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Contribution to the Understanding of Angulation in Three Sighthound Breeds

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Abstract

The present study investigated morphometric characteristics and the relationships between limb angulation and selected height parameters in three sighthound breeds: the Kazakh Tazy, Iranian Tazy, and Kyrgyz Taigan. A total of 86 adult dogs were included in the study: 29 Kazakh Tazies, 28 Iranian Tazies, and 29 Kyrgyz Taigans. The analyzed parameters included the shoulder, elbow, stifle, and hock joint angles, neck angle, croup angle, sternum apex height, and stifle joint height.

Morphometric measurements were performed using standardized methods, while statistical analysis included descriptive statistics, Pearson's correlation analysis, ANOVA, Kruskal–Wallis test, and multiple linear regression analysis.

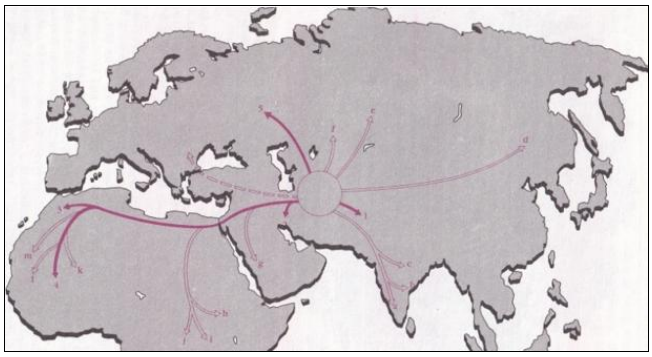
The results demonstrated breed-specific differences in several morphometric parameters. The Iranian Tazy showed generally more open limb angulations, whereas the Kyrgyz Taigan exhibited greater stifle joint height, likely reflecting adaptation to mountainous terrain and specific environmental conditions. Differences between males and females were generally small.Correlation and regression analyses revealed no statistically significant relationships between limb angulation and the analyzed height parameters. However, significant correlations were identified between certain joint angles, particularly between the hock joint angle and croup angle in the Kazakh Tazy, and between the stifle and hock joint angles in the Kyrgyz Taigan, indicating functional relationships within the locomotor system.

The findings suggest that sighthound morphology represents a complex biomechanical system shaped by functional adaptation, environmental conditions, and locomotor demands.

Keywords: Sighthounds, Morphometry, Limb Angulation, Biomechanics, Locomotion

Introduction

Sighthounds belong to one of the oldest groups of domestic dogs. Most authors consider that sighthounds originated from dogs whose existence has been associated with Central Asia. According to Stucchly and Cisarovsky (ISBN 80-900820-3-3), five principal sighthound lineages and fourteen subgroups spread from this region. Their dispersal occurred toward the east, west, north, and south.



Legend: 1 – Afghan Hound, 2 – Saluki, 3 – Sloughi, 4 – Azawakh, 5 – Borzoi; a, b, c – sighthound-type dogs of the Indian subcontinent; g – Sinai Sloughi; i – sighthound of southeastern Sahara; k, l – Azawakh-like sighthounds

Fig 1: Directions of sighthound dispersal from Central Asia

Archaeological findings and depictions discovered at the excavation site of Çatalhöyük in western Anatolia date back to approximately 5800 BCE. These findings include scenes of deer hunting with long-legged dogs that can be identified as sighthounds (Шрitт, 2009) [5].

Fig 2: Part of a deer hunting scene depicting long-legged dogs identified by many authors as sighthounds (Saluki type). Archaeological site Çatalhöyük. (Photo: M. Urošević)

Based on archaeological evidence, including skeletal remains, mummies, reliefs, sculptures, and drawings, it can be concluded that sighthounds certainly existed in the regions of North Africa, the Arabian Peninsula, and western Asia as early as 3500 BCE.

The presence of eastern sighthound forms in the regions of Western Asia and the southern Russian steppes may be associated with their spread from Mesopotamia. During the 4th millennium BCE, Mesopotamia represented a highly developed civilization. In the first half of this period, artistic objects and utilitarian items such as vases depicted short-haired dogs with pendant ears resembling Saluki or Sloughi types.

It is therefore logical to assume that the short-haired sighthounds of Iran and Kazakhstan descended from these ancient dogs. This lineage may also include the Kyrgyz sighthound, the Taigan, which possesses a somewhat longer coat due to the specific climatic conditions and high altitudes in which it hunts. In addition to this exterior difference, the Taigan is characterized by a distinct hunting style. Unlike most sighthounds, which primarily "hunt by sight" and must visually detect their prey, the Taigan relies not only on vision but also on olfaction. There are no available data in the literature regarding the hunting style of the Iranian Tazi. However, considering that Iran is predominantly mountainous terrain, it cannot be excluded that the Iranian Tazi, similarly to the Taigan, relies on both vision and scent during hunting activities.

Available literature does not provide data on the morphometric parameters analyzed in the present study. Of the three observed breeds, only the Kazakh Tazy has been officially recognized by the Fédération Cynologique Internationale (FCI). The official breed standard was published on September 3, 2024, under standard number 372. The Iranian sighthound (Kuche Tazi) and the Kyrgyz sighthound (Taigan) have not yet been officially standardized or recognized by the FCI. The official standard of the Kazakh Tazy does not include the parameters investigated in this study.

The angulation of the forelimbs and hindlimbs, as well as the angle of neck attachment, are of crucial importance for functional efficiency and working ability, particularly in hunting dogs. These dogs are renowned for their speed and endurance in movement. In order to achieve high-speed locomotion, the center of gravity must be positioned as far cranially as possible and maintained at a relatively high level. The vertical position of the center of gravity is determined by a plane parallel to the ground and tangent to the cranial point of the sternum (Urošević & Drobnjak, 2018) [3]. The extent to which the center of gravity is shifted cranially depends on the position of the neck, i.e., the angle at which the neck is attached to the body (Urošević & Drobnjak, 2018) [3].

Canine locomotion results from forward displacement of the body, which is conditioned by the production of biokinetic energy. This energy generates a biomechanical effect that produces forward movement. Energy production primarily occurs within the pelvic muscular system, while the hip joint represents the principal propulsive mechanism.

The further the center of gravity is shifted cranially, the greater the load distribution on the forequarters (approximately 60%) and the lower the load borne by the hindquarters (approximately 40%). This distribution is particularly important because reduced loading of the hindquarters allows the musculature of the pelvic region to generate greater biokinetic energy. For all these processes to occur with the necessary rhythm and intensity, the dog must possess an adequate biostatic model.

During locomotion, the primary role of the forelimbs is to provide support through forward extension and to receive the body mass during propulsion generated by the hindquarters.

The height of the stifle joint determines the length of the femur, which biomechanically functions as a lever. According to the laws of mechanics, a shorter lever can transmit greater force over a shorter distance, whereas a longer lever transmits less force over a greater distance. The same principle applies in biomechanics. Animals with shorter femora are generally not exceptionally fast but are capable of prolonged movement, whereas animals with longer femora, such as sighthounds, achieve greater speed and transfer body mass over greater distances, although such movement is temporally limited.

The angulation of the forelimbs and hindlimbs may be compared to mirror images, as the corresponding joint angles are generally of a similar order of magnitude. The magnitude of these angles directly influences stride length during locomotion. More open joint angles result in shorter strides, whereas more closed and properly balanced angulations enable longer and more efficient movement.

The terrain inhabited and hunted by the Kazakh Tazy differs considerably from the environments in which the Iranian Tazi and the Kyrgyz Taigan perform their hunting activities.

Materials and Methods

The study included a total of 86 dogs belonging to three related breeds: the Kazakh Tazy (n = 29), the Iranian Tazi (n = 28), and the Kyrgyz Taigan (n = 29). Only adult dogs older than one year of age were included in the study. All examined animals were clinically healthy and free from visible physical abnormalities.

Morphometric measurements of the Kyrgyz Taigan were performed at an international dog show in Bishkek. Measurements of the Kazakh Tazy were conducted at an international dog show in Almaty, whereas the parameters of the Iranian Tazi were obtained through field measurements in the vicinity of the city of Qazvin. All measurements were performed by a single examiner.

The morphometric analysis included the following parameters: shoulder joint angle (SA), elbow joint angle (EA), stifle joint angle (KA), hock joint angle (AA), neck angle (NA), croup angle (CA), sternum height (SH), and stifle joint height (KH). Angular measurements were determined using standardized morphometric methods described by Urošević and Drobnjak (2019) [4] on correctly positioned dogs standing in a natural posture. Angular measurements were performed using a goniometer, whereas height measurements were obtained using a Litinov measuring stick. All measurements were carried out by the same examiner in order to minimize observer-related variability.

Statistical analysis of the data was performed using the Statistical Package for Social Sciences (SPSS) for Windows, version 27.0.1. For each variable, the following descriptive statistical parameters were calculated: arithmetic mean (Mean), standard deviation (SD), standard error (SE), minimum value, and maximum value. Differences among the examined breeds were assessed using one-way analysis of variance (ANOVA). In cases where the assumptions of normal distribution were not satisfied, the nonparametric Kruskal–Wallis test was applied. Statistical significance was evaluated at the level of $p < 0.05$. Correlation analysis was performed to examine the relationships among individual morphometric parameters. The strength and direction of associations between variables were assessed using Pearson's correlation coefficient (r). In addition, linear regression analysis was conducted to determine the influence of specific morphological characteristics on dependent variables. The linear regression model was used to estimate the relationships between independent and dependent variables, and the results were interpreted based on the coefficient of determination (R^2), regression coefficient (β), and level of statistical significance (p).

Results

A total of 86 individuals belonging to three sighthound breeds were included in the study: the Kazakh Tazy (n = 29), the Iranian Tazy (n = 28), and the Kyrgyz Taigan (n = 29). The analysis included the evaluation of angular measurements of specific body regions, including the shoulder, elbow, stifle, and hock joints, as well as the neck and croup angles. In addition, the height of the sternum apex and the height of the stifle joint were measured. Table 1 presents the descriptive statistical parameters for all examined dogs collectively, as well as separately for each breed.

Table 1: Descriptive statistical parameters

Parameter	Breed	N	Mean	Std. Deviation	Std. Error	Minimum	Maximum
Shoulder joint angle	Kazakh Tazi	29	104.45	7.63	1.41	90	118
	Iranian Tazi	28	110.36	5.92	1.11	100	120
	Kyrgyz Taigan	29	108.79	7.75	1.44	90	125
	Total	86	107.84	7.51	0.81	90	125
Elbow joint angle	Kazakh Tazi	29	132.07	8.71	1.61	115	145
	Iranian Tazi	28	135.18	7.13	1.34	115	145
	Kyrgyz Taigan	29	137.24	4.74	0.88	130	145
	Total	86	134.83	7.29	0.78	115	145
Stifle joint angle	Kazakh Tazi	29	116.90	7.72	1.43	95	130
	Iranian Tazi	28	123.21	5.30	1.00	115	130
	Kyrgyz Taigan	29	123.28	9.56	1.77	100	140
	Total	86	121.10	8.23	0.88	95	140
Hock joint angle	Kazakh Tazi	29	135.17	10.39	1.93	115	155
	Iranian Tazi	28	146.07	6.43	1.21	135	160
	Kyrgyz Taigan	29	135.34	10.93	2.03	105	155
	Total	86	138.78	10.68	1.15	105	160
Neck angle	Kazakh Tazi	29	32.48	9.84	1.82	20	50
	Iranian Tazi	28	30.89	5.78	1.09	20	40
	Kyrgyz Taigan	29	43.97	8.59	1.59	20	55
	Total	86	35.84	10.06	1.08	20	55
Croup angle	Kazakh Tazi	29	25.69	4.95	0.91	15	35
	Iranian Tazi	28	21.43	6.21	1.17	15	35
	Kyrgyz Taigan	29	30.17	4.32	0.80	25	40
	Total	86	25.81	6.27	0.67	15	40
Sternum height	Kazakh Tazi	29	47.34	2.75	0.51	43	53
	Iranian Tazi	28	48.36	3.51	0.66	40	55
	Kyrgyz Taigan	29	46.72	4.84	0.89	39	56
	Total	86	47.47	3.82	0.41	39	56
Stifle joint height	Kazakh Tazi	29	34.66	3.90	0.72	29	49
	Iranian Tazi	28	35.14	3.10	0.58	29	40
	Kyrgyz Taigan	29	37.17	3.17	0.58	33	42
	Total	86	35.66	3.55	0.38	29	49

The mean value of the shoulder joint angle for all examined dogs was 107.84 degrees ± 7.51, with the lowest average value recorded in the Kazakh Tazy (104.45 degrees) and the highest in the Iranian Tazy (110.36 degrees). In the Kyrgyz Taigan, the mean value was 108.79 degrees. The observed values ranged from 90 degrees to 125 degrees.

The mean elbow joint angle for the entire sample was 134.83 degrees ± 7.29. The lowest average value was recorded in the Kazakh Tazy (132.07 degrees), whereas the highest value was observed in the Kyrgyz Taigan (137.24 degrees). In the Iranian Tazy, the mean value amounted to 135.18 degrees. The minimum recorded value was 115 degrees, while the maximum value reached 145 degrees.

The average stifle joint angle was 121.10 degrees ± 8.24. The lowest mean value was observed in the Kazakh Tazy (116.90 degrees), whereas similar values were recorded in the Iranian Tazy (123.21 degrees) and the Kyrgyz Taigan (123.28 degrees). The overall range of values extended from 95 degrees to 140 degrees.

For the hock joint angle, the mean value for the entire sample was 138.78 degrees ± 10.68. The highest mean value was recorded in the Iranian Tazy (146.07 degrees), while the Kazakh Tazy (135.17 degrees) and the Kyrgyz Taigan (135.34 degrees) exhibited very similar values. The observed values ranged from 105 degrees to 160 degrees.

The average neck angle for all examined individuals was 35.84 degrees ± 10.07. The highest mean value was observed in the Kyrgyz Taigan (43.97 degrees), whereas the Kazakh Tazy (32.48 degrees) and the Iranian Tazy (30.89 degrees) showed lower and mutually similar values. The overall range of measured values extended from 20 degrees to 55 degrees.

The mean croup angle was 25.81 degrees ± 6.27. The highest mean value was recorded in the Kyrgyz Taigan (30.17 degrees), followed by the Kazakh Tazy (25.69 degrees), while the lowest value was determined in the Iranian Tazy (21.43 degrees). The observed values ranged from 15 degrees to 40 degrees.

Analysis of the linear measurements demonstrated that the mean sternum apex height for the entire sample was 47.47 ± 3.82 cm. The highest mean value was recorded in the Iranian Tazy (48.36 cm), followed by the Kazakh Tazy (47.34 cm), whereas the lowest value was observed in the Kyrgyz Taigan (46.72 cm). The recorded values ranged from 39 cm to 56 cm.

The mean stifle joint height for all breeds was 35.66 ± 3.55 cm. The highest average value was registered in the Kyrgyz Taigan (37.17 cm), while slightly lower values were observed in the Iranian Tazy (35.14 cm) and the Kazakh Tazy (34.66 cm). The observed values ranged from 29 cm to 49 cm.

Descriptive statistics of the morphometric parameters related to limb angulation, sternum apex height, and stifle joint height were analyzed separately for males and females within the three examined breeds. The results, expressed as mean values and standard deviations, are presented in Table 2.

Table 2: Descriptive statistics of morphometric parameters by breed and sex (Mean ± SD)

Parametar	Kazakh Tazi ♂ (n=14)	Kazakh Tazi ♀ (n=15)	Iranian Tazi ♂ (n=14)	Iranian Tazi ♀ (n=14)	Kyrgyz Taigan ♂ (n=15)	Kyrgyz Taigan ♀ (n=14)
Shoulder joint angle	104.93 ± 9.47	104.00 ± 5.73	109.64 ± 6.03	111.07 ± 5.94	109.00 ± 9.86	108.57 ± 4.97
Elbow joint angle	132.86 ± 7.52	131.33 ± 9.90	134.29 ± 8.74	136.07 ± 5.26	138.67 ± 3.99	135.71 ± 5.14
Stifle joint angle	116.07 ± 8.36	117.67 ± 7.29	122.86 ± 5.45	123.57 ± 5.35	119.67 ± 9.90	127.14 ± 7.77
Hock joint angle	135.00 ± 10.56	135.33 ± 10.60	145.71 ± 6.46	146.43 ± 6.63	132.33 ± 13.74	138.57 ± 5.69
Neck angle	33.57 ± 8.86	31.47 ± 10.90	30.71 ± 5.50	31.07 ± 6.26	42.67 ± 10.50	45.36 ± 6.03
Croup angle	25.00 ± 5.55	26.33 ± 4.42	17.50 ± 3.25	25.36 ± 6.03	30.33 ± 4.81	30.00 ± 3.92
Sternum height	47.50 ± 2.74	47.20 ± 2.86	50.29 ± 2.67	46.43 ± 3.25	49.80 ± 4.23	43.43 ± 2.93
Stifle joint height	36.14 ± 5.05	33.27 ± 1.58	35.93 ± 2.43	34.36 ± 3.57	39.67 ± 2.19	34.50 ± 1.29

In the Kazakh Tazy breed, the mean shoulder joint angle in males was 104.93 degrees (SD = 9.47), whereas in females it was very similar, amounting to 104.00 degrees (SD = 5.73). The elbow joint angle was slightly greater in males (132.86 degrees ± 7.52) compared to females (131.33 degrees ± 9.90). The mean stifle joint angle was 116.07 degrees (SD = 8.36) in males and 117.67 degrees (SD = 7.29) in females. The hock joint angle was almost identical between sexes, measuring 135.00 degrees (SD = 10.56) in males and 135.33 degrees (SD = 10.60) in females. Males exhibited a slightly greater neck angle (33.57 degrees ± 8.86) compared to females (31.47 degrees ± 10.90), whereas the croup angle was slightly greater in females (26.33 degrees ± 4.42) than in males (25.00 degrees ± 5.55). Sternum apex height was nearly identical between sexes (47.50 ± 2.74 cm in males and 47.20 ± 2.86 cm in females), while stifle joint height was greater in males (36.14 ± 5.05 cm) compared to females (33.27 ± 1.58 cm).

In the Iranian Tazy breed, the mean shoulder joint angle was 109.64 degrees (SD = 6.03) in males and 111.07 degrees (SD = 5.94) in females. The elbow joint angle measured 134.29 degrees (SD = 8.74) in males and 136.07 degrees (SD = 5.26) in females. The stifle joint angle was 122.86 degrees (SD = 5.45) in males and 123.57 degrees (SD = 5.35) in females. The hock joint angle was slightly greater in females (146.43 degrees ± 6.63) than in males (145.71 degrees ± 6.46). The neck angle was approximately equal between sexes (30.71 degrees ± 5.50 in males and 31.07 degrees ± 6.26 in females). However, a more pronounced difference was observed in the croup angle, where females exhibited considerably greater values (25.36 degrees ± 6.03) compared to males (17.50 degrees ± 3.25). Sternum apex height was greater in males (50.29 ± 2.67 cm) than in females (46.43 ± 3.25 cm), whereas stifle joint height was relatively similar between sexes (35.93 ± 2.43 cm in males and 34.36 ± 3.57 cm in females).

In the Kyrgyz Taigan breed, the mean shoulder joint angle was 109.00 degrees (SD = 9.86) in males and 108.57 degrees (SD = 4.97) in females. The elbow joint angle was greater in males (138.67 degrees ± 3.99) than in females (135.71 degrees ± 5.14). The stifle joint angle measured 119.67 degrees (SD = 9.90) in males and was considerably

greater in females (127.14 degrees ± 7.77). The hock joint angle was also greater in females (138.57 degrees ± 5.69) compared to males (132.33 degrees ± 13.74). The neck angle was more pronounced in females (45.36 degrees ± 6.03) than in males (42.67 degrees ± 10.50), whereas the croup angle was almost identical between sexes (30.33 degrees ± 4.81 in males and 30.00 degrees ± 3.92 in females). Sternum apex height was greater in males (49.80 ± 4.23 cm) than in females (43.43 ± 2.93 cm), while males also exhibited greater stifle joint height (39.67 ± 2.19 cm) compared to females (34.50 ± 1.29 cm).

Overall, relatively small differences between sexes within each breed were observed for most forelimb angulation parameters, whereas more pronounced differences were recorded for certain hindlimb parameters, particularly the stifle joint angle and hock joint angle, as well as for the linear measurements of stifle joint height and sternum apex height.

In order to examine the influence of forelimb angulation on sternum apex height, multiple linear regression analysis was performed separately for each breed. In this model, sternum apex height represented the dependent variable, whereas the shoulder joint angle and elbow joint angle were used as independent variables.

In the Kazakh Tazy, the analysis demonstrated a weak positive correlation between sternum apex height and elbow joint angle (r = 0.304), whereas the correlation between sternum apex height and shoulder joint angle was negligible (r = 0.037). The results of the regression analysis indicated that the model was not statistically significant (R^2 = 0.095; F = 1.357; p = 0.275), suggesting that the examined variables do not explain a significant proportion of the variability in sternum apex height within this breed.

In the Iranian Tazy, correlation analysis revealed a weak negative association between sternum apex height and shoulder joint angle (r = –0.104), as well as between sternum apex height and elbow joint angle (r = –0.209). The regression model was not statistically significant (R^2 = 0.069; F = 0.930; p = 0.408), indicating that forelimb angulation does not have a significant influence on sternum apex height in this breed.

In the Kyrgyz Taigan, correlation analysis demonstrated a weak negative relationship between sternum apex height and shoulder joint angle (r = –0.223), whereas a weak positive correlation was identified between sternum apex height and elbow joint angle (r = 0.215). The results of the regression analysis showed that the model was not statistically significant (R^2 = 0.101; F = 1.465; p = 0.250), indicating that variations in the shoulder and elbow joint angles do not explain significant changes in sternum apex height.

Overall, the results of the regression analysis suggest that shoulder and elbow joint angles do not represent significant predictors of sternum apex height in the examined sighthound breeds.

Table 3: Results of multiple linear regression analysis for the prediction of sternum apex height

Breed	Predictor	r	R^2	F	p
Kazakh Tazi	Shoulder angle	0.037	0.095	1.357	0.275
	Elbow angle	0.304	0.095	1.357	0.275
Iranian Tazi	Shoulder angle	-0.104	0.069	0.930	0.408
	Elbow angle	-0.209	0.069	0.930	0.408
Kyrgyz Taigan	Shoulder angle	-0.223	0.101	1.465	0.250
	Elbow angle	0.215	0.101	1.465	0.250

In the analysis of the influence of hindlimb angulation, the stifle joint angle, hock joint angle, and croup angle were included as independent variables.

In the Kazakh Tazy, the analysis demonstrated a weak positive correlation between stifle joint height and stifle joint angle (r = 0.212), whereas a weak negative correlation was observed between stifle joint height and hock joint angle (r = –0.170). The relationship between stifle joint height and croup angle was very weak (r = 0.059). The results of the regression analysis indicated that the model was not statistically significant (R^2 = 0.072; F = 0.651; p = 0.590).

In the Iranian Tazy breed, the mean stifle joint height was 35.14 ± 3.10 cm. Correlation analysis revealed a weak positive association between stifle joint height and stifle joint angle (r = 0.129), whereas negative correlations were observed between stifle joint height and hock joint angle (r = –0.203) and between stifle joint height and croup angle (r = –0.290). Multiple regression analysis did not demonstrate a statistically significant model (R^2 = 0.166; F = 1.594; p = 0.217).

In the Taigan, correlation analysis showed a negative relationship between stifle joint height and stifle joint angle (r = –0.296), as well as between stifle joint height and hock joint angle (r = –0.202), whereas the association with croup angle was very weak (r = –0.041). The results of the regression analysis indicated that the model was not statistically significant (R^2 = 0.091; F = 0.833; p = 0.488).

Overall, the results of the regression analysis suggest that the stifle joint angle, hock joint angle, and croup angle do not represent significant predictors of stifle joint height in the examined sighthound breeds.

Table 4: Results of multiple linear regression analysis for the prediction of stifle joint height

Breed	Predictor	r	R^2	F	p
Kazakh Tazi	Stifle joint angle	0.213	0.072	0.651	0.590
	Hock joint angle	-0.182	0.072	0.651	0.590
	Croup angle	-0.065	0.072	0.651	0.590
Iranian Tazi	Stifle joint angle	0.085	0.166	1.594	0.217
	Hock joint angle	-0.256	0.166	1.594	0.217
	Croup angle	-0.356	0.166	1.594	0.217
Kyrgyz Taigan	Stifle joint angle	-0.271	0.091	0.833	0.488
	Hock joint angle	-0.059	0.091	0.833	0.488
	Croup angle	0.033	0.091	0.833	0.488

In order to examine the relationships between the angulation of the forelimbs and sternum apex height (SH), Pearson's correlation analysis was performed separately for each breed.

In the Kazakh Tazy, a weak positive correlation was identified between the shoulder and elbow joint angles (r = 0.267; p = 0.161). The association between the shoulder joint angle and sternum apex height was negligible (r = 0.037; p = 0.851), whereas a weak positive correlation was observed between the elbow joint angle and sternum apex height (r = 0.304; p = 0.109). None of the analyzed correlations reached statistical significance (p > 0.05).

In the Iranian Tazy, a weak negative correlation was identified between the shoulder and elbow joint angles (r = –0.243; p = 0.213). In addition, weak negative correlations without statistical significance were observed between sternum apex height and the shoulder joint angle (r = –0.104; p = 0.598), as well as between sternum apex height

and the elbow joint angle (r = –0.209; p = 0.285).

In the Kyrgyz Taigan, a very weak positive correlation was observed between the shoulder and elbow joint angles (r = 0.052; p = 0.789). A weak negative correlation was identified between the shoulder joint angle and sternum apex height (r = –0.223; p = 0.244), whereas a weak positive correlation was observed between the elbow joint angle and sternum apex height (r = 0.215; p = 0.263). As in the previous breeds, none of the observed correlations were statistically significant.

Overall, the results indicate that there is no statistically significant association between forelimb angulation and sternum apex height in the examined sighthound breeds.

Table 5: Pearson's correlation coefficients between forelimb joint angles and sternum apex height

Breed	Variables	r	p
Kazakh Tazi	SA – EA	0.267	0.161
	SA – SH	0.037	0.851
	EA – SH	0.304	0.109
Iranian Tazi	SA – EA	-0.243	0.213
	SA – SH	-0.104	0.598
	EA – SH	-0.209	0.285
Kyrgyz Taigan	SA – EA	0.052	0.789
	SA – SH	-0.223	0.244
	EA – SH	0.215	0.263

In order to examine the relationships between hindlimb joint angles and stifle joint height (KH), Pearson's correlation analysis was performed separately for each breed.

In the Kazakh Tazy, a weak positive correlation was identified between stifle joint height and stifle joint angle (r = 0.212; p = 0.270), whereas a weak negative correlation was observed between stifle joint height and hock joint angle (r = –0.170; p = 0.377). The association between stifle joint height and croup angle was negligible (r = 0.059; p = 0.761). A moderate negative and statistically significant correlation was identified between the hock joint angle and croup angle (r = –0.419; p = 0.024). The remaining correlations were not statistically significant.

In the Iranian Tazy, a weak positive correlation was observed between stifle joint height and stifle joint angle (r = 0.129; p = 0.514), whereas weak negative correlations were identified between stifle joint height and hock joint angle (r = –0.203; p = 0.300) and between stifle joint height and croup angle (r = –0.290; p = 0.135). A moderate negative correlation was found between the stifle and hock joint angles (r = –0.321; p = 0.095). However, none of the analyzed correlations reached statistical significance (p > 0.05).

In the Kyrgyz Taigan, a moderate negative correlation was observed between stifle joint height and stifle joint angle (r = –0.296; p = 0.120), as well as between stifle joint height and hock joint angle (r = –0.202; p = 0.292), whereas the association with croup angle was negligible (r = –0.041; p = 0.832). A moderate positive and highly statistically significant correlation was identified between the stifle and hock joint angles (r = 0.544; p = 0.002). The remaining correlations were not statistically significant.

Overall, the results indicate that stifle joint height is not significantly associated with hindlimb joint angles, whereas certain significant correlations are present among the joint angles themselves, particularly between the hock joint angle and croup angle in the Kazakh Tazy, and between the stifle and hock joint angles in the Kyrgyz Taigan.

Table 6: Pearson's correlation coefficients between hindlimb joint angles and stifle joint height

Breed	Variables	r	p
Kazakh Tazi	KH – KA	0.212	0.270
	KH – AA	-0.170	0.377
	KH – CA	0.059	0.761
	KA – AA	-0.071	0.715
	KA – CA	0.221	0.248
	AA – CA	-0.419*	0.024
Iranian Tazi	KH – KA	0.129	0.514
	KH – AA	-0.203	0.300
	KH – CA	-0.290	0.135
	KA – AA	-0.321	0.095
	KA – CA	0.108	0.583
	AA – CA	-0.225	0.250
Kyrgyz Taigan	KH – KA	-0.296	0.120
	KH – AA	-0.202	0.292
	KH – CA	-0.041	0.832
	KA – AA	0.544**	0.002
	KA – CA	0.245	0.201
	AA – CA	0.131	0.499

*p < 0.05; ** p < 0.01

Discussion

The results of the present study provide insight into the morphometric characteristics and interrelationships of limb angulation parameters in three sighthound breeds: the Kazakh Tazy, Iranian Tazy, and Kyrgyz Taigan. The analysis included descriptive statistics, correlation analyses, and regression models, with the aim of evaluating the functional relationships between limb angulation and the parameters of sternum apex height and stifle joint height.

Descriptive statistics demonstrated relatively uniform values of the analyzed parameters within breeds, although certain differences were observed that may reflect breed-specific structural characteristics and functional adaptations. The Iranian Tazy exhibited somewhat greater values of both forelimb and hindlimb joint angles, suggesting a tendency toward more open angulations, whereas the Kyrgyz Taigan showed greater stifle joint height, which may be associated with adaptation to specific environmental and terrain conditions.

The results of Pearson's correlation analysis for the forelimbs indicated the absence of statistically significant associations between the shoulder and elbow joint angles and sternum apex height in all examined breeds. Although weak positive or negative correlations were observed in certain cases, their low magnitude and lack of statistical significance suggest that sternum apex height is not directly conditioned by forelimb angulation. These findings indicate a relative morphological independence of these parameters.

A similar pattern was observed in the hindlimbs. Stifle joint height did not demonstrate statistically significant associations with the stifle joint angle, hock joint angle, or croup angle in any of the analyzed breeds. Although weak to moderate correlations were recorded in certain cases, such as the negative association between stifle joint height and stifle joint angle in the Kyrgyz Taigan, these relationships did not reach statistical significance. These findings further support the conclusion that stifle joint height is not directly determined by joint angulation, but rather depends on a broader spectrum of morphological and biomechanical factors.

In contrast to the relationships between height parameters and limb angulation, certain statistically significant correlations were identified among the joint angles themselves. In the Kazakh Tazy, a significant negative association was observed between the hock joint angle and croup angle. In the Kyrgyz Taigan, a highly significant positive correlation was recorded between the stifle and hock joint angles, suggesting a functional relationship between these structures during locomotion.

The results of the multiple linear regression analysis further confirmed the findings of the correlation analysis. In all examined cases, the regression models were not statistically significant, and the coefficients of determination (R^2) were low. This indicates a limited predictive value of joint angulation parameters in explaining the variability of height-related measurements in both the forelimbs and hindlimbs. Standardized regression coefficients (β) demonstrated different directions of influence; however, none reached statistical significance, further supporting the absence of clear functional relationships among the analyzed variables.

Overall, the results of this study indicate that although certain interrelationships exist among specific joint angles, parameters such as sternum apex height and stifle joint height are not directly determined by limb angulation. These findings suggest that the morphological structure of sighthounds represents a complex system in which individual measurements do not function independently, but rather as components of a broader functional and biomechanical entity. Furthermore, the observed differences among breeds may reflect specific selective pressures and adaptations to different environmental conditions and working purposes.

Conclusion

The present study demonstrated certain morphometric differences among the Kazakh Tazy, Iranian Tazy, and Kyrgyz Taigan, particularly in the angulation of the extremities and selected height parameters. The Iranian Tazy showed generally more open joint angles, whereas the Kyrgyz Taigan exhibited greater stifle joint height, likely reflecting functional adaptations to different environmental and terrain conditions.

Correlation and regression analyses indicated that sternum apex height and stifle joint height were not significantly associated with the angulation of the examined joints. However, significant correlations between certain joint angles suggest the existence of functional relationships within the locomotor system.

Overall, the results indicate that the morphology of sighthounds represents a complex biomechanical system shaped by functional adaptation, selective breeding, and environmental influences. The findings of this study contribute additional morphometric data for these insufficiently studied breeds and may serve as a basis for future research.

References

1. Fédération Cynologique Internationale (FCI). Kazakh Tazy - FCI Standard No. 372. Fédération Cynologique Internationale, Thuin, Belgium, 2024.
2. Stuchly I, Cisarovsky M. Chrti. ISBN: 80-900820-3-3.
3. Urošević M, Drobnjak D. Biomehanika i kretanje pasa. Kinološka akademija, Beograd-Zemun, 2018. ISBN: 978-86-920293-1-8.
4. Urošević M, Drobnjak D. Metodologija morfometrije pasa - Standard utvrđivanja eksterijernih parametara. Kinološka akademija, Beograd-Zemun, 2019. ISBN: 978-86-920293-3-2.
5. Шритт И, Шритт З. Борзые. Аквариум-Принт, 2009. ISBN: 978-5-9934-0048-8.