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Distribution and Phenotypic Characteristics of Warmblood Horses Breed for Equestrian Sports

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ABSTRACT: Equestrian sports are widely practiced worldwide and the physical characteristics of different horse breeds play an important role in these activities. In this study, the withers heights of half-blood horses bred in equestrian sports within the Turkish Equestrian Federation were investigated in relation to breed, gender, coat color and age. A total of 11 stallions, 48 mares and 85 geldings representing 4 breeds (German, Dutch, French, Belgian) and 4 age groups (5-9 years, 10-14 years, 15-19 years and 20 years and over) were included in the study. Information about the horses was obtained from pedigree records provided by the Turkish Equestrian Federation. The withers measurements of the horses were measured by the researchers on a flat surface from the left side of each horse with a measuring stick. The minimum, maximum and mean values of the withers heights of the horses were found to be 162.46 cm, 183.93 cm and 172.33 cm, respectively. The highest mean withers heights was observed in Belgian breed horses (173,80 cm), horses aged 5-9 years (172,86 cm), stallions (173,54 cm) and horses with bay color (173,15 cm). Statistical analysis revealed that the effect of the breed on the height of the withers was significant ($P < 0.05$), while the effects of age, sex and frost were insignificant ($P > 0.05$). According to the results of this study, it further strengthens the conclusion that breed is a factor affecting conformation in half-breed horses. Thanks to this study, some important characteristics of horses used in equestrian sports have been revealed.

Keyword: Equestrian sports; Warmblood horse breeds; Withers height; Phenotype

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INTRODUCTION

Horses were first domesticated by ancient Turkic civilizations in Kazakhstan around 5,000 years ago. In ancient times, horses were used for riding, livestock, labor, warfare, and agriculture, whereas today, they are primarily bred for sport and recreational purposes (Paksoy et al., 2025; Selvi and Paksoy, 2024). The recent evolution of horses has occurred according to human needs and preferences (Akçapınar and Özbeyaz, 2021). In addition to the 200 recognized breeds, there are approximately 300 horse types, which are classified in various ways (Skinner et al., 2019). Literature includes coldblooded, hotblooded, and warmblooded horses (Tuncer and Kozat, 2021). Coldblooded horses are calm, large horses bred to pull heavy loads and be used in agricultural work. Examples of coldblooded horses include the Friesian, Haflinger, and Shire. Hotblooded horses used in racing and equestrian sports. Arabians and Thoroughbreds are examples of hotblooded horses (Paksoy and Unal, 2010). Warmblood horses were developed by crossbreeding coldblooded and hotblooded horses for equestrian sports, competitions, and shows. These horses have large bodies and calm temperaments. Unlike hotblooded horses, warmblooded horses are not easily agitated and are more active than coldblooded horses. Warmblood horses are ideal for disciplines such as dressage and therapeutic riding. Examples of warmblood horses include Belgian Warmblood, American Warmblood, Irish Draft, Mustang, Quarter Horse, Holsteiner, and Hanoverian (Brendt, 2002; Kockar, 2012).

Understanding the physiological characteristics and genetic diversity of horses contributes to the improvement of both horse care and selection processes. Withers height is a morphological trait, which is a primary measurement for determining their size. Withers height is the measurement taken from the highest point of a horse's shoulders to the ground. Withers height can be changed on factors such as breed, age and gender (Paksoy and Unal, 2019).

The withers height of horses is typically desired to be higher, as this is associated with improved stride length, speed, and jumping ability (Catalano et al., 2016; Mostafa et al., 2019). The wither height must be in accordance with the breed standards of the horse and in harmony with the rest of the horse's body (Gurgul et al., 2019; Liu et al., 2017). In Arabians, for example, foals with a withers height above a certain level during weaning are not granted pedigree status, nor are they allowed to race. Similarly, in show jumping, horses with a withers height greater than 1.48 meters are not allowed to compete in pony competitions (Gul and Oflaz, 2021). Conformation is crucial in performance horse selection and breed identification. Desired leg movements in equestrian training, for instance, are related to body size and posture. The position of the legs, the distance from the withers to the croup, and the angles of the shoulder and pastern affect a horse's performance and purpose. It is well-known that breed, age, and gender influence the body measurements of horses (Anonymous, 2007; Anonymus, 2024; Staiger et al., 2016).

Coat color and markings are critical for horse identification. Many animal species share similar coat colors, which can provide advantages in terms of camouflage, reproductive success, adaptation, and disease tolerance (Corbin et al., 2020; Sponenberg and Bellone, 2017). For centuries, horse owners and scientists worldwide have been fascinated by coat color phenomenon, as they are easily recognizable phenotypic traits. As a result, tracking the inheritance of these traits across generations is relatively straightforward. Coat color has become an essential focus of genetic research due to its economic, aesthetic, and health implications (Gurgul et al., 2019; Grilz-Seger et al., 2021). In horses, coat color is determined by many genes. Primitive coat colors are determined by the melanocortin-1 receptor gene, and other genes affect the expression of the E gene. The E and A genes together contribute to the formation of colors like black and chestnut. The A gene is only effective in the presence of the E gene and distributes the blackness to the mane, tail and lower legs (Bailey and Brooks, 2020; Kocakaya et al., 2023; Neves et al., 2017; Nguyen et al., 2020; Sponenberg and Bellone, 2017). Most horse breeds are likely to have a bay coat, followed by chestnut and black. Coat color is influenced by breed. Markings on the head and legs of horses are formed under the influence of both the environment and genes (Paksoy, 2024; Sponenberg and Bellone, 2017).

Flat racing and show jumping are the leading equestrian sports. In flat racing, Thoroughbred horses start their racing careers at the age of 2, while Arabian horses begin racing at the age of 3. Thoroughbred and Arabian horses are raced separately. In some races, male and female horses are raced together, while in others, they are separated. Racing life usually continues until the age of 10. (Anonymous, 2007). In show jumping, ponies and other breeds (warmblood, hotblooded) compete separately. Horses can partici-

pate in show jumping competitions from the age of 4 and continue until their 20s. In show jumping, both female and male horses compete in the same races. In flat racing, horses are not expected to be calm because their speed is the primary factor. However, in show jumping, horses are expected to be calmer in order to avoid knocking over obstacles and to prevent their rider from falling. Geldings are known to be calmer than stallion due to hormonal changes, which is why they are often gelded at a young age for use in show jumping. Horses are sometimes gelded due to health problems or behavioral disorders at the racetrack. Horses with a single testicle can compete in any race, while horses with both testicles removed cannot participate in Group 1 races like the Gazi Race (Anonymous, 2007; Anonymous, 2024; Ozen and Gurcan, 2016; Ozen and Gurcan, 2017).

Today, horse breeding is an industry that requires significant investments labor, time, and resources. Phenotypically and genetically superior horses are sold at high prices in both national and international markets (Kocakaya et al., 2023). Coat color and withers height are crucial for the preservation of breed purity and proper identification. The aim of this study is to determine the withers height according to breed, gender, coat color and age in warm-blooded horses used in equestrian sports.

MATERIALS AND METHODS

The study was approved by the Cukurova University Faculty of Veterinary Medicine Experimental Animal Production and Research Center Ethics Committee (Decision No: 12 Date: 26.12.2024).

The study was conducted at various equestrian facilities located in different regions of Türkiye, involving a total of 144 warmblood horses. These horses were raised in breeding operations characterized by intensive management practices and uniform care and feeding protocols. The horses' diet consisted of hay, silage, and a specially formulated ration containing 12-14% crude protein, 10-11 Mcal/kg metabolizable energy, 0.6% calcium, and 0.40% phosphorus. The health management practices for the animals were strictly supervised by a team of veterinary specialists, with daily monitoring and the routine implementation of preventive healthcare measures.

The research was carried out from October 1, 2023, to January 15, 2025. The material of the study consisted of different warmblood horses, including 29 German, 63 Dutch, 22 French, and 30 Belgian horses, aged between 5 and 27 years. Information on the horses' age, breed, gender, and coat color was extracted from pedigree records provided by the Turkish Equestrian Federation.

The withers height of the horses was measured by the researchers, who stood on a flat surface, using a standardized measuring stick on the left side of each horse. During the measurement, the distance between the highest point of the withers and the ground was recorded.

The distribution of data obtained from 7 different regions of Türkiye is presented in (Figure 1).

One-way analysis of variance (ANOVA) was

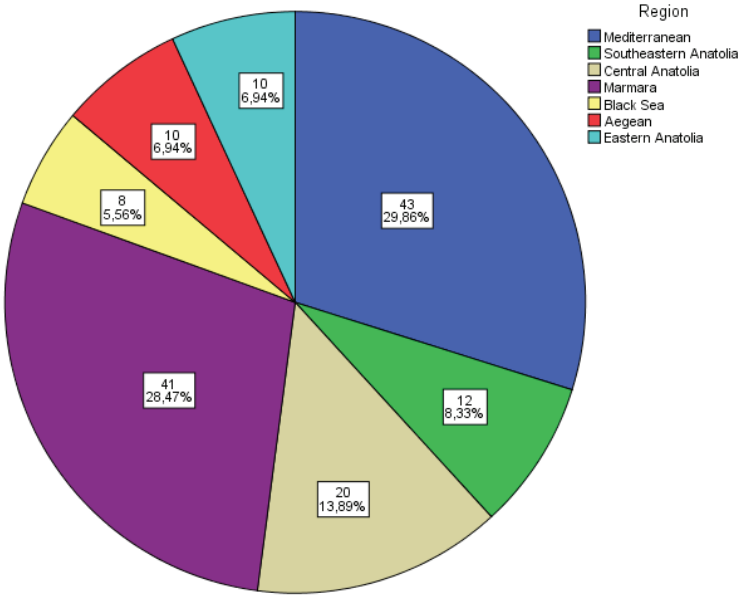

Figure 1. Regional distribution of warmblooded horses in the study.

applied to the data obtained withers heights across breeds, age, gender, and coat colors. Differences between the means were compared using the Duncan multiple comparison test. Statistical analyses were performed using SPSS version 21 software. The data were presented using sample size (N), mean ($\bar{X}$), standard deviation (S), standard error ($S_{\bar{x}}$), coefficient of variation (CV) and the maximum and minimum values. A p-value less than 0.05 was considered statistically significant.

RESULTS AND DISCUSSION

The withers heights of warmblood horses from different breed, gender, coat color and age are presented in (Table 1). The overall minimum-maximum value and mean withers heights were found to be 162.46 cm, 182.93 cm and 172.33 cm, respectively.

In equine breeding, the withers height is a critical morphological trait that serves as a reliable indicator of overall body development and performance potential in horses. Among the horse breeds included in the study, the highest average wither height was observed in the Belgian breed (173.80 cm), and the lowest average wither height was observed in the French breed (170.18 cm). The statistically significant effect of breed on withers height ($p < 0.05$) aligns with previous studies that indicate breed-specific differences in body conformation, suggesting that Belgian horses generally have a higher wither height than French, Dutch and German breeds. These findings are consistent with the idea that conformation, including withers height, can vary substantially across different horse breeds and is influenced by both genetic and environmental factors (Paksoy and Unal, 2019).

This study showed that horses in the 5-9 year-old had the highest mean withers height (172.86 cm), while the 15-19-year-old horses showed the lowest mean (171.55 cm). This result supports the knowledge that growth and physical maturity in horses, especially in warmblooded and hotblood breeds, continue until they reach 4 to 5 years of age (Pagan and Nash, 2009). Warmblood horses are known for their gradual growth patterns, reaching full physical maturity later than more rapidly maturing breeds such as Thoroughbreds and Arabians (Trachsel et al., 2016). The fact that withers height did not significantly vary across the older age groups is consistent with the literature that suggests horse growth stabi-

Table 1. Descriptive statistics for the withers height of warmblood horses

Factors		N	$\bar{X}$	$S_{\bar{x}}$	S	CV (%)	Max	Min	P
Breed	German	29	170.82^{bc}	0.92	4.97	2.90	180	160	0.016*
	Dutch	63	173.06^{ab}	0.67	5.34	3.08	186	160	
	French	22	170.18^{c}	1.07	5.03	2.95	180	162	
	Belgian	30	173.80^{a}	0.75	4.13	2.37	181	165	
Age	5-9	46	172.86	0.77	5.25	3.03	184	165	0.683
	10-14	46	172.34	0.79	5.36	3.11	185	160	
	15-19	40	171.55	0.66	4.19	2.44	180	162	
	≥20	12	172.75	1.93	6.68	3.86	186	165	
Gender	Gelding	85	172.69	0.61	5.66	3.27	186	160	0.269
	Mare	48	171.39	0.57	3.97	2.31	181	162	
	Stallion	11	173.54	1.49	4.96	2.85	180	165	
Coat color	Bay	64	171.93	0.65	5.20	3.02	185	162	0.754
	Chestnut	32	172.81	0.88	4.98	2.88	184	162	
	Grey	29	172.10	0.97	5.26	3.05	180	160	
	Dun	19	173.15	1.17	5.12	2.95	186	167	
Overall		144	172.33	0.92	5.07	2.93	182.93	162.46	

a,b,c: $p < 0.05$

lizes once it reaches maturity, typically around 5-6 years of age (Kocher and Staniar, 2013).

Furthermore, the study found that male horses (stallions and geldings) exhibited greater withers height compared to mares. Specifically, stallions had the highest mean withers height (173.54 cm), followed by geldings (172.69 cm) and mares (171.39 cm) had the lowest. This finding is in agreement with the males typically exhibit larger body sizes due to differences in hormonal influences during growth. Such differences in withers height between males and females are common in many horse breeds and are consistent with previous studies examining the impact of gender on morphological traits in equines (Paksoy and Unal, 2019).

The impact of coat color on withers height was also explored, revealing that dun horses had higher mean height (173.15 cm) than those with a bay coat (171.93 cm). While this result was not statistically significant, it suggests that coat color may be associated with certain physical traits, a relationship that has been previously reported in other studies, although it remains an area of debate in equine research (Bayram et al., 2005; Gmel et al., 2024). The finding that grey horses had lower withers height could be explained by underlying genetic differences, as coat color is often influenced by multiple genetic factors that may also affect other aspects of conformation.

The literature review highlights that studies on warmblood horses, particularly those focused on their conformation and withers height, are limited in number. Additionally, previous studies on Arabian and Thoroughbred horses Paksoy and Unal (2019) have reported withers heights lower than those found in the present study, indicating that warmblood horses typically have larger frames. This difference is particularly relevant in equestrian sports, where withers height and overall conformation are closely linked to performance characteristics, such as stride length and balance, which are essential for success in disciplines such as show jumping and dressage.

In addition, the finding that withers height did not change according to age groups in horses older than 5 years-is consistent with the findings of other studies (Baykalır et al., 2019; Bayram et al., 2005; Kirmizibayrak et al., 2004; Yildirim and Yildiz, 2013), that did not find statistically significant differences for withers height between various age groups. The results suggest that once horses achieve their adult size, withers height, stabilizes and shows minimal change with age.

When comparing the results of this study with those of similar studies in endurance racing in France Trachsel et al. (2016), the key similarities are the inclusion of withers height, breed, age, and gender as primary factors influencing horse conformation. However, this study extends previous research by examining a broader age range (5–27 years) of warmblood horses, providing a more comprehensive understanding of their conformation characteristics. The data also corroborate findings from studies in other countries (e.g., England) where warmblood horses withers height ranges from 152 to 180 cm, further validating the consistency of the warmblood breed's conformation across different populations and geographical regions.

In equine performance, withers height is positively correlated with stride length, which in turn is associated with improved performance in equestrian sports (Smith et al., 2006). The higher withers height in warmblood horses, particularly those used in competitive equestrian disciplines, supports the theory that taller horses may have an advantage in terms of stride length and overall balance. The preference for warmbloods in various equestrian disciplines in Türkiye, such as show jumping and endurance racing, aligns with the finding that these horses' physical traits are suited for competitive success (Taskin and Kocak, 2013).

CONCLUSIONS

In this study, the finding of a statistically significant effect of breed on the withers height further strengthens the conclusion that breed is the primary factor affecting conformation in warmblood horses. The results also support the notion that, while genetic factors play a substantial role in determining withers height, environmental factors such as diet, training, and exercise also contribute to the final physical development of the horses. The fact that the average withers height of warmblood horses used in equestrian sport was 172.33 showed that larger horses were preferred compared to flat races. Additionally, it was determined that these horses mostly completed their bone development until the age of 5 years. It was determined that the withers heights of gelding and male horses were higher than female horses. When the body measurements of different horse's coat colors were analyzed, it was observed that small changes were not statistically significant. This study also determined the horse preferences of breeders.

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Conflicts of Interest
We declare that there is no conflict of interest between us as the article authors.

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