

Frequency of hoof conformation faults and disorders in horses of several breeds

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Abstract: The aim of the study was to compare the frequencies of hoof conformation faults and disorders in the front and hind legs of horses of different breeds. The study was conducted on 346 horses over 3 years old (167 Anglo-Arabians, 130 Hucul horses, and 49 Silesian horses). In the study population, over 60% of the horses had some kind of hoof conformation faults and disorders. A significant difference in the incidence of hoof conformation faults (65.5%) and hoof disorders (35.5%) was shown in the analyzed population of horses. In the case of Hucul and Silesian horses, hoof conformation faults were observed more than twice as often as hoof disorders. In addition, the frequency of hoof conformation faults in Hucul and Silesian horses was highly significantly greater than that in Anglo-Arabian horses, in which the hoof disorders appeared highly significantly more often. Both hoof conformation faults and hoof disorders were observed highly significantly more often on the front than on the hind legs. The results suggest that the frequency of hoof conformation faults and disorders is breed-dependent, which may be connected with the tendency of horses of each breed to be used in a specific way.

Key words: Hoof conformation faults, hoof disorders, horse breed, front and hind limb

1. Introduction

Hooves constitute an important element of horse conformation and thus influence a horse's usability. Despite some differences in shape, hoof wall slope, and size, hooves should be proportional to the size of the horse; otherwise, they will hamper the ability of the horse to perform certain tasks to a greater or lesser extent. Stachurska et al. (1) reported that the hoof width-to-chest circumference ratio is the best measure of hoof size in relation to body size. Hoof size depends on the size of the coffin bone and is influenced by genetic factors, but proper hoof shape is also significantly determined by the horse's posture, its gaits, and hoof care (2). According to Reinhard (3), all hoof irregularities should be taken care of, beginning with the first days of a foal's life. Otherwise, at a later age, hoof defects can cause not only serious health problems, but can also preclude proper use of the horse and increase costs incurred by the owner for treatment (4,5). Also, when one plans to buy a horse, he should definitely perform a thorough evaluation of its hooves and limbs, with consideration given to the horse's future use (6). Environmental impact (changing climatic and natural conditions) and intentional human interference (breeding and selection programs) have led over the ages

to the selection of types and breeds of horses differing in the exterior, size, and use. Breed-related predispositions to characteristic hoof defects caused by specific housing conditions, management, or use of different breeds may also exist. To address this issue, we compared the frequency of front and hind hoof conformation faults and disorders in different breeds of horses.

2. Materials and methods

This study was conducted on 346 horses over 3 years of age (167 Anglo-Arabians from the Ochaby stud farm, 65 Hucul horses from a stud farm in Wołosate and Gładyszów, and 49 Silesian horses from the stud farm in Książ). Anglo-Arabian horses are warm-blood saddle horses weighing 550–600 kg. Thanks to a perfect combination of optimal traits of the output breeds, they are characterized among others by a good gallop and a high jumping ability, so they are perfectly suited for equestrian sports. Hucul horses are small, primitive mountain horses weighing 350–400 kg. They are one of the oldest Polish breed of consolidated genotype, formed in the harsh conditions of the Eastern Carpathians. Formerly they were used primarily as pack horses. Hucul horses are now saddle-sledge suitable for recreation, mountain hiking, and endurance type

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of activities. Due to their gentleness and intelligence, they are often used in hippotherapy. Silesian horses are a warm-blood sledge breed weighing 650–750 kg. They originated from the local Polish dams and by the stallions of Oldenburg and East Frisian breeds. Silesian horses are used primarily in carriage driving, but also in other types of use. All studied horses were breeding horses (not on any kind of training) kept in a stable-grazing system. In the stables the Anglo-Arabian and Silesian horses were kept in individual boxes, and Hucul horses were kept in free-range stables. They were fed with meadow hay, oats, and pasture grazing in the amount and ratio adjusted for breed, sex, and feeding season according to the Polish requirements of equine nutrition.

The hooves of each leg were examined before trimming; this was carried out regularly every 6–8 weeks, but horses were not shod. Experienced farriers were consulted regarding the presence of hoof problems. All observed defects were classified for hoof conformation faults and disorders using the classification of Kolstrung et al. (2):

- hoof conformation faults: uneven hoof (one of the quarters is upright while the other is sloping, i.e. asymmetrical hoof); flat hoof (toe and quarters heavily sloping, low heels, no sole arching); wide hoof (frog overgrowth, widely spaced heels and bars); upright hoof (toe at an angle >60°, high heels that can grow to the height of the toe); crooked hoof (concave toe, very long heels with convex edge); narrow hoof (vertical quarters, sole edge of heels rolled inward);
- hoof disorders: white line diseases (delamination, infections and their complications); frog diseases (pseudotumor of the frog, thrush, frog atrophy, narrow frog, deformed frog); defects of the sole (uneven sole, corn); other disorders (hoof coronet's lesion, cracks, clefts, undulating hoof, postlaminitis defects, hoof abscesses).

The chi-square test (χ^2) was used to determine the significance of differences in the percentage frequency

distributions of hoof defects in different breeds of horses. The null hypothesis assumed that the frequency distribution of hoof defects for each breed was the same as the cumulative frequency for all breeds. The same procedure was applied to show the significance of differences in the frequency distributions of hoof defects between the front and hind legs.

3. Results

Over 60% of the horses in the study population had hoof conformation faults and disorders, which were significantly more frequent in the front legs than in the hind legs or in both legs simultaneously (Table 1). Hoof conformation faults and disorders were highly significantly more frequent in Anglo-Arabian horses (68.3%) and least frequent in Hucul horses (59.2%). Front hoof problems were observed highly significantly more often in Anglo-Arabian horses (46.1%) as compared with Hucul horses (19.2%) and Silesian horses (16.3%). Hind hoof problems were detected highly significantly more frequently in Silesian horses (32.7%) and Hucul horses (18.5%) than in Anglo-Arabian horses (12.3%).

A significant difference in the incidence of hoof conformation faults (65.5%) and hoof disorders (35.5%) was shown in the analyzed population of horses (Table 2). In the case of Hucul and Silesian horses, hoof conformation faults were observed more than twice as often as hoof disorders. In addition, the frequency of hoof conformation faults in Hucul and Silesian horses was highly significantly greater than that in Anglo-Arabian horses, in which the hoof disorders appeared highly significantly more often.

Comparisons of the frequencies of individual hoof conformation faults and disorders in different breeds (Table 2) showed that white line defects and upright hooves were noted most often in Anglo-Arabian horses (42.6% and 17.5%, respectively), and least often in Hucul horses (1.0%, and 11.6%, respectively). The differences in white line disease between Anglo-Arabian horses,

Table 1. The occurrence of hoof problems (%) on different limbs in horses of several breeds.

Limbs	Breed			
	Anglo-Arabian	Hucul	Silesian	Total
Front	46.1 ^{Aa}	19.2 ^A	16.3 ^a	81.6 ^{bc}
Hind	3.6 ^{BC}	18.5 ^B	32.7 ^C	54.8 ^b
Front and hind	18.6	21.5	12.3	52.4 ^c
Total	68.3	59.2	61.2	

Values with the same lowercase letter differ significantly ($P \leq 0.05$).

Values with the same uppercase letter differ highly significantly ($P \leq 0.01$).

Hucul horses, and Silesian horses were highly statistically significant. The most frequent problems in Hucul horses included crooked hooves (16.4%), flat hooves (15.9%), and sole defects (11.6%). The frequency of crooked hooves and sole defects was highly significantly lower in Anglo-Arabian horses (5.2% and 2.2%, respectively). No such problems were observed in Silesian horses, and only 5.3% of the horses of this breed had flat hooves. The remaining hoof conformation faults and disorders examined in this study were predominant in Silesian horses. The differences in the frequency of uneven hooves (36.9%), narrow hooves (12.3%), and other disorders (10.5%) in this breed were highly significant compared with Anglo-Arabian horses in which these problems were the rarest (in 5.6%, 3.4%, and 2.2% of horses, respectively). The percentage of Hucul horses with uneven hooves (18.4%) was also significantly lower than in that in Silesian horses, but highly significantly higher than that in Anglo-Arabian horses. Both hoof conformation faults and hoof disorders were observed highly significantly more often on the front than on the hind legs (Table 2). Highly statistically significant differences, amounting to 73.4%, 42.5%, 41.6% and 41.2%, were noted for wide hooves, flat hooves, sole defects, and crooked hooves, respectively. White line

diseases also appeared significantly more often (by 22.6%) in front hooves. On the other hand, narrow hooves were detected nearly twice as frequently in hind legs, and the difference from front legs was significant.

4. Discussion

The etiology of hoof problems in horses is complex. Such hoof conformation faults and disorders usually develop as a result of concomitant exposure to several genetic, environmental, or biochemical factors that may lead to different degrees of functional impairment of the whole leg (7–9). These problems often affect considerable percentages of the examined breeds of horses. Bigham and Tabatabaei (10) demonstrated that as many as 90% of Bulgarian workhorses had various hoof wall defects, probably caused by a lack of correction and shoeing, inappropriate maintenance and feeding conditions, and harsh environmental conditions. The same frequency of hoof cracks was reported by Josseck et al. (11) in Austrian Lipizzan horses, whereas in a Malaysian population 50% of the horses exhibited various hoof problems (4). In contrast, studies of Slater and Hood (12) revealed hoof defects in only 28% of horses, mostly racehorses of different breeds. Also, Dzierżęcka et al. (13), analyzing injuries sustained

Table 2. The incidence of particular hoof conformation faults and disorders in horses of several breeds and on different limbs.

Hoof problems (%)	Breed				Limbs	
	All horses	Anglo-Arabian	Hucul	Silesian	Front	Hind
Hoof conformation faults						
Uneven hoof	20.3	5.6 ^{AB}	18.4 ^{Aa}	36.9 ^{Ba}	46.1	53.9
Flat hoof	11.8	14.2	15.9	5.3	71.3 ^C	28.8 ^C
Wide hoof	5.1	3.4	4.8	7.0	86.7 ^D	13.3 ^D
Upright hoof	13.8	17.5	11.6	12.3	55.5	44.5
Crooked hoof	7.2	5.2 ^E	16.4 ^E	0.0	70.6 ^F	29.4 ^F
Narrow hoof	7.3	3.4 ^G	6.3	12.3 ^G	33.9 ^b	66.1 ^b
Total	65.5	49.3 ^{Hl}	73.4 ^{Hl}	73.8 ^I	60.7 ^J	39.3 ^J
Hoof disorders						
White line diseases	16.9	42.6 ^K	1.0 ^K	7.0 ^K	61.3 ^c	38.7 ^c
Frog diseases	6.5	3.7	7.2	8.7	57.8	42.2
Defects of sole	4.6	2.2 ^L	11.6 ^L	0.0	70.8 ^M	29.2 ^M
Other disorders	6.5	2.2 Nd	6.8 ^d	10.5 ^N	51.6	48.4
Total	34.5	50.7 ^{Op}	26.6 ^O	26.2 ^P	60.4 ^R	39.6 ^R

Values with the same lowercase letter differ significantly ($P \leq 0.05$).
 Values with the same uppercase letter differ highly significantly ($P \leq 0.01$).

during race training of 2-year-old Thoroughbred horses, observed only a few structural hoof defects (inflammation of the hoof corium, hoof cracks, thrush, hoof deformation) among about 60% of horses suffering from limb diseases. In the present study, hoof problems were observed in more than one-half of the horses in the analyzed population. In a majority of cases, their frequency was significantly dependent on the breed of the horse and the affected leg. A significantly greater percentage of hoof conformation faults and disorders was detected in the front legs as compared with the hind legs, which may be a result of uneven strain on legs due to their different functions and biomechanics of movement. Due to the locations of the center of gravity of the horse and of the head and neck, and the absorption of shocks caused by landing and hitting the ground with a greater vertical velocity, the front legs are subject to more concussion than the hind legs (14–18). The greater and differently directed forces to which a front leg hoof is exposed in comparison with hind legs not only determine differences in hoof and sole shape (2,18), but can also make horses more prone to developing certain disorders in their front hooves. Leise et al. (19) and Wylie et al. (20) reported that laminitis was associated more often with front than hind hooves. Stashak (21) also observed a greater susceptibility of front hooves to different injuries, while Jaworski (22), investigating Polish Konik horses raised in a nature reserve, noted the development of hoof cracks of different degrees and depths occurring in the front legs only. According to Sasimowski et al. (14), due to differences in body proportions, the heavier a horse of a certain type or breed is, the greater the strain on the front legs. However, in this paper, significantly more front hoof problems were detected in Anglo-Arabian horses compared with Silesian horses, which are much heavier. Probably the frequency of hoof failures can also be associated with other factors, e.g., the type of use of horses of certain breeds. The front legs of Anglo-Arabian horses may be exposed to much greater strain because of their use as sports horses (especially in jumping) than those of Silesian horses (used mostly as sledge horses), in which hind hoof problems were observed significantly more often compared with the remaining breeds. Malaysian studies (4) demonstrated that it was not the breed of horses, but the way they were used that determined the development of hoof derangements, which were significantly more frequent in horses used for riding than for dressage, jumping, or polo. The same authors (4) suggested that the frequency of such problems also depended on the system of management. In studs where hoof conditions are regularly checked and which employ a farrier and practice proper supplementation of diet with all necessary nutrients, hoof conformation faults and disorders are significantly rarer than in other studs that do not adhere to the standard rules of horse keeping. Each

breed examined in our study was kept in a different state-owned stud farm; however, all of the farms maintained similarly high standards of management. Thus, it can be expected that it was the breed and not the management system that determined the different frequencies of hoof problems. It has also been suggested that the time of attainment of somatic maturity is another breed-related factor influencing susceptibility to hoof conformation faults and disorders. Since it was reported that different leg injuries or orthopedic developmental diseases are more frequent in horses attaining earlier maturity (23,24), it might be suspected that susceptibility to certain hoof problems can also be associated with the maturation rate of horses of different breeds. However, our studies did not confirm this hypothesis, as hoof defects were observed less frequently in Hucul horses than in Anglo-Arabian horses. Earlier studies (25) based on the analysis of body growth rate and age of ossification of the epiphysal cartilage of the lower end of the radial bone showed that Hucul horses attained a more advanced stage of somatic maturity in a shorter time than Anglo-Arabians. According to Slater and Hood (12), the significant effect of breed on the development of hoof wall defects may result from the genetic predispositions of studied breeds of horses and from differences in hoof shape.

In the present study, analysis of a number of hoof conformation faults and disorders demonstrated that Anglo-Arabian horses suffered more frequently from white line diseases, while uneven hooves were predominant in Hucul and Silesian horses. However, it is difficult to unequivocally prove a significant relationship between the frequency of certain hoof problems and the studied breeds. As mentioned earlier, the genesis of hoof defects can be due to different factors; moreover, some hoof conformation faults and disorders can coincide with or develop due to the prior existence and action of other defects (4,10,26,27). Rooney (28) suggested that flat hooves may be one of the causes of white line diseases, due to increased pressure from the coffin bone on the hoof wall. This suggestion was not confirmed by the studies of Bigham and Tabatabaei (10), in which only 4 cases of white line disease were detected in 20 horses with flat hooves. In our work as well, even though flat hooves were the most frequent in Hucul horses as compared with other breeds, white line diseases were the rarest in this breed. Also, in our studies we observed no tendency for white line diseases and hoof cracks (classified as 'other disorders') to coincide, although such an association was suggested in studies by other authors. Josseck et al. (11) and Kuwano et al. (29) analyzed the hooves of Lipizzan horses and Thoroughbred horses with white line disease and noted that these hooves had additional cracks in a majority of cases. Stashak (21) and Bigham and Tabatabaei (10) suggested that hoof

cracks often develop on even hooves and narrow hooves with rolled-up heels, conditions which often coexist (30). However, in the present study, no relationship was found between flat and narrow hooves in the studied breeds of horses; moreover, flat hooves were significantly more frequently observed in the front legs as compared with the hind legs, while for narrow hooves, the reverse was true. Based on the results of the present study, it can be concluded that the frequency of hoof conformation faults and disorders was significantly determined by the horse breed and the leg in which they occurred. This is probably related to the tendency of horses of certain breeds to be used in a specific way, causing different strains in the front and hind legs in sports horses, sledge horses, and workhorses. The presented study results may constitute

a contribution to further investigations using a larger population of horses that could confirm the possible relationship between a breed of horses and the frequency of specific hoof conformation faults and disorders. The demonstration of such a relationship would be of great practical significance in horse breeding and could serve as the basis for adjusting conditions such as housing, care and exercise, along with proper management of existing irregularities in the structure and function of horses' hooves.

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