanations: H-GL – the greatest length of humerus, R-GL – the greatest length of radius, F-GL – the greatest length of femur, T-GL – the greatest length of tibia

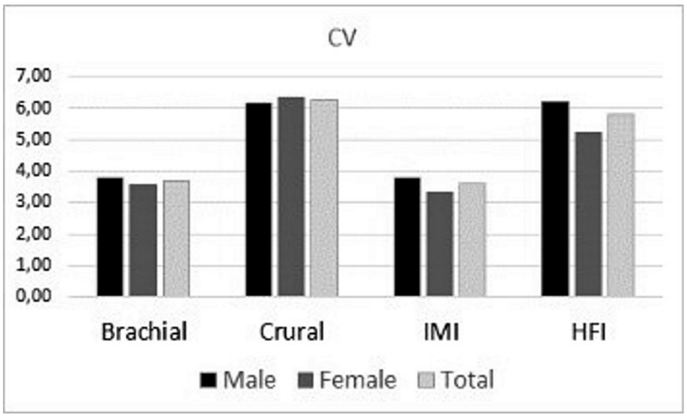

Fig. 2. Coefficients of variation (CV) of the indices
Explanations: Brachial – brachial index, Crural – crural index, IMI – intermembral index, HFI – humerofemoral index

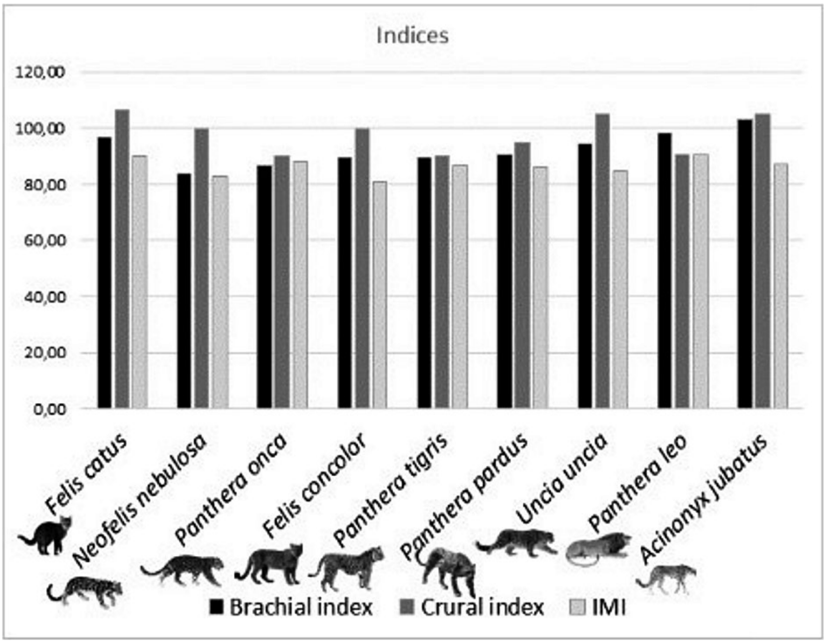

Fig. 3. Comparison of the indices
Explanations: *Felis catus* – domesitic cat, *Neofelis nebulosa* – clouded leopard, *Panthera onca* – jaguar, *Felis concolor* – cougar, *Panthera tigris* – tiger, *Panthera pardus* – leopard, *Uncia uncial* – snow leopard, *Panthera leo* – lion, *Acinonyx jubatus* – cheetah

ments. The crural and humerofemoral indices showed a moderate level of variation compared to the brachial and intermembral indices (Fig. 2).

The thoracic and pelvic limb ratios are a relative comparison of the lengths of the different limb segments that comprise them, allowing for the observation of relative changes between limbs (1, 8, 29). These limb ratios are effective not only in movement but also in revealing feeding and hunting strategies (8, 22). Therefore, the thoracic and pelvic limbs have different functions in the movement strategy. The pelvic legs provide greater propulsive force than the thoracic limbs (10, 30) and play an active role in stabilising the body (32). In contrast, the thoracic limbs play a role both in hunting strategy (17) and in climbing to high places (13).

Whether between the thoracic and pelvic limbs or in terms of the ratio of the limbs to the body length, these are generally referred to as limb ratios, and these proportional differences are defined by a general limb index (11). These indices are evaluated as humerofemoral, intermembral, brachial, and crural indices, depending on the locomotor model of the animals (1, 21, 29). In big cats, these indices provide important information for evaluating ecological adaptations such as hunting and movement strategies (22, 24). The Felidae family provides an ideal model for studying these adaptations, as hunting behaviours, habitat preferences, and locomotor styles vary greatly among species (2, 3). Differences in the thoracic and pelvic limb length in felids, particularly in large felids, are due to differences in distal (radius/tibia) and proximal (humerus/femur) bone length (8). It has been noted that differences in limb length and proportions according to habitat are particularly evident in large felids, with differences between closed (forest) and open habitat species (14, 22).

It has been suggested that species such as the jaguar (*Panthera onca*) and clouded leopard (*Neofelis nebulosa*), which inhabit dense forest habitats, possess shorter distal parts of thoracic limbs and consequently a lower brachial index in order to subdue and control their prey (14).

In our study, the intermembral index in domestic cats (*Felis catus*) was found to be 89.83 on average, indicating that the pelvic limbs are significantly longer than the thoracic limbs. This is consistent with the general morphological plan of felids and is critical for behaviours such as jumping, sudden acceleration, and tree climbing (Fig. 3). For example, in open-country predators such as the cheetah (*Acinonyx jubatus*), the requirement for high speed is supported by long limbs, whereas in arboreal (tree-dwelling) species such as the clouded leopard (*Neofelis nebulosa*), climbing and balancing abilities are directly reflected in limb proportions (22).

The lowest intermebral index value in big cats was found in the cougar (*Felis concolor*) (81.00), while the highest was found in the lion (*Panthera leo*) (90.60) (14). In our study, domestic cats were found to have a value between that of the jaguar (*Panthera onca*) (88.10) and the lion (*Panthera leo*) (90.60) (14), with a value of 89.83. When comparing the lengths of the thoracic and pelvic limbs, it has been reported that the greatest difference among all big cats is found in the cougar (*Felis concolor*), which probably reflects an adaptation for leaping in its habitat (14).

Despite the relative length of the pelvic limbs, our study found that the tibia was longer than the femur. This situation is likely to contribute to the pelvic limbs having greater propulsive force in pushing the body forward (10, 30) and playing a more effective role in stabilising the body during movement (32). In cats, both the effective pursuit of prey and the attainment of maximum speed can be observed with longer pelvic limbs (22) and an intermembral index value below 100. This situation indicates that cats land on all four limbs and also points to their locomotor differences in catching prey. This is because, unlike quadrupedal species where the thoracic and pelvic limbs are of similar length (11), cats are also animals with jumping and climbing abilities.

Cats are animals that have adapted to a high level of mobility due to their anatomical structure. The fundamental components of this adaptation are the proportional arrangement of the limbs' own components. The brachial index in the thoracic limbs and the crural index in the pelvic limbs are the most fundamental components of this adaptation (1). The presence of proportionally longer distal parts of limbs in digitigrade mammals has been identified as a factor that increases movement speed (26). In animals such as cheetahs (*Acinonyx jubatus*), which have the ability to run faster, a brachial index above 100 is indicative of this (23). In our study, the brachial index value of 96.65 indicates that the radius is shorter than the humerus. Similar to species such as the jaguar (*Panthera onca*) and clouded leopard (*Neofelis nebulosa*), which live in dense forest habitats and have shorter distal thoracic limbs (low brachial index) to subdue and control their prey (14), this morphology is also present in domestic cats. This morphology may reflect the efficiency of domestic cats in power-demanding movements such as catching small prey, manipulating it, and climbing. If domestic cats had a longer radius, similar to a speed-oriented open-field runner (e.g., Cheetah – *Acinonyx jubatus*), one could speak of an adaptation for speed (14). However, we do not believe that the adaptation of domestic cats to urban life indicates a situation that would require this.

Unlike the brachial index, the crural index in cats is 106.55. Based on this value, domestic cats have a tibia that is longer than the femur. The advantage created by the long tibia is considered an adaptation that increases stride length and movement speed (26). A high crural index, similar to that of cheetah-like open-country felids (14), should be associated with jumping performance and agility in domestic cats living in urban environments.

A similar situation to the intermembral index applies to the humerofemoral index. In our study, a value of 94.42 was obtained in domestic cats, confirming that the femur is longer than the humerus. Although it is reported that it is not surprising that ratios between homologous bones in the thoracic and pelvic limbs of mammals (e.g., humerofemoral index) generally fail to show any correlation with body size or mode of locomotion (18, 19, 21, 28), it has been reported that the humerofemoral index, in particular, is of great benefit in determining whether bones belong to the same individual in osteoarchaeological/forensic science studies (7, 16, 31). Beyond this, it is believed that this index will enable a broader assessment of humerus/femur morphometry in zooarchaeology, such as in estimating body mass and calculating shoulder height (25).

The limb indices and ratios of domestic cats are believed to be effective not only in revealing their movement, feeding, hunting, and habitat preference strategies (22, 24), but also to contribute significantly to pathological and orthopaedic applications in veterinary medicine. The morphometric characterisation of domestic cat bones is likely to contribute to regional anatomy and pathology studies, as well as serve as a useful reference for orthopaedic research and clinical applications (such as anatomical reconstruction in surgery) (27). Furthermore, it is suggested that the quantitative radiographic assessment of skeletal bones may assist in identifying skeletal anomalies (6). It is believed that all the morphometric and index data presented in our study on domestic cats will serve as a resource for the aforementioned veterinary approaches.

In conclusion, it is observed that in domestic cats, both the thoracic and pelvic limbs have different levels of activity in hunting, movement, and habitat strategies. The intermembral and humerofemoral indices obtained indicate that the pelvic limbs of domestic cats are longer than the thoracic limbs. A low brachial index indicates hunting manipulation and climbing movements requiring strength, while a high crural index and low intermembral index support jumping and agility capacities. The limb ratios in domestic cats represent a morphological compromise reflecting their versatile abilities as both hunters and climbers. This study demonstrates that the morphology of domestic cats is an important key not only to understanding their locomotor, but also their behavioural and ecological strategies. The data obtained are expected to serve as a reference for veterinary practice and zooarchaeological approaches, in addition to understanding habitat strategy in urban living.

References

1. *Aiello L., Dean C.*: An Introduction to Human Evolutionary Anatomy. Academic Press. UK, London 1990.
2. *Anyonge W.*: Locomotor behaviour in Plio-Pleistocene sabre-tooth cats a biomechanical analysis. Journal of Zoology, Lond. 1996, 238, 395-413.
3. *Arribas A., Palmqvist P.*: On the Ecological Connection Between Sabretooths and Hominids: Faunal Dispersal Events in the Lower Pleistocene and a Review of the Evidence for the First Human Arrival in Europe. Journal of Archaeological Science 1999, 26, 571-585.
4. *Bertram J. E. A., Biewener A. A.*: Differential scaling of the long bones in the terrestrial carnivora and other mammals. J. Morphol. 1990, 204, 157-169.
5. *Biewener A. A.*: Allometry of quadrupedal locomotion: the scaling of duty factor, bone curvature and limb orientation to body size. J. Ex. Biol. 1983, 105, 147-171.
6. *Choi Y., Pilton J., Foo T., Malik R., Haase B.*: Feline Skeletal Reference Guide: A Cadaveric Radiographic Measurement on Lower Limb Extremities. Vet. Comp. Orthop. Traumatol. 2021, 34, 401-410.
7. *Çöloğlu S., İşçan M. Y.*: Adli Osteoloji. İstanbul Üniversitesi Adli Tıp Enstitüsü Number 4150., Istanbul 1998 (in Turkish).
8. *Day L. M., Jayne B. C.*: Interspecific scaling of the morphology and posture of the limbs during the locomotion of cats (Felidae). Journal of Experimental Biology 2007, 210, 642-654.
9. *Driesch A. von den*: A Guide to the Measurement of Animal Bones from Archaeological Sites. Peabody Museum Bulletin 1. Cambridge, Harvard University, Massachusetts 1976.
10. *Ewer R. F.*: The carnivores. Weidenfeld & Nicolson, London 1973.
11. *Fleagle J. G.*: Primate Adaptation and Evolution. Third Edition, San Diego, Academic Press. 2013, p. 9-33.
12. *Garland T. Jr., Janis C. M.*: Does metatarsal/femur ratio predict maximal running speed in cursorial mammals? Journal of Zoology, London 1993, 229, 133-151.
13. *Gonyea W., Ashworth R.*: The form and function of retractile claws in the felidae and other representative carnivorans. Journal of Morphology 1975, 145, 229-238.
14. *Gonyea W. J.*: Adaptive differences in the body proportions of large felids. Acta Anatomica 1976, 96, 81-96.
15. *Gospodarek K.*: Determination of relative lengths of bone segments of the domestic cat's limbs based on the digital image analysis. Applied Computer Science 2019, 15, 89-97.
16. *Gök Ş.*: Adli Tıp Pratiği. Filiz Kitapevi, Istanbul 1962 (in Turkish).
17. *Harris M. A., Steudel K.*: Ecological correlates of hind-limb length in Carnivora. Journal of Zoology, London 1997, 241, 381-408.
18. *Hildebrand M.*: An analysis of body proportions in the Canidae. American Journal of Anatomy 1952, 90, 217-256.
19. *Hildebrand M.*: Body proportions of didelphid (and some other) marsupials, with emphasis on variability. Am. J. Anat. 1961, 109, 239-249.
20. *Holliday T. W.*: Brachial and crural indices of European late Upper Paleolithic and Mesolithic human. J. Human Evol. 1999, 36, 549-566.
21. *Jungers W. L.*: Body size and scaling of limb proportions in Primates, [in:] Jungers W. L. (ed.): Size and Scaling in Primate Biology. Plenum Press, New York 1985, p. 345-381.
22. *Kitchener A. C., Van Valkenburgh B., Nobuyuki Y.*: Felid form and function, [in:] Macdonald D. W., Loveridge A. J. (eds.): Biology and Conservation of Wild Felids. Oxford University Press 2010, p. 83-106.
23. *Kitchener A. C., Yamaguchi N.*: What is a tiger? Biogeography, morphology, and taxonomy, [in:] Tilson R. and Nyhus P. J. (eds): Tigers of the world (2nd ed.). Academic Press, London 2010, p. 53-84.
24. *Meachen-Samuels J., Van Valkenburg B.*: Forelimb indicators of prey-size preference in the Felidae. Journal of Morphology 2009, 270, 729-744.
25. *Mutlu Z., Chroszcz A., Kaya D. A., Mutuş R., Kartal M., Poradowski D., Onar V.*: Correlation between long-bone dimensions and body mass in cats. Med. Weter. 2025, 81, 67-72.
26. *Polly P. D.*: The Evolution of Mammalian Characteristics, Springer 2007, p. 245-268.
27. *Preston T., Glyde M., Hosgood G., Snow L.*: Morphometric description of the feline radius and ulna generated from computed tomography. Journal of Feline Medicine and Surgery 2015, 17, 991-999.
28. *Schmidt M., Fischer M. S.*: Morphological integration in mammalian limb proportions: Dissociation between function and development. Evolution 2009, 63, 3, 749-766.
29. *Stein P. L., Rowe B. M.*: Physical Anthropology. 5th Ed. McGraw-Hill, Inc. New York 1993, p. 306-308.
30. *Taylor M. E.*: Locomotor adaptations by carnivores, [in:] Gittleman J. L. (ed.): Carnivore behavior, ecology, and evolution. Ithaca, New York, Cornell University Press. 1989, p. 382-409.
31. *Ubelaker D. H.*: Human Skeletal remains: Excavation, analysis, interpretation, Aldine, Chicago 1978.
32. *Valkenburgh B. V.*: Skeletal indicators of locomotor behavior in living and extinct carnivores. Journal of Vertebrate Paleontology 1987, 7, 162-182.
33. *Weigel J. P., Arnold G., Hicks D. A., Millis D. L.*: Biomechanics of rehabilitation. Veterinary Clinics of North America 2005, 35, 1255-1285.

Corresponding author: prof. Aleksander Chrószcz, Kożuchowska 1, 51-631 Wrocław, Poland; e-mail: aleksander.chroszcz@upwr.edu.pl