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ASSESSMENT OF THE RELATIONSHIP BETWEEN BODY WEIGHT AND GAITS QUALITY TRAITS IN YOUNG HORSES OF THE EAST BULGARIAN BREED

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Abstract

The study aimed to assess the relationship between body weight and gait quality traits in young horses of the East Bulgarian breed. A total of 32 clinically healthy horses were evaluated, including 20 two-year-olds and 12 three-year-olds, all raised under similar feeding, housing, and training conditions. The quality of gaits was assessed by an expert committee according to an approved evaluation protocol, which included overall gait score, walk, trot, and canter. Body weight was determined using a specialized measuring tape at the chest girth level. Horses were grouped by age and classified into categories based on body weight. Data were analyzed using multifactorial analysis of variance (ANOVA) and Spearman's rank correlation (ρ) with SPSS v.21 software. Results showed a clear age-related improvement in gait scores, particularly in trot and canter. In two-year-old horses, groups with medium and higher body weight had significantly higher scores for overall gait quality, walk, and canter ($P < 0.05$ – 0.01). A positive correlation between body weight and walk score was observed ($\rho = 0.466$; $P < 0.05$), whereas correlations with trot and canter were weak and nonsignificant. Among three-year-old horses, no statistically significant effects of body weight, sex, or their interaction were detected.

Keywords: body weight, East Bulgarian breed, gait quality, performance traits, sport horses, variability

INTRODUCTION

The evaluation of gait quality in horses is an essential component of performance assessment and selection in sport horse breeding (Barrey, 1999; Rozanowski et al., 2013; Olsson et al., 2000, Posta et al., 2010; Clayton et al., 2019; Serra et al., 2020; Asti et al., 2024). Gait characteristics such as regularity, rhythm, and elasticity are closely linked to the horse's functional ability and athletic potential (Komosa & Purzyc, 2009; Schacht, 2011). In modern warmblood breeding programs, gait quality serves as a key indicator for early

selection, as it reflects both genetic and biomechanical aspects of locomotor performance (Barzev, 2011; Dolis et al., 2011). Therefore, the analysis of the relationship between body conformation, body weight, and gait traits provides valuable insight into optimizing breeding strategies for sport horses.

Body weight is a major morphometric and physiological factor influencing movement efficiency, biomechanical balance, and performance in horses (Henneke et al., 1983; Trachsel et al., 2016). Several studies have demonstrated that both underweight and overweight conditions can negatively affect locomotion, stride symmetry, and coordination (Dyson et al., 2019; Stefánsdóttir et al., 2017). The distribution of body mass influences kinetic and kinematic parameters, altering joint loading and muscular effort during walk, trot, and canter (Jensen et al., 2016; Jansson et al., 2021). Moreover, morphometric indices such as girth circumference and height at withers are often used to estimate body weight and adiposity, which have been associated with variations in gait amplitude and energy expenditure (Potter et al., 2023).

Experimental research on the impact of weight on gait symmetry and regularity using objective tools such as accelerometry has shown that excessive load beyond 25–30% of body mass significantly deteriorates gait quality (Matsuura et al., 2013). Similar tendencies have been reported in warmblood and Icelandic horses, where higher rider-to-horse body weight ratios caused measurable alterations in gait rhythm, stride length, and overall movement elasticity (Stefánsdóttir et al., 2017; Dyson et al., 2019). These findings emphasize that both the magnitude and distribution of weight can affect the biomechanical efficiency of gaits, making the study of weight–gait relationships crucial from a welfare and performance standpoint.

In addition to biomechanical factors, genetic background and developmental characteristics also play a significant role in determining gait quality. Studies on the East Bulgarian breed have demonstrated moderate heritability for gait-related traits and significant influence of lineage and family affiliation on gait scores (Popova & Sabeva, 2021). Previous work on conformation and exterior traits in this breed has revealed clear age-related trends in morphometric development, with most body dimensions approaching adult proportions by three years of age (Popova et al., 2025). The breed, classified as a warmblood sport horse, has been shaped under a selection system focused on improving elasticity, balance, and impulsion of movement, traits that are directly associated with gait performance (Sabeva & Popova, 2018).

Despite the recognized importance of gait evaluation in breeding programs, there is limited information regarding the relationship between body weight and qualitative gait traits in young East Bulgarian horses. Understanding these associations is essential for developing optimal selection criteria that integrate both functional and morphological parameters.

Therefore, the aim of the present study was to assess the relationship between body weight and gait quality traits in two- and three-year-old East Bulgarian horses. By combining expert-based gait evaluation with morphometric assessment and statistical analysis, this research seeks to identify whether

variations in body weight are associated with measurable differences in gait performance at an early stage of development.

MATERIALS AND METHODS

The study was conducted on young horses (N = 32; 20 two-year-olds and 12 three-year-olds) of the East Bulgarian breed. All animals were clinically healthy at the time of evaluation and were raised under comparable feeding, housing, and age-appropriate training conditions. Data were structured into two age groups (2 years; 3 years) and by sex.

Gaits were evaluated according to the following traits: gait quality (average score), walk, trot, and canter. The assessment was performed by an expert committee using a standardized scoring scale applied uniformly to all horses within the group, on a hard, level surface. The evaluation took place during the annual testing events organized by the East Bulgarian Horse Association, following an approved standardized protocol.

Body weight was determined using a specialized measuring tape designed for horses. This method was chosen due to its wide applicability in field practice and high convenience and repeatability, particularly for young animals. Measurements were taken at the level of chest girth by the same operator to minimize variation.

For each age group, animals were classified into body weight categories, defined according to pre-set thresholds derived from the dataset to ensure adequate sample size per category. In two-year-old horses, three body weight groups were formed:

G1 (low): 308–378 kg

G2 (medium): 384–426 kg

G3 (high): 432–532 kg

In three-year-old horses, two body weight groups were established:

G1 (low): 426–440 kg

G2 (high): 445–524 kg.

The statistical analysis of the studied traits was carried out using a multifactor analysis of variance (ANOVA) based on the following model:

$$Y_{ijk} = \mu + G_i + P_j + GP_{ij} + \varepsilon_{ijk},$$

where: Y_{ijk} – observation for the respective trait; μ – overall mean constant; G_i – fixed effect of body weight group (for two-year-olds: $i = 1-3$; for three-year-olds: $i = 1-2$); P_j – fixed effect of sex ($j = 1-2$); GP_{ij} – interaction between body weight group and sex; ε_{ijk} – residual variation.

Additionally, Spearman's rank correlation coefficients (ρ) were calculated between body weight and the individual traits - gait quality, walk, trot, and canter.

All statistical analyses were performed using **SPSS v.21**

RESULTS AND DISCUSSION

Table 1 presents the mean values \pm SE for four gait traits — overall gait quality (average score), walk, trot, and canter — in two- and three-year-old East Bulgarian horses grouped according to body weight (measured using a weight tape).

Table 1. Mean values \pm SE of gait quality traits in two- and three-year-old horses grouped by body weight.

Traits	2 years old			3 years old	
	Mean \pm SE	Mean \pm SE	Mean \pm SE	Mean \pm SE	Mean \pm SE
	G1, n=6	G2, n=9	G3, n=5	G1, n=6	G2, n=6
Gait quality (average score)	6.449 \pm 0.238	7.191 \pm 0.145	7.150 \pm 0.199	7.861 \pm 0.174	8.022 \pm 0.164
Walk	6.285 \pm 0.273	6.988 \pm 0.166	7.159 \pm 0.228	7.649 \pm 0.214	7.918 \pm 0.202
Trot	6.539 \pm 0.281	7.459 \pm 0.171	6.950 \pm 0.234	7.929 \pm 0.171	7.973 \pm 0.161
Canter	6.520 \pm 0.320	7.311 \pm 0.194	7.348 \pm 0.266	7.998 \pm 0.208	8.230 \pm 0.196

The results clearly demonstrate an age-related improvement in gait quality across all evaluated traits. Both the overall gait score and the individual gait scores increased between two and three years of age, with mean differences ranging from approximately 0.6 to 1.0 points. The most pronounced changes were observed in trot and canter, indicating that locomotor performance improves significantly as horses approach functional maturity. This trend reflects the expected musculoskeletal development and improved neuromuscular coordination occurring between 24 and 36 months of age, leading to greater stride regularity, better engagement of the hindquarters, and more economical movement patterns. Similar age-related increases in gait quality have been reported in other warmblood breeds (Sabeva & Popova, 2017; Popova & Sabeva, 2021; Popova et al., 2025), confirming that the period between the second and third year is critical for locomotor refinement.

Within the two-year-old group, a moderate trend associated with body weight was observed. Horses in the medium and high body weight categories (G2 and G3) obtained slightly higher scores in walk and canter compared to lighter individuals, while the medium-weight group (G2) showed the best mean values for overall gait score and trot. These differences may reflect a more advanced physical development among horses with higher live weight, as better muscle tone and more balanced body proportions can positively influence gait elasticity and rhythm (Jensen et al., 2016; Potter et al., 2023). Comparable relationships between body mass and movement regularity have been noted in Icelandic and native Japanese horses, where greater relative load or body weight was linked to changes in stride symmetry and quality (Matsuura et al., 2013; Stefánsdóttir et al., 2017).

At the age of three years, the effect of body weight became negligible. The differences between the two weight categories (G1 and G2) were minimal across all traits — for example, canter: 7.998 vs. 8.230; trot: 7.929 vs. 7.973; overall gait score: 7.861 vs. 8.022. This suggests that, by this age, East Bulgarian horses have reached a relatively uniform stage of morphological and functional maturity, reducing inter-group variation in gait quality. Such stabilization is consistent with

the findings of Popova et al. (2025), who reported that most body dimensions and performance indicators in this breed reach near-adult levels by the third year.

According to the data presented in Table 2A, a significant effect of body weight group was established for all gait traits in two-year-old horses: overall gait score ($P < 0.01$), walk ($P < 0.01$), trot ($P < 0.01$), and canter ($P < 0.05$). This indicates that, at the age of two years, different body weight ranges are associated with statistically distinct mean scores for gait quality traits. Comparison with Table 1 shows that the medium (G2) and high (G3) body weight groups achieved higher mean values than the light group (G1) for most traits, while for trot the highest mean score was recorded in G2. These findings support practical observations that, in early developmental stages, better body and muscular condition are often associated with more stable rhythm, improved balance, and smoother coordination of movement.

The effect of sex was significant for overall gait score ($P < 0.05$) and walk ($P < 0.05$), but non-significant for trot and canter. This suggests moderate sex-related differences in overall gait quality and the four-beat walk pattern at two years of age, which, however, do not consistently extend to the more dynamic gaits. A possible explanation lies in differences in muscle tone, coordination, and psychomotor maturity between males and females at this age, which may initially influence the more elementary gait patterns (e.g., walk) and only later the complex, energy-demanding ones such as trot and canter.

Table 2A. Multifactor analysis of variance: effect of body weight group, sex, and their interaction on gait quality traits in two-year-old horses (F, df, significance).

Trait	Body weight group F-value, df=2	Sex F-value, df=1	Body weight×Sex F-value, df=1
Gait quality (average score)	F=10.255**	F= 6.668*	F= 13.482**
Walk	F=8.730**	F= 7.577*	F= 11.555**
Trot	F=8.634**	F= 2.704	F= 13.421**
Canter	F=6.312*	F= 3.722	F= 4.102

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

A statistically significant interaction between body weight and sex was detected for overall gait score ($P < 0.01$), walk ($P < 0.01$), and trot ($P < 0.01$), whereas for canter the interaction was not significant. This finding implies that the influence of body weight on some gait traits depends on sex (and vice versa) — for instance, the differences between body weight groups may be more pronounced in one sex than in the other. Such sex-dependent expression of morpho-functional traits has also been reported in other warmblood populations (Trachsel et al., 2016; Popova & Sabeva, 2021), reflecting distinct growth dynamics and muscle development patterns between male and female horses at this stage of maturity.

According to the data presented in Table 2B, in three-year-old horses no statistically significant effects were found for body weight group, sex, or their interaction on overall gait quality (average score), walk, trot, or canter. This indicates that, within the examined range of body weight and under the actual sex–

age structure of the sample, the mean gait scores are practically equivalent across all subgroups.

These findings suggest that the maturation process occurring between two and three years of age leads to a levelling of coordination and motor control, such that moderate variations in body weight no longer result in perceptible differences in rhythm, impulsion, or balance. This finding is consistent with previous reports on the East Bulgarian breed, which highlight that morphological and performance-related differences between sexes and weight categories tend to diminish around the third year of age (Popova et al., 2025).

Table 2B. Multifactor analysis of variance: effect of body weight group, sex, and their interaction on gait quality traits in three-year-old horses (F-values, df, significance).

Trait	Body weight group F-value, df=2	Sex F-value, df=1	Body weight×Sex F-value, df=1
Gait quality (average score)	F=0.451	F=0.031	F=0.011
Walk	F=0.841	F=0.320	F=0.081
Trot	F=0.036	F=0.137	F=0.356
Canter	F=0.665	F=0.038	F=0.538

*P<0.05; **P<0.01; ***P<0.001.

In two-year-old horses (Table 3A), a weak to moderate positive correlation was observed between body weight (measured by tape) and walk ($\rho = 0.466$; $P = 0.038$). The effect for walk was moderate in strength and consistent with the practical observation that two-year-olds in better condition tend to show a more stable and rhythmic walk, while for the more dynamic gaits, trot and canter, the influence of body mass was less consistent. This pattern corresponds with the descriptive means presented in Table 1. At the same time, the absence of a relationship for trot suggests that body weight alone is not a determining factor for the quality of all gaits at this age. Similar trends have been reported in other young sport breeds, where moderate body condition is associated with improved coordination and rhythm in basic gaits (Popova & Sabeva, 2021; Jensen et al., 2016).

In three-year-old horses (Table 3B), no statistically significant correlations were found between body weight and any of the gait traits — overall gait score, walk, trot, or canter. The Spearman coefficients were low (≈ 0.13 – 0.37), indicating a weak positive association that was not significant within the current sample ($N = 12$).

Table 3A. Spearman’s rank correlations (ρ) between body weight and gait quality traits in two-year-old horses.

Factor	Trait	ρ (Spearman)	p	N
Body weight	Gait quality (average score)	0.382	0.096	20
	Walk	0.466	0.038 *	20
	Trot	0.177	0.454	20
	Canter	0.444	0.050	20

*P<0.05; **P<0.01; ***P<0.001.

Table 3B. Spearman correlations (ρ) between live weight (bar) and movement indicators in 3-year-old horses

Factor	Trait	ρ (Spearman)	p	N
Body weight	Gait quality (average score)	0.152	0.637	12
	Walk	0.131	0.684	12
	Trot	0.140	0.664	12
	Canter	0.369	0.237	12

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

These results are fully consistent with those presented in Table 1, where differences between the G1 and G3 groups among three-year-olds were minimal, and with the multifactor ANOVA results (Table 2B), where neither body weight, sex, nor their interaction showed a significant effect on gait traits. Thus, in three-year-old horses maintained within a normal body condition range, managing body weight does not represent an effective lever for improving gait performance.

CONCLUSIONS

The present study demonstrates that in young East Bulgarian horses, gait quality improves markedly between the second and third year of age, reflecting the progressive development of musculoskeletal structure, coordination, and balance. At two years of age, body weight exerts a moderate influence on gait expression, particularly in walk, where horses with better body condition tend to show more stable and rhythmical movement. However, by the third year, this relationship becomes negligible, indicating that locomotor performance stabilizes once functional maturity is achieved.

Sex-related differences were minor and limited to specific traits at an early stage, while the interaction between body weight and sex suggested some variation in developmental timing between males and females. Overall, the findings confirm that age is the dominant factor shaping gait quality in the East Bulgarian breed, whereas the effect of body weight is transient and diminishes with maturity.

From a practical standpoint, maintaining an adequate but not excessive body condition supports optimal gait development in young horses, yet further improvements in gait quality at later stages should be sought primarily through training and selection rather than weight management.

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