

COMPARATIVE ANALYSIS OF CORPORAL INDICES IN HORSE POPULATIONS FROM NORTH-EASTERN ROMANIA

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Abstract

This study analyzes corporal indices in horse populations from North-Eastern Romania, comparing unimproved groups with populations ameliorated using stallions of different breeds (Shagya Arab, Hucul, Lipizzaner, Romanian Semigreu, Trăpaș, Gidran and Romanian Sport Horse) across several counties. Descriptive statistics were calculated for compactness, chest depth, bone index, substernal void, height difference, massiveness and lateral body format. Differences between stallions and their half-breeds were evaluated using one-way ANOVA within county–breed groups. Most indices showed low coefficients of variability (generally <10%), indicating high population homogeneity. Differences were predominantly non-significant; however, significant effects were recurrently observed for height difference and lateral body format, and occasionally for compactness and massiveness. The results indicate that breed-based amelioration contributes to measurable improvements in corporal traits, with half-breeds generally approaching the morphological characteristics of the breeding stallions.

Key words: horse, corporal indices, amelioration, ANOVA, morphology

INTRODUCTION

Morphological assessment based on corporal indices represents a widely used and effective method for characterizing body constitution, robustness, proportionality and breed type in horses, as well as for evaluating the results of breeding programs [1, 2]. In production systems where local mares are mated with stallions from specialized or improved breeds, the degree to which the offspring's body conformation converges toward that of the sires constitutes a relevant indicator of amelioration efficiency [3, 4, 5].

The present study provides a comparative analysis of corporal indices recorded in horse populations from several counties in North-Eastern Romania, encompassing both unimproved groups and populations subjected to breed-based amelioration. The objectives were to

describe the main corporal indices and their variability within each county breed group and identify, using analysis of variance (ANOVA), those indices that exhibit significant differences between stallions and their half-breeds, thereby highlighting the morphological traits most responsive to amelioration [6, 7].

MATERIAL AND METHOD

Study design and groups

Corporal indices were evaluated in horses from several counties (Neamț, Iași, Bacău, Botoșani, Suceava, Vaslui). Within each county, horses were grouped according to breeding background: unimproved (local) populations and populations ameliorated by mating with stallions from specific breeds (Shagya Arab, Hucul, Lipizzaner, Romanian Semigreu, Trăpaș, Gidran, Romanian Sport

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Horse). Sample size (n) varied by group as reported in the data tables.

Indices and statistical descriptors

The following indices (expressed as %) were analyzed: compactness index, chest depth index, bone index, substernal void index, height difference index, massiveness index, and lateral body format index. For each group, descriptive statistics were compiled (mean $\pm$ standard error, standard deviation, coefficient of variation, minimum and maximum).

Significance testing

Differences between stallions and their half-breeds were assessed using ANOVA (F test), with significance thresholds reported as non-significant (ns), significant (*), *distinctly significant* (**), and *very significant* (***), according to the provided F comparisons

RESULTS AND DISCUSSIONS

Neamț county

In the population ameliorated with Shagya Arab stallions (n = 3), horses exhibited a well-developed skeletal structure, reflected by a mean bone index of 11.49%, and a moderate degree of compactness (mean 101.42%) (Table 1). Most corporal indices did not differ significantly between stallions and their half-breeds; however, compactness showed distinctly significant differences, while the lateral body format differed significantly. These results suggest that compactness and body proportionality are among the traits most responsive to Shagya Arab amelioration in this county.

Horses ameliorated with Hucul stallions (n = 3) were characterized by a pronounced massiveness (mean 116.37%) and high compactness (mean 120.10%), with a bone index of approximately 10.78%. Differences between stallions and half-breeds were generally non-significant, except for the height difference index, which showed distinctly significant differences, and the lateral body format, which differed significantly. This pattern

indicates that vertical proportions and body format may be more sensitive indicators of breeding effects than other corporal indices in this group.

The Lipizzaner ameliorated population (n = 10) displayed a robust constitution, as indicated by a compactness mean of 115.76% and a bone index of 11.17%, accompanied by a high degree of homogeneity (CV < 10%). ANOVA results revealed non-significant differences for all indices except the lateral body format, which differed significantly between stallions and half-breeds, highlighting this trait as particularly discriminant under Lipizzaner influence.

In the population ameliorated with Romanian Semigreu stallions (n = 10), robustness was reflected by a compactness mean of 110.95% and a bone index of 11.65%, with low variability across indices. Most differences between stallions and half-breeds were non-significant; nevertheless, the height difference index showed distinctly significant differences, suggesting that vertical conformation is especially responsive to this breeding direction.

The group ameliorated with Trăpaș stallions (n = 3) exhibited a prominent skeletal structure (bone index mean 11.99%), together with compactness and massiveness values indicative of a robust constitution. However, detailed significance testing was not available for this group (Table 1).

The unimproved population from Neamț County (n = 10) was also characterized by a robust constitution, with a compactness mean of 110.95% and a bone index of 11.65%. Low coefficients of variability (CV < 10%) and a height difference mean of 101.08% suggest a relatively homogeneous population, providing a suitable baseline for comparisons with ameliorated groups.

Table 1 Corporal indices and ANOVA significance of horse populations from Neamț County

Breed / Population	n	Compactness (%)	Bone index (%)	Height difference (%)	Massiveness (%)	Lateral body format (%)	ANOVA – significant indices
Shagya Arab ameliorated	3	101.42 ± 3.15	11.49 ± 0.40	100.95 ± 0.21	108.40 ± 0.29	107.10 ± 3.64	Compactness **; Lateral format *
Hucul ameliorated	3	120.10 ± 3.53	10.78 ± 0.06	98.83 ± 0.22	116.37 ± 1.82	96.98 ± 1.63	Height difference **; Lateral format *
Lipizzaner ameliorated	10	115.76 ± 1.17	11.17 ± 0.22	101.26 ± 0.15	118.24 ± 1.96	102.13 ± 1.32	Lateral format *
Romanian Semigreu ameliorated	10	110.95 ± 1.97	11.65 ± 0.17	101.08 ± 0.14	110.96 ± 2.55	100.09 ± 2.01	Height difference **
Trăpaș ameliorated	3	107.31 ± 2.45	11.99 ± 0.29	100.04 ± 0.55	115.42 ± 1.80	107.74 ± 1.22	-
Unimproved population	10	110.95 ± 1.97	11.65 ± 0.17	101.08 ± 0.14	110.96 ± 2.55	100.09 ± 2.01	-

Values are expressed as mean ± SD; ANOVA significance refers to differences between stallions and half-breeds. ns = not significant; * p < 0.05; ** p < 0.01; *** p < 0.001.

Iași county

Horses ameliorated with Lipizzaner stallions (n = 3) showed a robust constitution (compactness mean 113.24%), a bone index of 11.87%, and low variability

across all indices. No significant differences were detected between stallions and half-breeds, indicating a strong convergence of offspring morphology toward that of the sires in this population (Table 2).

Table 2 Corporal indices and ANOVA significance of horse populations from Iași County

Breed / Population	n	Compactness (%)	Bone index (%)	Height difference (%)	Massiveness (%)	Lateral body format (%)	ANOVA – significant indices
Lipizzaner ameliorated	3	113.24 ± 4.16	11.87 ± 0.42	100.85 ± 0.43	110.25 ± 3.26	97.46 ± 2.30	ns
Romanian Sport Horse ameliorated	3	110.40 ± 0.59	10.92 ± 0.19	101.81 ± 0.62	106.63 ± 0.64	96.58 ± 0.18	ns
Romanian Semigreu ameliorated	10	108.81 ± 1.38	12.70 ± 0.24	100.25 ± 0.41	110.44 ± 1.95	101.58 ± 1.84	ns
Unimproved population	10	111.16 ± 1.82	11.62 ± 0.17	100.35 ± 0.48	110.23 ± 1.96	99.27 ± 1.66	–

Values are expressed as mean ± SD; ANOVA significance refers to differences between stallions and half-breeds. ns = not significant; * p < 0.05; ** p < 0.01; *** p < 0.001.

In the group ameliorated with Romanian Sport Horse stallions (n = 3), animals were characterized as moderately massive (massiveness mean 106.63%), with a

compactness mean of 110.40% and a bone index of 10.92%. ANOVA revealed no significant differences between stallions and half-breeds for any of the analyzed indices.

The Romanian Semigreu ameliorated population ($n = 10$) exhibited robustness, reflected by a compactness mean of 108.81% and a relatively high bone index (12.70%). The lateral body format indicated a predominantly rectangular conformation (mean 101.58%). No statistically significant differences were observed between stallions and half-breeds.

The unimproved population from Iași County ($n = 10$) showed a compactness mean of 111.16%, with lateral body format values ranging widely from 91.25% to 106.99% and a massiveness mean of 110.23%. These values suggest moderate robustness combined with greater variability in body proportions.

Bacău county

In horses ameliorated with Hucul stallions ($n = 4$), a massive conformation was evident (massiveness mean 108.39%), together with a compactness mean of 101.35% and a bone index of 12.02% (Table 3). ANOVA revealed distinctly significant differences for compactness, height difference and massiveness, as well as significant differences for the bone index, while chest depth, substernal void and lateral body format were non-significant. This indicates that several conformation traits differentiate stallions from half-breeds under Hucul amelioration in this county.

Table 3 Corporal indices and ANOVA significance of horse populations from Bacău County

Breed / Population	n	Compactness (%)	Bone index (%)	Height difference (%)	Massiveness (%)	Lateral body format (%)	ANOVA – significant indices
Hucul ameliorated	4	101.35 ± 1.67	12.02 ± 0.21	101.42 ± 0.29	108.39 ± 0.47	107.03 ± 1.75	Compactness **, Bone index *, Height difference **, Massiveness **
Lipizzaner ameliorated	5	117.79 ± 0.90	10.16 ± 0.30	98.93 ± 0.16	119.97 ± 0.11	101.87 ± 0.68	Height difference *, Massiveness ***, Lateral format ***
Romanian Semigreu ameliorated	10	108.55 ± 2.03	11.81 ± 0.15	101.15 ± 0.16	109.78 ± 1.70	101.24 ± 1.18	Height difference **
Unimproved population	10	107.87 ± 2.41	11.85 ± 0.28	99.71 ± 0.39	115.74 ± 1.60	107.53 ± 1.50	–

Values are expressed as mean ± SD; ANOVA significance refers to differences between stallions and half-breeds. ns = not significant; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

The Lipizzaner ameliorated group ($n = 5$) exhibited high robustness and massiveness (compactness mean 117.79%; massiveness mean 119.97%). Very strong differences were recorded for massiveness and lateral body format, while the height difference index also showed significant differences, emphasizing the importance of these traits as indicators of breeding impact.

In the Romanian Semigreu ameliorated population ($n = 10$), robustness and a rectangular body format were observed (compactness mean 108.55%; lateral format mean 101.24%), with low variability. Among the analyzed indices, only height difference showed distinctly significant differences between stallions and half-breeds.

The unimproved population ($n = 10$) showed greater variability, with compactness values ranging from 97.09% to 125.57%, a lateral body format mean of 107.53% and a massiveness mean of 115.74%.

Botoșani county

In horses ameliorated with Lipizzaner stallions ($n = 3$), high compactness (mean

117.96%), a bone index of 11.13% and a height difference mean of 101.09% were recorded (Table 4). No significant differences were identified between stallions and half-breeds.

Table 4 Corporal indices and ANOVA significance of horse populations from Botoșani County

Breed / Population	n	Compactness (%)	Bone index (%)	Height difference (%)	Massiveness (%)	Lateral body format (%)	ANOVA – significant indices
Lipizzaner ameliorated	3	117.96 ± 1.28	11.13 ± 0.35	101.09 ± 0.23	117.16 ± 4.23	99.28 ± 2.78	ns
Romanian Semigreu ameliorated	5	111.62 ± 2.90	11.80 ± 0.14	101.02 ± 0.25	110.64 ± 2.26	99.23 ± 1.68	Height difference *; Lateral format *
Trăpaș ameliorated	4	112.90 ± 1.48	10.51 ± 0.26	97.95 ± 0.29	109.34 ± 2.19	96.85 ± 1.78	ns
Unimproved population	8	113.52 ± 2.30	11.29 ± 0.27	99.39 ± 0.63	115.77 ± 2.23	102.15 ± 2.06	–

Values are expressed as mean ± SD; ANOVA significance refers to differences between stallions and half-breeds. ns = not significant; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

The Romanian Semigreu ameliorated population ($n = 5$) was characterized by robustness and homogeneity, with significant differences observed for height difference and lateral body format, again indicating the sensitivity of vertical proportions and body format to breeding effects.

Horses ameliorated with Trăpaș stallions ($n = 4$) showed a bone index mean of 10.51%, compactness mean of 112.90% and a lower height difference mean of 97.95%, suggesting distinct vertical conformation characteristics.

The unimproved population ($n = 8$) presented a lateral body format mean of 102.15% and a bone index mean of 11.29%, indicating moderate variability.

Suceava county

In the Shagya Arab ameliorated group ($n = 4$), horses displayed a bone index mean of 11.39%, compactness mean of 103.24% and

height difference mean of 101.05%. Very significant differences were observed for height difference, while massiveness differed significantly, highlighting these traits as key indicators of breeding effects (Table 5).

The Romanian Semigreu ameliorated population ($n = 5$) showed significant differences for height difference and distinctly significant differences for massiveness and lateral body format, indicating a broader response to amelioration compared with other counties.

Horses ameliorated with Gidran stallions ($n = 4$) exhibited very high compactness (mean 121.68%) and a relatively lower height difference (mean 98.54%), reflecting a compact and strongly built conformation.

The unimproved population ($n = 7$) showed compactness and bone index means of 114.86% and 11.85%, respectively, with generally low variability.

Table 5 Corporal indices and ANOVA significance of horse populations from Suceava County

Breed / Population	n	Compactness (%)	Bone index (%)	Height difference (%)	Massiveness (%)	Lateral body format (%)	ANOVA – significant indices
Shagya Arab ameliorated	4	103.24 ± 2.88	11.39 ± 0.30	101.05 ± 0.18	108.85 ± 0.50	105.67 ± 2.95	Height difference ***; Massiveness *
Romanian Semigreu ameliorated	5	107.53 ± 2.58	11.43 ± 0.20	100.99 ± 0.15	105.13 ± 1.95	97.90 ± 2.10	Height difference *; Massiveness **; Lateral format **
Gidran ameliorated	4	121.68 ± 0.97	10.39 ± 0.19	98.54 ± 0.30	119.28 ± 0.30	98.04 ± 0.60	ns
Unimproved population	7	114.86 ± 2.83	11.85 ± 0.49	98.40 ± 0.54	123.67 ± 3.02	107.82 ± 2.36	–

Values are expressed as mean ± SD; ANOVA significance refers to differences between stallions and half-breeds. ns = not significant; * p < 0.05; ** p < 0.01; *** p < 0.001.

Vaslui county

In horses ameliorated with Shagya Arab stallions (n = 5), most indices did not differ significantly between stallions and half-

breeds, except for the bone index, which showed significant differences, indicating divergence in skeletal robustness (Table 6).

Table 6 Corporal indices and ANOVA significance of horse populations from Vaslui County

Breed / Population	n	Compactness (%)	Bone index (%)	Height difference (%)	Massiveness (%)	Lateral body format (%)	ANOVA – significant indices
Shagya Arab (ameliorated)	5	104.79 ± 2.87	11.72 ± 0.13	98.88 ± 0.16	108.96 ± 1.26	104.21 ± 2.37	Bone index *
Gidran (ameliorated)	3	122.24 ± 1.13	10.45 ± 0.25	98.70 ± 0.37	119.30 ± 0.43	97.61 ± 0.58	Massiveness *
Lipizzaner (ameliorated)	4	117.11 ± 1.24	10.95 ± 0.31	100.99 ± 0.19	118.11 ± 3.14	100.86 ± 2.52	ns
Romanian Semigreu (ameliorated)	7	111.24 ± 2.06	12.00 ± 0.16	101.10 ± 0.18	111.46 ± 1.65	100.29 ± 1.37	Height difference **
Unimproved population	7	108.65 ± 3.44	11.86 ± 0.37	99.21 ± 0.41	115.67 ± 2.32	106.76 ± 2.10	–

Values are expressed as mean ± SD; ANOVA significance refers to differences between stallions and half-breeds. ns = not significant; * p < 0.05; ** p < 0.01; *** p < 0.001.

The Gidran ameliorated group (n = 3) exhibited very high compactness (mean 122.24%), with significant differences observed only for massiveness.

In the Lipizzaner ameliorated population (n = 4), no significant differences were detected across indices.

Horses ameliorated with Romanian Semigreu stallions (n = 7) showed distinctly

significant differences for height difference, while other indices remained non-significant.

The unimproved population ($n = 7$) presented low variability ($CV < 10\%$), with compactness, bone index and height difference means of 108.65%, 11.86% and 99.21%, respectively.

Cross county interpretation

Across counties and breeds, the indices most frequently showing significant differences between stallions and their half-breeds were the height difference index, the lateral body format index, and, in specific contexts, compactness and massiveness. The generally low coefficients of variability and the predominance of non-significant differences support the conclusion that breed-based amelioration led to an evident improvement of corporal traits, with half-breeds often approaching the morphological characteristics of the stallions used for breeding.

CONCLUSIONS

The horse populations analysed across the studied counties generally exhibited low variability of corporal indices, indicating a high degree of morphological homogeneity within most groups.

In the majority of county–breed combinations, the analysis of variance revealed predominantly non-significant differences between stallions and their half-breeds for most corporal indices. This finding suggests that the offspring frequently tend to approach the morphological profile of the breeding stallions.

Among the analysed traits, the height difference index and the lateral body format index most consistently displayed significant differences, highlighting vertical proportions and overall body format as particularly sensitive indicators of the effects of breed-based amelioration.

In certain specific contexts, especially in Bacău County, additional indices such as

massiveness and compactness also showed pronounced differences, including very significant effects in populations ameliorated with Lipizzaner stallions.

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