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Comparative cranial anatomy of *Homo sapiens* and *Canis lupus familiaris*: morphological, functional, and educational perspectives with a glance to biodiversity

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Abstract

Cranial morphology reflects a species' evolutionary history, functional adaptations, and environmental interactions. This comparative anatomical study examines the key structural differences between the cranium of humans (*Homo sapiens*) and that of domestic dogs (*Canis lupus familiaris*). Through a multi-level analysis encompassing gross anatomy, comparative anatomy, and anthropological implications, we highlight how evolutionary divergence, bipedalism, olfactory function, diet, and domestication have shaped the skulls of these two species. The findings underline the relevance of interspecies cranial comparisons for understanding human evolution, craniofacial development, and the broader patterns of mammalian biodiversity.

Introduction

The vertebrate cranium is a highly integrated anatomical complex that serves multiple vital functions: it encases and protects the brain, supports key sensory structures, provides the framework for mastication and feeding, and plays an important role in vocalisation and communication. Its form and variation across species reflect a combination of genetic, developmental, and environmental influences, shaped over millions of years of evolution. Because of its multifaceted function and evolutionary significance, the skull remains a focal point for comparative anatomy, functional morphology, and evolutionary biology.[1] Among mammals, the cranium is particularly sensitive to ecological pressures and life history traits. Its morphology is shaped by dietary adaptations, modes of locomotion, social behaviours, and sensory specialisations. As such, comparative studies of skull structure across species can yield profound insights into phylogeny, biomechanics, sensory ecology, and even cultural history. Importantly, such analyses can also inform biomedical and anthropological research by identifying patterns of morphological integration and variation relevant to human development, pathology, and evolution. In this study, we present a comparative anatomical analysis of the cranium of *Homo sapiens* and *Canis lupus familiaris*, two species that, despite their divergent evolutionary paths, share a deep historical and biological connection. The domestic dog has co-evolved alongside humans for tens of thousands of years, a relationship that has influenced not only canine behaviour and physiology, but also their cranial morphology.[2] Dogs offer a unique perspective for comparative anatomical studies: they are phylogenetically distant from humans but live in the same ecological and social environments, and they display extraordinary cranial variability due to intense artificial selection.[1,3] This paper explores the structural, functional, and evolutionary dimensions of the human and canine cranium, examining both commonalities and contrasts. Special attention is given to the implications of bipedalism versus quadrupedalism, the impact of domestication on cranial diversity, and the comparative roles of olfaction and vision in shaping orbital and nasal anatomy. The analysis further highlights how interspecies differences in skull morphology reflect broader evolutionary trajectories and how such comparisons can enhance our understanding of human craniofacial development and biodiversity.

Materials and Methods

This study employed a comparative anatomical approach grounded in the direct observation of osteological specimens of *Homo sapiens* and *Canis lupus familiaris*. The specimens were sourced from the Anatomical Collection of the University of Palermo, Italy (https://musei.unipa.it/anatomia.html), which provided well-preserved adult skulls representing standard morphological features (*i.e.*, without any pathological/deviant traits) for each species. Unfortunately, we could not have had access to additional information regarding sex, approximate age, stature/weight, for humans, or breed/cranial type, for dogs, since all this information was not reported in the files of our Collection.

In particular, three-dimensional (3D) digital scans were performed on a selection of *Homo sapiens* and *Canis lupus familiaris* skulls (three per each) using high-resolution structured-light 3D scanners, *i.e.* Artec Eva (Artec 3D, Artec Europe, Luxembourg, EU) and Artec Spider (Artec 3D, Artec Europe, Luxembourg, EU). The Artec Eva scanner was employed for capturing overall morphology and large-scale features, while the Artec Spider scanner was used to acquire fine anatomical details. Multiple scans were acquired for each specimen from different angles to ensure full surface coverage and to minimize artifacts due to occlusion. All scans were performed using the proprietary software Artec Studio 18 professional (Artec 3D, Artec Europe, Luxembourg, EU), which was used for image acquisition, processing, and export of the final 3D models. The individual scans were subsequently aligned and merged within Artec Studio 18 professional to produce high-fidelity digital reconstructions of the cranial structures. The resulting 3D reconstructions were used for comparative morphological analyses focusing on both the neurocranium and the splanchnocranium.

After scanning, each skull was analysed using standard anthropometric and osteological parameters, including cranial index measurements, dental formulae, foramen magnum position, nasal cavity architecture, and the orientation and structure of the orbits and jaw. Observations were conducted using calipers, protractors, and anatomical reference scales in a controlled laboratory setting. Particular attention was paid to identifying functionally significant structures such as muscle attachment sites, cranial fossae, and sensory apertures. To contextualize these findings, we conducted a comprehensive review of the comparative anatomy and evolutionary morphology literature, including primary anatomical sources, morphometric analyses, and relevant paleontological and anthropological studies. Peer-reviewed articles, academic textbooks, and evolutionary biology monographs were consulted to enrich the interpretation of observed differences and to place them within an evolutionary and functional framework.

For analytic clarity, the cranial differences were categorised into three thematic domains: i) basic cranial structure, encompassing overall skull shape, braincase dimensions, and facial-to-cranial proportion; ii) comparative morphological features, including muscle attachments, orbital and nasal anatomy, dental architecture, and neurocranial versus splanchnocranial development; iii) anthropological implications, addressing the evolutionary, behavioral, and ecological significance of cranial adaptations, particularly those associated with bipedalism in humans and domestication in dogs.

This triadic classification facilitated a systematic comparison that integrates morphological detail with broader functional and evolutionary interpretations, providing a holistic perspective on interspecies cranial variation.

Results

Cranial dimensions and braincase proportions

The cranial capacity of *Homo sapiens*, averaging approximately 1,350 cm^3, reflects a pronounced degree of encephalization relative to body size, one of the defining traits of the human lineage. This volumetric expansion of the neurocranium accommodates a highly developed cerebral cortex, particularly in regions associated with abstract reasoning, language processing, problem-solving, and complex social interactions.[4] The human brain exhibits a high neuron density and an intricate pattern of cortical folding, which together enable advanced cognitive capacities that underlie cultural development, technological innovation, and symbolic thought. In contrast, domestic dogs (*Canis lupus familiaris*) possess a markedly different cranial architecture. Their neurocranium is more elongated, dorsally flattened, and generally smaller in proportion to body mass, reflecting a lower encephalization quotient compared to humans and some non-human primates (Figure 1). The canine brain is structurally and functionally adapted to a different set of evolutionary priorities, particularly those involving olfaction, sensorimotor integration, and social communication within a pack structure.[5,6] While dogs exhibit notable cognitive skills, especially in social cognition and human-animal interaction contexts, these do not stem from frontal lobe expansion but rather from specialized neural circuits shaped by ecological demands. Breed-specific variations in brain size and cranial shape have also been documented, with some dolichocephalic breeds showing slightly larger cranial capacities than brachycephalic ones, though these differences are generally minor in comparison to interspecies variation. Overall, the contrast in neurocranial morphology between humans and dogs highlights how brain size and shape co-evolve with behavioural niches, sensory prioritization, and functional demands, reinforcing the tight link between anatomy and adaptive strategy.

Facial skeleton and mandibular architecture

Humans display a markedly reduced facial skeleton compared to other primates and most quadrupedal mammals, including domestic dogs. This gracilization is most evident in the maxillary and mandibular bones, which are significantly smaller and less robust in *Homo sapiens* (Figure 2). The trend toward reduced facial projection and smaller jaws has been linked to a fundamental shift in dietary mechanics, particularly following the evolutionary advent of cooking and food processing.[7] The transition from consuming raw, fibrous foods to softer, thermally processed meals led to a reduced reliance on strong masticatory forces, thereby decreasing selective pressure for large jawbones and the associated musculature. Over time, this facilitated the development of flatter facial profiles, a vertically aligned face, and smaller teeth, features that are especially prominent in anatomically modern humans compared to their hominin ancestors. This facial reduction also corresponds with a diminished need for expansive masticatory muscle attachment sites, such as a sagittal crest or a pronounced zygomatic arch, both of which are largely absent or less developed in humans. As a result, the human face reflects not only biomechanical changes but also broader cranial reorganizations associat-

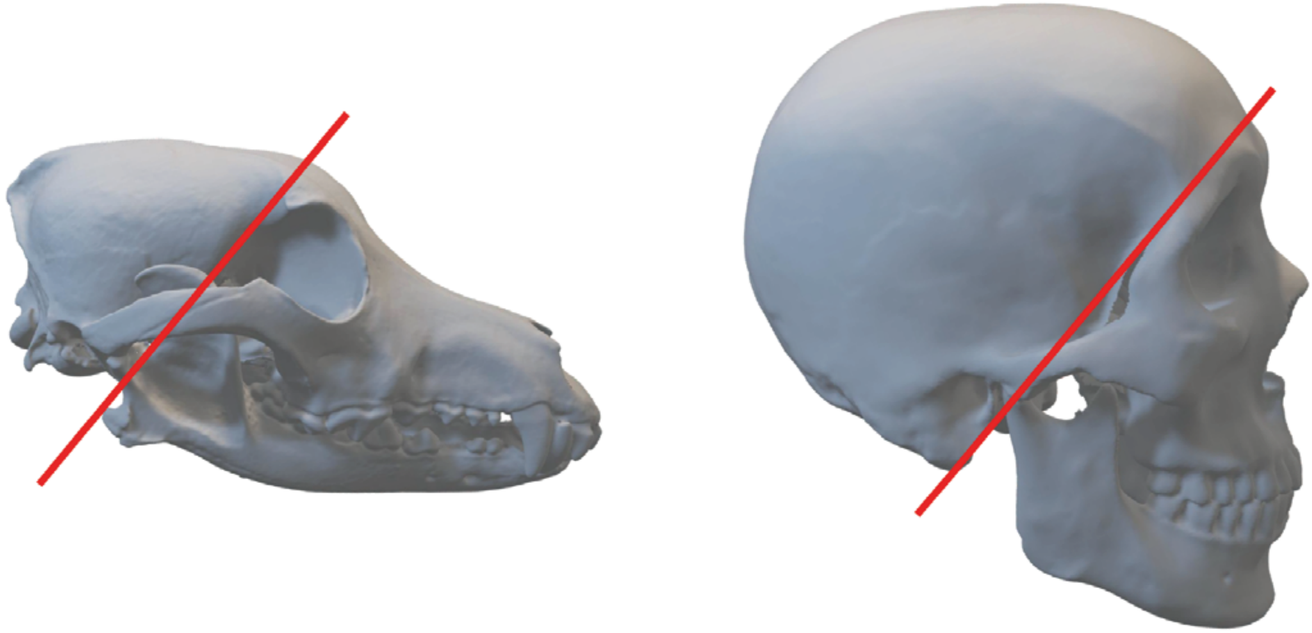

Figure 1. Comparative images of the skull of *Canis lupus familiaris* and *Homo sapiens* in lateral view. The markedly different ratio between the splanchnocranium and the neurocranium is clearly visible (the red line helps to distinguish them), with a relative predominance of the neurocranium in *Homo sapiens*. See main text for further details.

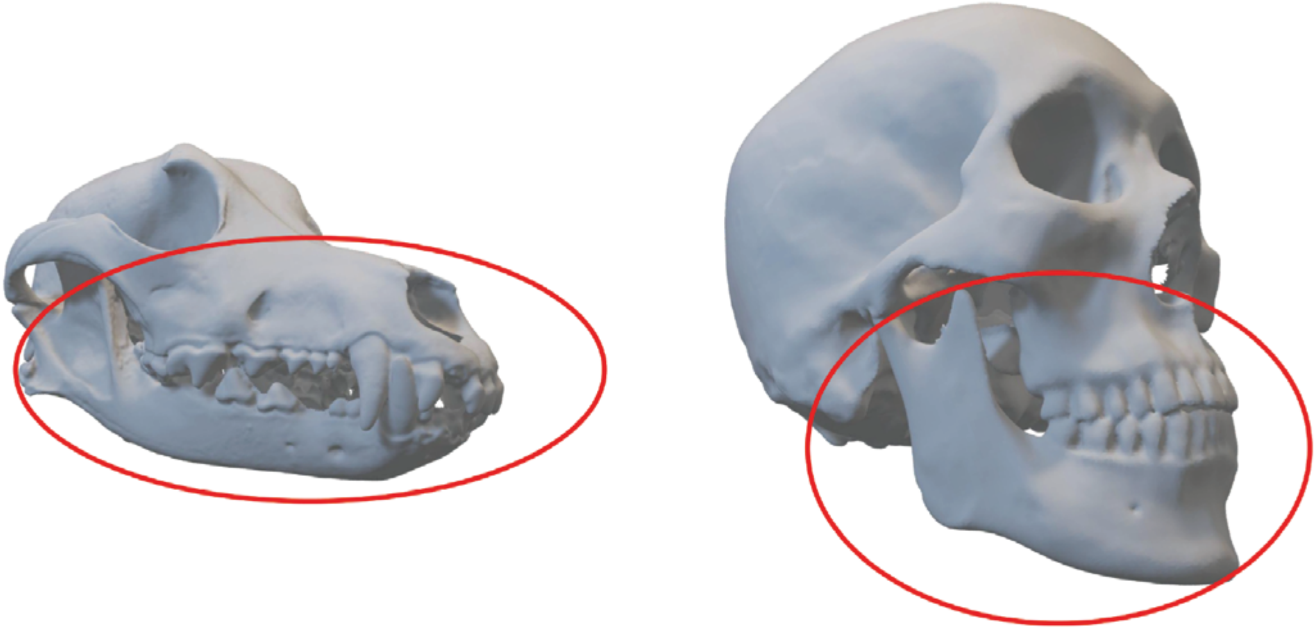

Figure 2. Mandibular and maxillary prominence in lateral view. This view highlights the prominence of the maxillary and mandibular bones (red circles aid in their identification), which are significantly more pronounced in *Canis lupus familiaris* than in *Homo sapiens*, where the dentition is also less robust. See main text for further details.

ed with increased neurocranial volume and more centrally positioned orbits and foramen magnum. In contrast, dogs retain robust maxillofacial bones, especially in breeds historically selected for high bite force, such as mastiffs, shepherds, and other working or guarding breeds. These animals exhibit thickened zygomatic arches, deep mandibular bodies, and large coronoid processes, all of which support the attachment and function of powerful jaw muscles, particularly the temporalis and masseter.[8] These structural reinforcements are necessary to accommodate a feeding ecology that traditionally involved biting, tearing, and crushing raw animal tissues, bones, and other mechanically challenging food sources. Moreover, artificial selection has maintained or enhanced these traits in various breeds according to functional needs. For instance, breeds used in police or military roles often retain large, muscular jaws with high bite pressures, whereas companion breeds may show somewhat reduced features due to relaxed selective pressures. Despite this variation, the general retention of a prominent facial skeleton in dogs highlights their sustained reliance on oral and dental functions for environmental interaction, feeding, and communication.

Foramen magnum position

One of the most diagnostically informative cranial features distinguishing bipedal from quadrupedal species is the placement and orientation of the foramen magnum, the large opening at the base of the skull through which the spinal cord exits. In *Homo sapiens*, the foramen magnum is located anteriorly and inferiorly on the occipital bone, near the central base of the skull. This positioning allows the skull to rest in a balanced, vertical alignment atop the vertebral column, minimizing muscular effort to maintain head posture (Figure 3). It is a hallmark adaptation to habitual bipedalism, facilitating upright walking by aligning the head directly above the body's centre of gravity.[9,10] This reorientation of the cranial base is accompanied by a shortened nuchal plane and reduced muscular attachment areas on the occiput, reflecting decreased reliance on powerful neck extensors. The human cranial base is also more flexed, a change that contributes to cranial vault expansion and facilitates the reorganization of the face beneath the braincase, a process known as orthognathy. In contrast, domestic dogs (*Canis lupus familiaris*) exhibit a more posteriorly located and caudally oriented foramen magnum, consistent with a horizontal vertebral axis typical of quadrupedal mammals.[8] This configuration supports a head posture that projects forward in line with the spine, enabling visual scanning, olfactory tracking, and locomotor balance during rapid movement. The occipital region in dogs tends to be more robust, with enlarged nuchal crests to anchor the strong cervical musculature needed to stabilize and mobilize the head during locomotion and predation. The contrasting locations of the foramen magnum in dogs and humans thus represent functional responses to fundamentally different modes of locomotion and postural demands.

Dentition and diet

The dentition of *Homo sapiens* is adapted for omnivory, featuring a bunodont molar morphology characterized by rounded cusps suitable for crushing and grinding a wide range of food types, including cooked vegetables, grains, and meats. Humans have a dental formula of 2.1.2.3 in both upper and lower jaws, with moderately sized incisors, small canines, premolars, and molars adapted to a largely non-specialized diet. The evolution of cooking, tool use, and food processing has led to a significant reduction in both tooth size and jaw robustness (Figure 2), reflected in flatter faces,

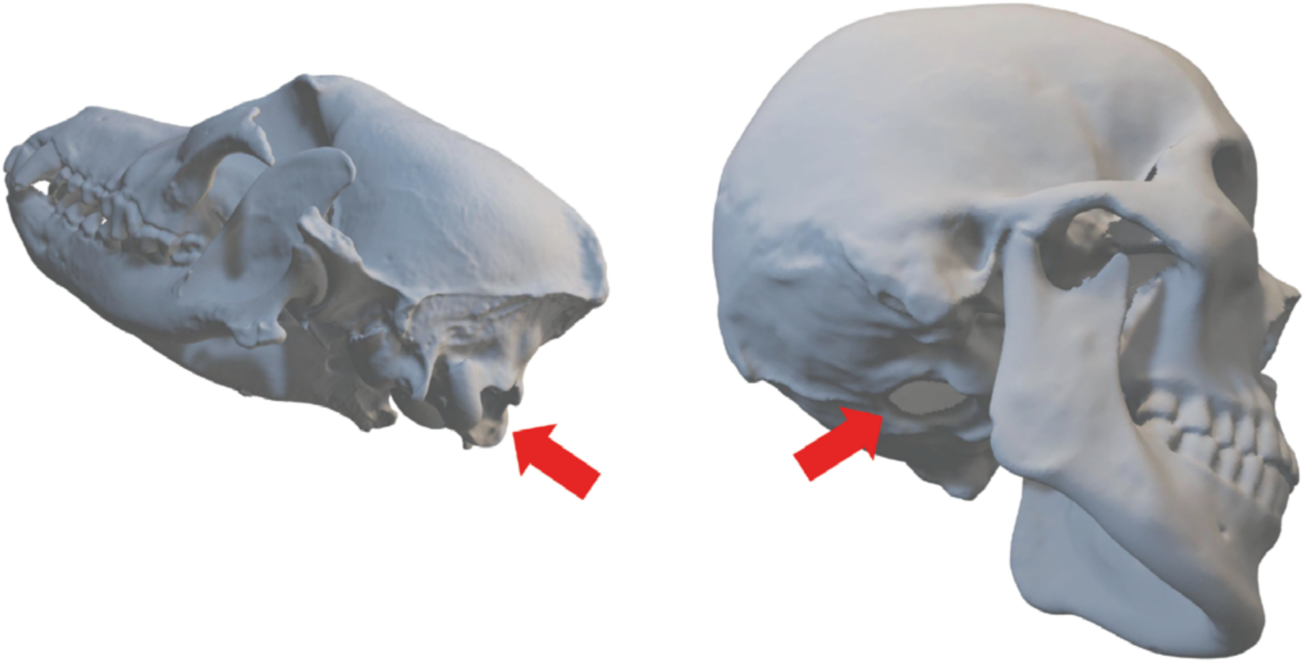

Figure 3. Relative position of the foramen magnum in lateral view. This perspective highlights the relative position of the foramen magnum in the two species. While in both it is located on the basal aspect of the skull, in *Canis lupus familiaris* it is positioned much more posteriorly than in *Homo sapiens*, where it is more centrally located. This difference reflects the fact that the dog is a quadruped, whereas the human is a biped and must keep the head aligned with the body's center of gravity. See main text for further details.

reduced prognathism, and lower bite forces compared to ancestral hominins and other mammals.[1,7] Additionally, the diminished need for heavy mastication in modern diets has changed the functional dynamics of the human dental arch, contributing to common dental crowding and malocclusion in post-industrial populations, a phenomenon often cited in evolutionary medicine.[7] In contrast, the dental anatomy of dogs reflects their carnivorous ancestry and ecological niche as predators and scavengers (Figure 2). Dogs possess prominent canines for seizing and holding prey, as well as specialized carnassial teeth, modified upper fourth premolars and lower first molars, designed for shearing flesh with a scissor-like action.[11] Their molars are pointed and laterally compressed rather than flattened, supporting a diet historically composed of raw meat, connective tissue, and even bone. However, domestication has introduced significant dietary shifts in dogs. As they adapted to cohabiting with humans, selective pressures favoured genetic modifications associated with starch digestion. One landmark genomic study identified copy number variation in the *AMY2B* gene, which encodes pancreatic amylase, as a key adaptation that enables dogs to efficiently metabolize complex carbohydrates, a trait far less developed in their wild wolf ancestors.[12] This genomic shift suggests that early domestic dogs co-evolved not only in social and behavioural traits but also in digestive physiology, aligning their diet more closely with that of agricultural human societies. Thus, while the dental morphology of dogs retains its carnivorous blueprint, modern breeds demonstrate considerable flexibility in dietary assimilation, reflecting a dual influence of evolutionary heritage and anthropogenic adaptation.

Sagittal crest and masticatory musculature

Large dog breeds often exhibit a pronounced sagittal crest, a midline bony ridge running along the dorsal surface of the cranial vault (Figure 4). This feature serves as a major site for the attachment of the temporalis muscles, one of the principal muscle groups involved in mastication. The prominence of the sagittal crest is directly correlated with the size and strength of these muscles, which are critical for forceful jaw closure, particularly in carnivorous animals that rely on tearing and crushing food.[8] This morphological adaptation enables dogs, especially those historically bred for guarding, hunting, or prey capture, to exert substantial bite forces necessary for subduing and processing tough, fibrous or raw materials. In contrast, the human cranium lacks a sagittal crest entirely, reflecting the evolutionary regression of the masticatory apparatus. The reduction of jaw muscle mass and attachment areas in *Homo sapiens* is largely attributed to cultural and dietary transitions, particularly the widespread adoption of cooking, food processing, and the shift toward softer, more easily chewable diets.[7] These changes significantly reduced the selective pressures for large masticatory musculature, contributing to the flatter cranial vault and more gracile facial skeleton typical of modern humans. Electromyographic studies have demonstrated that the maximum bite force generated by modern humans is substantially lower than that of non-human primates and canids, supporting the anatomical evidence of diminished jaw power.[13] Additionally, the decline in cranial and mandibular robustness over evolutionary time is paralleled by changes in dental wear patterns and occlusal morphology,

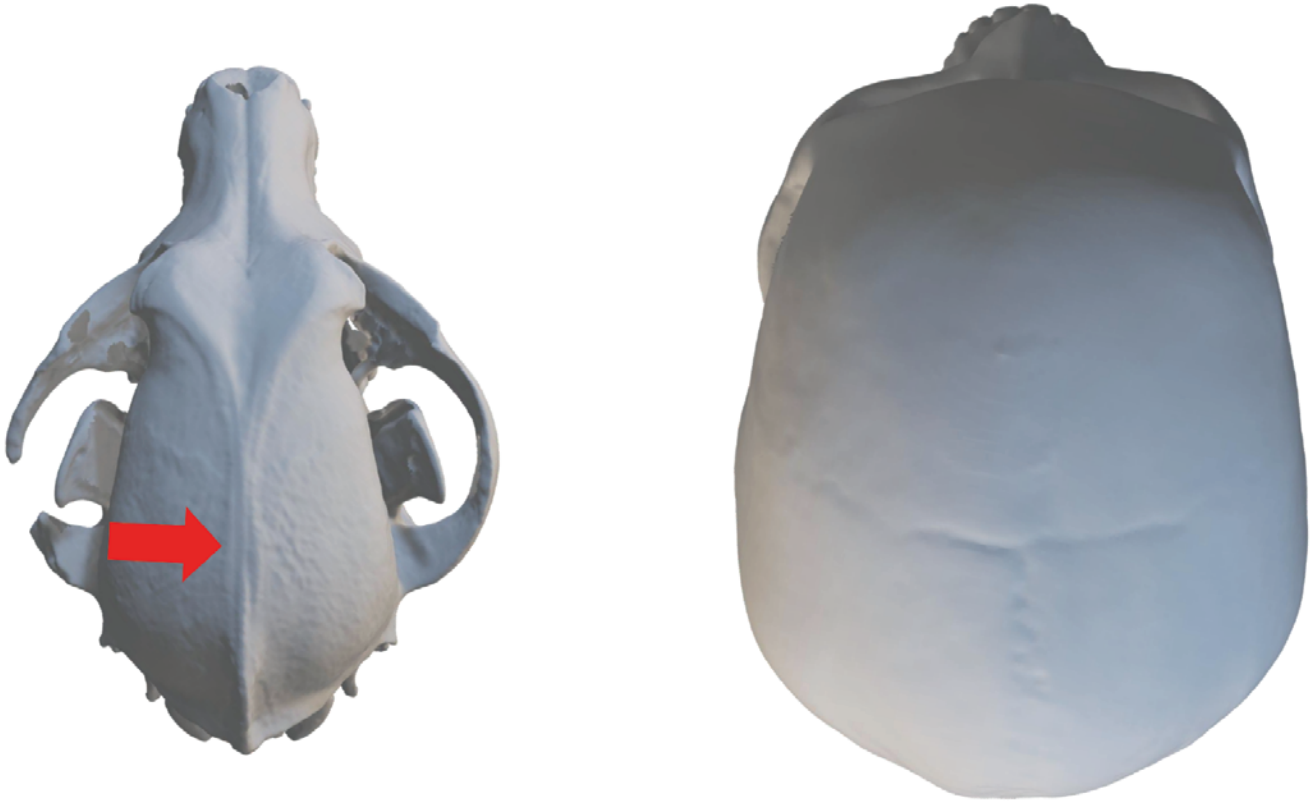

Figure 4. Sagittal crest and muscle attachment. This view clearly shows the sagittal crest on the superior aspect of the skull. This Y-shaped crest serves as the insertion site for the temporalis muscle, one of the main muscles involved in mastication. In *Homo sapiens*, this crest is absent because the temporalis muscle is less developed and inserts on the corresponding bone (not shown). See main text for further details.

further reflecting decreased mechanical demands in the human masticatory system.

Nasal anatomy and olfaction

The canine and human nose are also different (Figure 5). In particular, the canine nasal cavity is highly specialised and morphologically complex, reflecting the evolutionary priority of olfaction in the behavioural ecology of *Canis lupus familiaris*. It contains a series of intricate ethmoturbinate structures, thin, scroll-like bony plates within the nasal passage, that dramatically increase the surface area available for olfactory epithelium.[14] These turbinates are lined with millions of sensory neurons equipped with odorant receptors, enabling dogs to detect an extraordinarily wide range of chemical compounds. Indeed, domestic dogs possess up to 300 million olfactory receptors, compared to only approximately 5–6 million in humans,[14] making their sense of smell between 10,000 to 100,000 times more sensitive than that of humans, depending on the compound. Functional neuroimaging studies, including functional magnetic resonance imaging, have shown that olfactory stimulation in dogs activates large regions of the brain, particularly the olfactory bulb and associated cortical areas, which occupy a proportionally larger volume than in humans.[15] This underscores the central role of olfaction in canine cognition, navigation, social communication, and memory encoding. Scent-driven behaviour governs key aspects of canine life, from territory marking and mate selection to tracking and detection work in service roles. In contrast, the human nasal anatomy reflects a marked evolutionary shift away from olfactory dependence. The nasal cavity is smaller, and the turbinates are less developed, offering a reduced surface for olfactory epithelium. Consequently, the human olfactory bulb is proportionally much smaller than that of canids. This reduction corresponds with the primate transition toward vision-dominant sensory processing, wherein visual and auditory information became primary channels for environmental interaction, social recognition, and threat detection.[16,17] In humans, this shift is reflected not only in anatomy but also in neurodevelopmental and behavioural patterns, highlighting a profound sensory divergence from their canine counterparts.

Orbital orientation

Orbital morphology also diverges significantly between *Canis lupus familiaris* and *Homo sapiens* (Figure 6), reflecting the sensory priorities and ecological adaptations of each species. In humans, the orbits are positioned frontally, a configuration that facilitates binocular vision and high-resolution stereopsis. This arrangement allows for precise depth perception, which is critical for complex visuomotor tasks such as fine motor coordination, object manipulation, and tool use, hallmarks of hominin behavioural evolution.[18] The overlap in the visual fields of both eyes creates a three-dimensional representation of space, essential for navigating arboreal environments in early hominins and for later cultural advancements requiring preci-

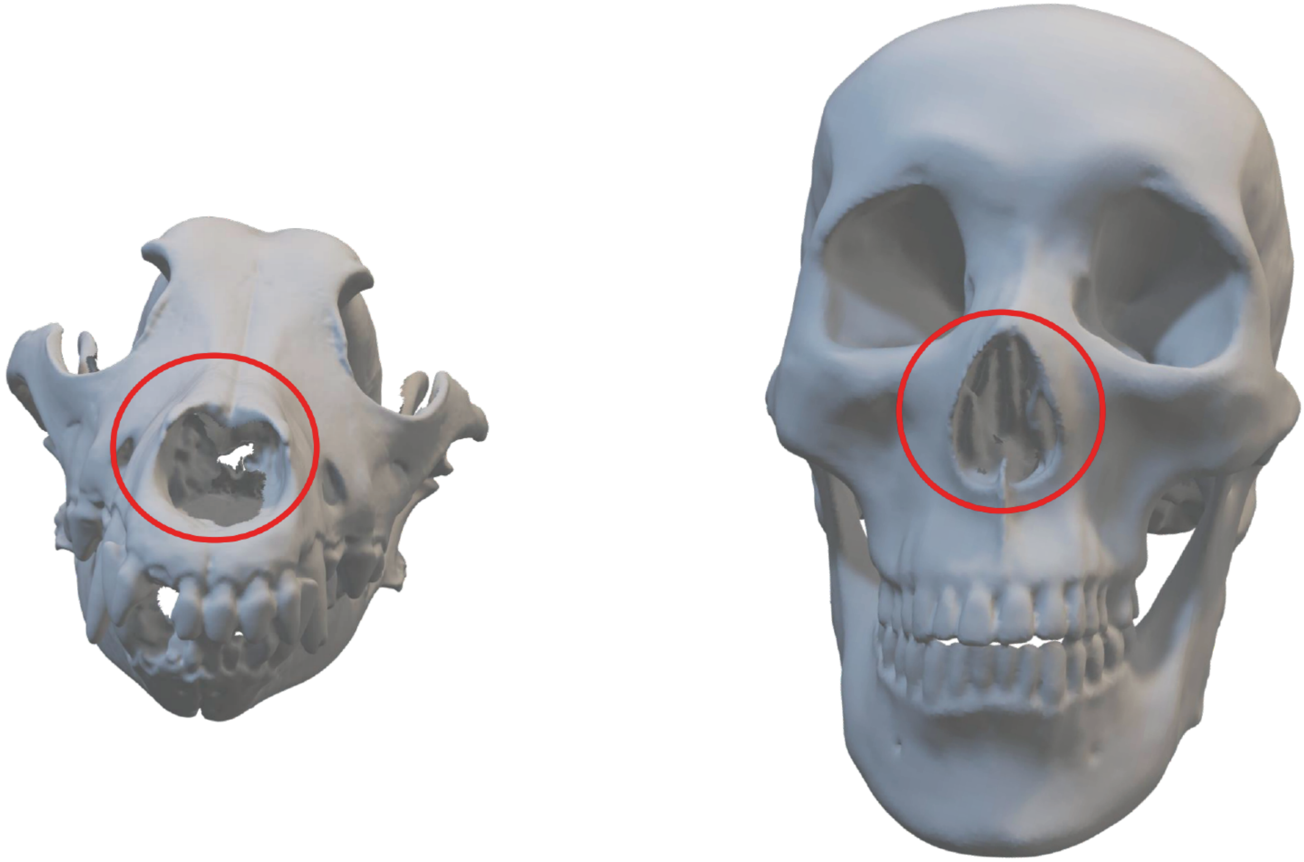

Figure 5. Nasal cavity entrance and turbinate morphology. From this perspective, the entrance to the nasal cavities is clearly visible, rounded in dogs and piriform in humans. The different morphology of the turbinates in the two species can also be partially observed. See main text for further details.

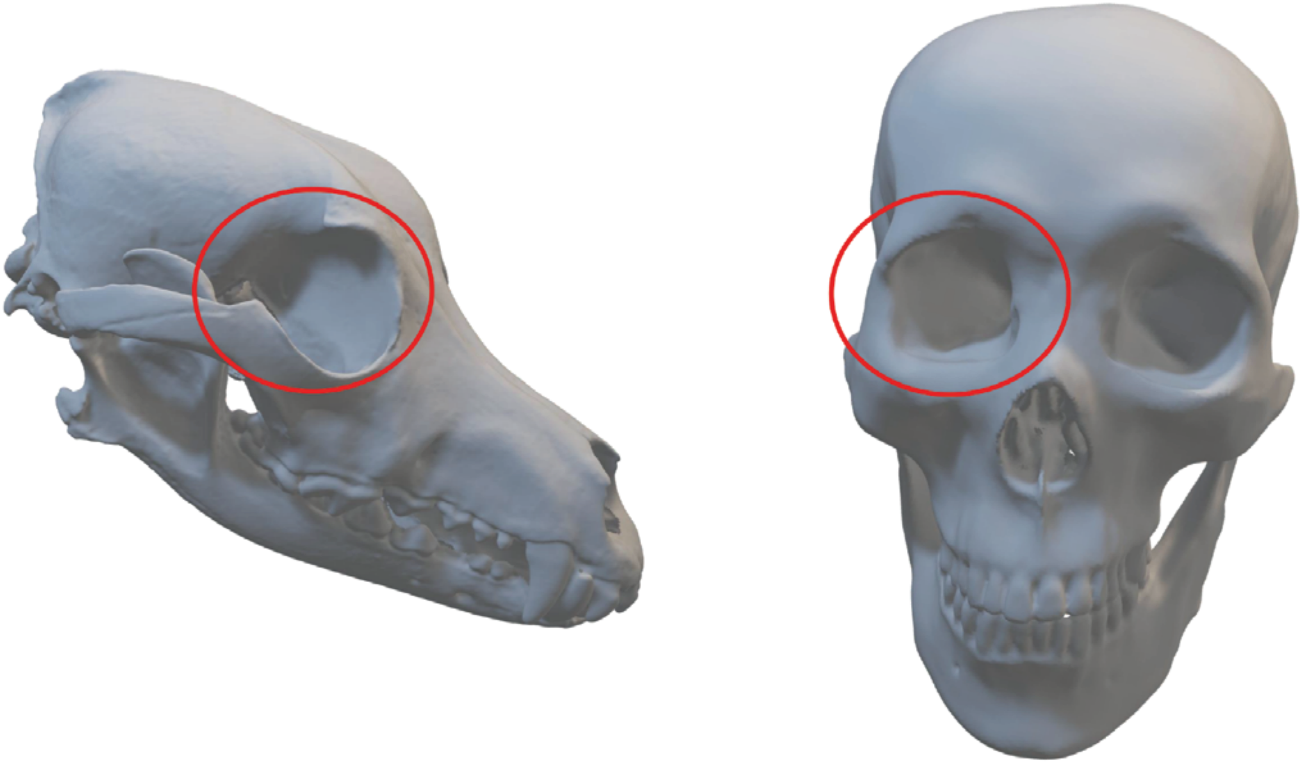

Figure 6. Orbital orientation and visual field differences. This view shows the difference in the orientation of the orbital cavities (right side only, circled in red) and, consequently, of the eyeballs. In the dog, the orbits are positioned more laterally, whereas in humans they are more frontally oriented. The main difference lies in the resulting visual field: dogs have a wider field with greater peripheral vision, while in humans, and in other primates, the field is more focused on objects to be manipulated, reflecting the evolutionary refinement of hand use. See main text for further details.

sion, such as writing, crafting, and surgery. In contrast, dogs possess orbits that are oriented more laterally on the skull, resulting in a wider field of peripheral vision. While this reduces the degree of binocular overlap and depth discrimination, it significantly enhances their ability to detect movement across a broad visual range, an adaptation well-suited to their ancestral roles as predators and scavengers.[8] This orbital arrangement supports a visual strategy that prioritises spatial awareness, motion detection, and environmental monitoring, essential for hunting and for avoiding potential threats. Breed-specific variation also exists in dogs, with sighthounds displaying slightly more forward-facing orbits to improve binocular acuity during pursuit, suggesting that even within the species, orbital morphology can be finely tuned to behavioural specialization.

Other anthropological and evolutionary considerations

These anatomical contrasts vividly illustrate the distinct evolutionary pressures that have shaped the skulls of humans and dogs over millions of years. In hominins, the adoption of obligate bipedalism led to a cascade of cranial adaptations, including the anterior repositioning of the foramen magnum, a more flexed cranial base, and increased neurocranial volume to accommodate a rapidly expanding brain. These changes were accompanied by a marked reduction in facial prognathism and masticatory musculature, reflecting dietary transitions toward softer, processed foods and an increasing reliance on culture, tools, and language. In contrast, the cranial morphology of domestic dogs reflects an evolutionary trajectory shaped by quadrupedal locomotion, acute olfactory demands, and carnivorous ancestry. The elongation of the rostrum, the lateral orientation of the orbits, and the prominence of sagittal crests in some breeds underscore the importance of smell, wide visual fields, and powerful jaw musculature in the ecological niches occupied by ancestral canids. These fundamental adaptations have remained largely conserved even as dogs underwent significant morphological diversification under the influence of domestication. Indeed, domestication introduced a powerful anthropogenic force that rapidly altered canine skull morphology. Selective breeding over only a few centuries has generated extreme morphotypes, from brachycephalic breeds such as pugs and bulldogs, with shortened snouts and compressed nasal structures, to dolichocephalic breeds like greyhounds, characterised by elongated skulls and refined facial features. This range of variability, unparalleled among terrestrial mammals, provides a living model of how artificial selection can mimic or even accelerate evolutionary processes.[19] Moreover, advances in comparative genomics have revealed striking developmental parallels between humans and dogs, particularly in genes governing craniofacial morphogenesis. Mutations in *BMP3*, a gene crucial for cranial vault formation, have been linked to variations in skull shape across both species, highlighting a conserved genetic framework for cranial development.[20] These findings support the emerging view that domestic dogs may serve as valuable translational models in biomedical research, especially for the study of craniofacial malformations, growth disorders, and evolutionary developmental biology. Thus, the comparative anatomy of the human and canine skull is more than a descriptive exercise; it serves as a gateway to understanding the evolutionary forces that shape morphology and offers a robust platform for exploring genetic and developmental mechanisms relevant to both veterinary and human medicine. The intersection of natural and artificial selection in shaping the dog skull, combined with shared genetic pathways, makes the domestic dog an indispensable model in modern craniofacial research.

Discussion

This comparative analysis demonstrates and confirms that cranial morphology in *Homo sapiens* and *Canis lupus familiaris* is the product of deeply divergent evolutionary pathways, shaped by specific environmental, functional, and behavioural pressures.[1,4] In humans, the morphology of the skull is closely tied to the demands of upright bipedal locomotion, expanded cerebral capacity, reduced masticatory force, and the increasing reliance on stereoscopic vision and complex social interaction. These traits have contributed to a cranial architecture characterised by a large, rounded braincase, a centrally positioned foramen magnum, and a gracile facial skeleton. By contrast, the canine skull retains morphological features adapted for quadrupedal movement, enhanced olfactory function, and a carnivorous feeding ecology. The elongated snout, lateralised orbits, and robust masticatory structures reflect ancestral functional imperatives associated with hunting, scent tracking, and meat processing.

Notably, domestication and human-driven selective breeding have added a layer of morphological complexity, producing a degree of cranial variability unmatched in any other mammalian species.[12] This variation, from extreme brachycephaly to dolichocephaly, illustrates how artificial selection can rapidly shape anatomical traits within a relatively short evolutionary timeframe.

Recent morphometric studies have emphasized that, although domestic dog breeds are often classified into broad functional or morphological groups, such as working, herding, sporting, hound, terrier, toy, or foundation/primitive types, cranial shape variation does not always follow clear-cut boundaries among these categories. For instance, Hebdon *et al.*[21] demonstrated substantial morphometric overlap between functional breed groups despite the remarkable overall cranial diversity observed across domestic dogs.[21,22]

Beyond highlighting differences, this comparative study reveals areas of anatomical and developmental convergence that are of great interest to evolutionary biologists, anthropologists, and medical researchers.[5] Dogs, due to their shared mammalian lineage and extensive morphological diversity, serve as an increasingly valuable model in biomedical research, particularly in the study of craniofacial development, congenital malformations, and genetic regulation of bone growth.

Comparative cranial analysis not only enriches our understanding of functional anatomy and evolutionary adaptation but also contributes to translational research aimed at improving clinical approaches to craniofacial disorders in humans. Ultimately, this interdisciplinary perspective underscores the importance of comparative morphology as a bridge between evolutionary theory, veterinary and human medicine, and developmental biology. By studying the skull through the dual lens of divergence and convergence, we gain not only a deeper understanding of our own anatomical heritage but also practical tools for advancing scientific and medical knowledge.

Conclusions

The integration of comparative anatomy into the medical curriculum offers significant pedagogical benefits for training future physicians. While gross human anatomy remains a foundational subject in medical education, incorporating comparative perspectives, particularly using species like the domestic dog (*Canis lupus familiaris*), deepens students' understanding of morphological variability, functional adaptation, and evolutionary context. Comparative anatomy encourages learners to go beyond memorizing human structures, prompting them to analyze why certain anatomical features exist, how they vary across species, and what functional roles they serve. This fosters critical thinking and supports the development of clinical reasoning skills, especially in interpreting atypical presentations of human anatomy.

One of the primary educational advantages is the enhancement of spatial and structural comprehension. Many anatomical structures, such as cranial foramina, muscles of mastication, or neurovascular pathways, can be better understood when observed across different species. For example, examining the orientation of the foramen magnum in quadrupeds versus bipeds highlights the relationship between posture, locomotion, and cranial base morphology. Similarly, comparing nasal anatomy and olfactory adaptations between humans and dogs can illustrate the principles of sensory prioritization and craniofacial evolution, thereby helping students make sense of human variations and pathologies.

Furthermore, the use of non-human models aids in reinforcing the concept of structural homology. Recognizing that the basic vertebrate body plan underlies mammalian anatomy allows students to appreciate the conserved and divergent aspects of biological design. This insight is particularly useful in specialties like radiology, orthopedics, surgery, and pathology, where structural relationships must be interpreted precisely.

Comparative anatomy also prepares students to engage with interdisciplinary fields such as evolutionary medicine, bioethics, and biomedical research. From a pedagogical standpoint, incorporating comparative anatomy stimulates active learning. Dissections of animal specimens or the use of 3D models and imaging technologies across species promotes tactile engagement and visual literacy. When taught alongside evolutionary and clinical relevance, such exercises make anatomy more dynamic, memorable, and intellectually rewarding. Importantly, educational research supports this approach. As highlighted by Varotto *et al.*,[23] the ability to accurately distinguish between human and non-human skeletal remains is a fundamental yet often underemphasized skill in forensic anthropology, hence comprehensive training in comparative osteology is essential for avoiding critical errors in forensic contexts, errors that may compromise legal investigations or mislead identification processes.

Last but not the least, the comparative study of human and canine skulls, integrated with modern genetic knowledge, can offer an in-depth perspective on biodiversity and the evolutionary processes that shape living forms. This understanding is essential to appreciate the variety of life on Earth and to apply this knowledge in fields such as medicine, species conservation, and anthropology. Ultimately, by doubling our focus through both traditional anatomical observation and modern genetic inquiry, we deepen our grasp of evolutionary biology. Future studies building on these insights may unravel even more intricate connections between form and function, providing a richer narrative of life's evolutionary journey.

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Online supplementary material:

Animated GIF comparing rotating skulls of a human and a dog. For further details on the anatomy of the regions displayed, refer to the text and figures.