

Effect of breed, sex, and age, on hooves conformation in local Iraqi Arabian horses

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Abstract

The study was conducted on (50) Iraqi Arabian horses of different colors, age groups and sub-breeds (Saklawi (S), Kehalan (K), Hamadani (H), and Mauniqi (M)). The linear measurements of hoof which were studied: hoof length (HL), hoof width (HW), hoof height (HH), hoof circumference (HC) toe length (TL), quarter length (QL), heel length (HeL), heel height (HeH), frog length (FL) and frog width (FW). The study showed many different results submitted to statistical analysis according to (ANOVA) program at $P < 0.05$. The HL and HW in S sub-breed showed significant differences (SD) between fore and hind limbs. There were SD in the HH of both limbs between (H, S) and (M, K). The HC of the forelimbs, there were SD between S and other sub-breeds, while the hind limbs there were SD between (H, K) and other sub-breeds. The TL of the forelimbs were SD between (H,S) and other sub-breeds, but there were SD between (H,M) and other sub-breeds. The QL of the forelimbs were SD between M and other sub-breeds, while the hind limbs were SD between (H, K) and other sub-breeds. The HeL of the fore limbs were SD between M and other sub-breeds. The HeH of the fore limbs were SD between (H, S) and other sub-breeds, while in the hind limbs, there were SD between M and (H, K). The FL of the forelimbs and hind limbs were SD between M and other sub-breeds. The FW of the hind limbs were SD between (H, K) and other sub-breeds, while in the hind limbs, there were SD between M and other subbreeds. The HeL of the forelimbs showed SD between ((group (6-9 years), and group (above 9 years)) and other age groups, while the HW of the hind limbs were SD between group (above 9 years) and other age groups. The study results showed that the breed and age effected on the hooves conformation and Al-Saklawi had the highest hoof dimensions in general, which refer that the Iraqi Arabian Horses are nearly pure Arabian horses, while sex, and limb type have no effect on hooves conformation.

Keywords: Hooves conformation, hoof, Iraqi horses, Arabian horses.

تأثير السلالة والجنس والعمر على التكوين الخلقي لحوافر الخيل المحلية العراقية

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الخلاصة

شملت الدراسة (50) جوادا عربيا عراقيا من مختلف الانسال (الصقلاوي ، الكحيلان ، الحمداني ، المعنقي) ، وكانت ذات ألوان مختلفة وقسمت الخيل الى مجاميع بأعمار مختلفة. سجلت القياسات الخطية للحافر كما يلي: طول الحافر و عرض الحافر و ارتفاع الحافر و محيط الحافر و طول مقدم الحافر و الطول الرباعي للحافر و طول عقب الحافر و ارتفاع عقب الحافر و طول النسر و عرض النسر. أظهرت الدراسة نتائج كثيرة ومختلفة تم تحليلها إحصائيا وحسب برنامج (ANOVA) باتجاه واحد بمستوى 0.05 فقد سجل طول و عرض الحافر لسلالة الصقلاوي اختلافا معنويا بين القوائم الأمامية والخلفية. وكان اختلاف ارتفاع الحافر معنويا في كلا الاطراف الامامية والخلفية بين انسال (الصقلاوي والحمداني) مع (المعنقي والكحيلان). ولقد سجل محيط الحافر في القوائم الأمامية للصقلاوي اختلافا معنويا مع باقي الانسال ، بينما في القوائم الخلفية للحمداني والكحيلان فقد سجل اختلافا معنويا مع الانسال الاخرى. كما سجل طول مقدمة الحافر في القوائم الأمامية ل (الحمداني والصقلاوي) اختلافا معنويا مع باقي الانسال ، ولكن الحمداني والمعنقي سجلا

اختلافاً معنوياً مع الانسال الأخرى. ولقد سجل الطول الرباعي للحافر في القوائم الأمامية اختلافاً معنوياً بين المعنقي وباقي الانسال ، بينما في القوائم الخلفية فقد سجل اختلافاً معنوياً بين (الحمداني والكحيلان) مع الانسال الأخرى. كما سجل طول عقب الحافر في القوائم الأمامية اختلافاً معنوياً بين المعنقي وباقي الانسال. وكذلك سجل ارتفاع عقب الحافر في القوائم الأمامية ل(الحمداني والصقلاوي) اختلافاً معنوياً عن الانسال الأخرى ، بينما في القوائم الخلفية للمعنقي فقد سجل اختلافاً معنوياً مع (الحمداني والصقلاوي). ولقد سجل طول النسر للقوائم الأمامية والخلفية اختلافاً معنوياً بين المعنقي وباقي الانسال. سجل عرض النسر في القوائم الأمامية ل(الحمداني والكحيلان) اختلافاً معنوياً مع الانسال الأخرى ، اما في القوائم الخلفية فقد سجل اختلافاً معنوياً بين المعنقي وباقي الانسال. وكذلك سجل طول الحافر في القوائم الأمامية ل(مجموعة 6)- (9سنوات) ومجموعة (أكثر من 9سنوات) اختلافاً معنوياً مع المجاميع العمرية الأخرى. وقد سجل عرض الحافر في القوائم الخلفية لمجموعة (أكثر من 9سنوات) اختلافاً معنوياً مع باقي المجاميع. بينت نتائج الدراسة ان السلالة والعمر يؤثران على التكوين الخلقي للحوافر ، وان الصقلاوي بصورة عامة امتلك أعلى قياسات في ابعاد الحافر والتي تشير الى ان الخيل العراقية العربية هي تقريبا خيل عربية اصيلة. بينما الجنس ونوع القوائم لم تؤثر على التكوين الخلقي للحوافر. الكلمات المفتاحية: التكوين الخلقي ، الحوافر ، الخيول العراقية ، الخيول العربية ، الخيل.

Introduction

Arabian horses are the most beautiful and highest performance than the other breeds. The foot of the horses is a complex organ which is frequently responsible for lameness (1). The hooves are one of the most important factors which decide on the horse's value. They play a crucial role in the organism supporting it, absorbing concussion, preventing skids and protecting the sensitive portions of the digit (2). The front hoof capsules have shorter heel length and different hoof angles than that of hinds (3), (4) Viewed from the solar surface, the fore hooves are wider and more round than the hind hooves which are narrower and more triangular or peer shaped (5), (6) Announce the fronts hooves have less concave sole, shorter and broader frog, as well as more shallow frog commissures (4). The poor conformation and imbalance in forelimbs had the most importance since 60% of weight was supported on them (7). American studies show that the horn in front hooves grow 12% slower than that in hind hooves in suckling, 7% lower in weanlings and in older animals the tendency is opposite: it grows 6% faster than that in hinds (8). Heritability coefficient of hoof conformation traits ranges from 0.16 for heel height to 0.27 for hoof shape (9). Apart from the length, the hoof size is usually judged subjectively. There is no commonly assumed parameter which would show univocally whether the hoof is big or small relative to the horse's size. It is necessary to point which hoof is considered since in spite of high correlation between the fore and hind hoof dimensions, differences related to specific functions of fore and hind limbs are known (10), (11) Affirm the hoof

absolute size is measured in various ways. The width is the most characteristic hoof dimension with respect to the breed (12). In the analysis of the hoof size relative to the body size, besides various types of horses, the age of animals should be taken into account. The size of the hoof raises up to the age of six years and bigger hooves in older horses grow slower. The hoof wall length grows 0.5mm daily in suckling and 0.2mm in adults (3). According to our knowledge, there are no any researches define the differences of hooves measurements between Arabian sub-breeds (Saklawi, Kihalan, Hamadani, Mauniqi), ages and sex. The objective of the study was to know the effect of sub-breed, age, and sex factors on hooves conformation in local Iraqi Arabian horses.

Materials and methods

The study was conducted during March and April of the year on (50) Iraqi Arabian horses of different sub-breeds (Saqlawi, Kehalan, Hamadani, and Muniqi). Their ages are classed into different groups (1-3) years, (3-6) years, (6-9) years and (above 9) years. Their colors are different (white, black, red and brown) (Table 1). These horses have the same feeding protocol (grains, alfalfa and hay) with ad libitum water. Their hooves are trimmed routinely (3) months interval. The linear measurements of hoof are measured with a plastic tape (1cm accuracy), as below, and the results were analyzed by one way analysis of variance (ANOVA) test at $P < 0.05$ level of significance.

Measurements of hoof

1-Hoof length (HL): The distance from the toe to the buttress line of the heels.

2-Hoof width (HW): The distance measured from the widest part of the solar surface.

3-Hoof height (HH): The distance from the rim of coronary band to the ground surface.

4-Hoof circumference (HC): The distance around the hoof wall.

5-Toe length (TL): The distance from coronary rim to the center of the toe.

6-Quarter length (QL): The distance between the quarter sides of the hoof.

7-Heel length (HeL): The length of the wall at the heel.

8-Heel height (HeH): The distance from the lower point of the coronary band to the ground surface.

9-Frog length (FL): The distance from the apex of the frog to the buttress of heel.

10-Frog width (FW): The distance of the widths line at the base of frog.

Table 1: Shows the total numbers, sub-breeds, ages, sex and colors of horses.

Total no.	Sub-breeds	No.	%	Ages (years)	No.	%	Sex	No.	%	Colors	No.	%
50	Muniqi	9	18	2-3	5	10	Male	14	28	White	18	36
	Hamadani	14	28	3-6	14	28	Female	36	72	Black	4	8
	Kehalan	17	34	6-9	19	38				Red	12	12
	Saklawi	10	20	Above 9	12	24				Brown	16	16

Results

Table 2 showed that only the (HL) and (HW) are statistically significant at $P < 0.05$ in Saklawi between fore and hind limbs. The (HH) of the both limbs were registered no significant differences between Hamadani and Saklawi, but there were significant differences between them and Muaniqui, and Kehalan. The (HC) of the forelimbs, were significant between Saklawi and other sub-breeds while the (HC) of the hind limbs, were non-significant between Hamadani and Kehalan, but significant with other sub-breeds. The (TL) of the forelimbs, were non-significant differences between Hamadani and Saklawi, but there were significant differences with other sub-breeds, while there were no significant differences between Muaniqui and Hamadani but there were significant differences with other sub-breeds. The (QL) of the forelimbs, were significant differences between Muaniqui and the other sub-breeds, while the (QL) of the hind limbs, were non-significant between Hamadani and Kehalan, but there were significant with other sub-breeds. The (HeL) of the fore limbs, were significant between Muaniqui and all the other sub-breeds. The (HeH) of the fore limbs, were non-significant between Hamadani and Saklawi, but significant with other sub-breeds, while the (HeH) of the hind limbs, were non-significant between

Hamadani and Kehalan, no significant differences between Hamadani and Saklawi, but there were significant with Muaniqui. The (FL) of the forelimbs, were significant between Muaniqui and all the other sub-breeds. The (FL) of the hind limbs, were non-significant between Hamadani and Kehalan, no significant between Kehalan and Saklawi, but there were significant between Muaniqui and all the other sub-breeds. The (FW) of the forelimbs, were non-significant between Hamadani and Kehalan, but there were significant between them and the other sub-breeds. The (FW) of the hind limbs, were significant between Muaniqui and the other breeds. Table 3 shows no any significant differences between all mean values of the hooves measurements according to the limbs (fore and hind limbs). Table 4 shows no significant differences between the (6-9) years and (above 9) years group, but there were significant differences with the other ages of (HL) of the forelimbs. The (HW) of the hind limbs, were significant differences between group (above 9) years and the other groups of age. While there were no significant differences between the means of the rest hooves measurements. Table 5 shows no significant differences between all the mean values of the hooves measurements according to the sex.

Table (2): Hooves measurements (cm) ($M \pm SE$) of both limbs according to the sub-breeds.

Sub breed	HL		HW		HH		HC		TL		QL		HeL		HeH		FL		FW	
	Fore	Hind	Fore	Hind	Fore	Hind	Fore	Hind	Fore	Hind	Fore	Hind	Fore	Hind	Fore	Hind	Fore	Hind	Fore	Hind
Mauniqi	8.0 \pm 0.89a	12.94 \pm 0.13a	12.02 \pm 0.38a	10.9 \pm 0.31ab	7.56 \pm 0.24a	8.1 \pm 0.25a	32.37 \pm 0.48a	30.63 \pm 0.55a	9.95 \pm 0.26a	8.48 \pm 0.3a	11.76 \pm 0.25a	10.92 \pm 0.29a	4.35 \pm 0.12a	3.83 \pm 0.14a	4.33 \pm 0.11a	3.96 \pm 0.1a	8.13 \pm 0.14a	7.63 \pm 0.14a	4.2 \pm 0.09a	3.77 \pm 0.13a
Hamadani	7.97 \pm 0.13a	12.33 \pm 0.18a	12.65 \pm 0.18a	11.06 \pm 0.23ab	9.16 \pm 0.18b	8.4 \pm 0.2abc	32.93 \pm 0.32a	32.42 \pm 0.62b	9.17 \pm 0.13b	8.76 \pm 0.11a	12.93 \pm 0.18b	11.81 \pm 0.22b	5.42 \pm 0.14b	4.87 \pm 0.13b	4.97 \pm 0.08b	4.62 \pm 0.11bc	8.74 \pm 0.16b	8.22 \pm 0.16b	4.8 \pm 0.1b	4.42 \pm 0.1b
Kehalan	8.17 \pm 0.13a	12.97 \pm 0.13a	12.55 \pm 0.21a	11.58 \pm 0.23a	8.41 \pm 0.14c	7.92 \pm 0.14b	32.92 \pm 0.12a	32.21 \pm 0.15b	11.08 \pm 0.14c	10.4 \pm 0.1b	12.98 \pm 0.1b	11.72 \pm 0.21b	5 \pm 0.09c	4.67 \pm 0.07b	4.7 \pm 0.08c	4.42 \pm 0.07b	8.86 \pm 0.07b	5.51 \pm 0.08bc	4.67 \pm 0.08b	4.41 \pm 0.08b
Saklawi	8.32 \pm 0.1a	10.89 \pm 0.89b	11.19 \pm 0.11b	10.87 \pm 0.09b	9.23 \pm 0.1b	8.92 \pm 0.11c	34.2 \pm 0.21b	33.78 \pm 0.24c	11.65 \pm 0.13b	11.4 \pm 0.12c	13.19 \pm 0.11b	12.92 \pm 0.11c	4.95 \pm 0.06c	4.71 \pm 0.07b	5.06 \pm 0.06b	4.88 \pm 0.07c	8.95 \pm 0.11b	8.8 \pm 0.1c	5.07 \pm 0.1c	4.87 \pm 0.1d

Similar letters mean no significant differences

Table (3): Hooves measurements (cm) ($M \pm SE$) according to the limb.

Limb	HL	HW	HH	HC	TL	QL	HeL	HeH	FL	FW
Fore limb	8.12 \pm 0.06a	12.21 \pm 0.13a	8.36 \pm 0.12a	33.08 \pm 0.15a	10.45 \pm 0.15a	12.76 \pm 0.1a	4.99 \pm 0.07a	4.78 \pm 0.05a	8.71 \pm 0.07a	4.7 \pm 0.06a
Hind limb	12.38 \pm 0.21a	11.17 \pm 0.12a	8.26 \pm 0.1a	32.29 \pm 0.24a	9.84 \pm 0.16a	11.81 \pm 0.14a	4.56 \pm 0.07a	4.48 \pm 0.06a	8.3 \pm 0.08a	4.39 \pm 0.06a

No significant differences between all

Table (4): Hooves measurements (cm) ($M \pm SE$) according to age.

Age	HL		HW		HH		HC		TL		QL		HeL		HeH		FL		FW	
	Fore	Hind	Fore	Hind	Fore	Hind	Fore	Hind	Fore	Hind	Fore	Hind	Fore	Hind	Fore	Hind	Fore	Hind	Fore	Hind
1-3 years	7.4 \pm 0.09a	12.72 \pm 0.18a	12.8 \pm 0.25a	11.66 \pm 0.25a	8.68 \pm 0.27a	8.24 \pm 0.29a	33.42 \pm 0.3a	32.44 \pm 0.22a	10.66 \pm 0.35a	10.08 \pm 0.22a	12.82 \pm 0.39a	11.3 \pm 0.52a	5.18 \pm 0.27a	4.88 \pm 0.28a	4.86 \pm 0.17a	4.64 \pm 0.14a	8.88 \pm 0.14a	8.56 \pm 0.12a	4.66 \pm 0.1a	4.26 \pm 0.15a
3-6 years	7.8 \pm 0.07b	12.58 \pm 0.39a	12.37 \pm 0.26a	11.39 \pm 0.24a	8.63 \pm 0.22a	8.21 \pm 0.16a	32.61 \pm 0.35a	32.37 \pm 0.72a	10.15 \pm 0.34a	9.59 \pm 0.34a	12.85 \pm 0.17a	11.97 \pm 0.22a	5.06 \pm 0.11a	4.61 \pm 0.13a	4.79 \pm 0.01a	4.47 \pm 0.11a	8.66 \pm 0.28a	8.31 \pm 0.28a	4.62 \pm 0.4a	4.32 \pm 0.13a
6-9 years	8.27 \pm 0.08c	12.25 \pm 0.4a	12.11 \pm 0.25a	11.28 \pm 0.18a	8.73 \pm 0.22a	8.5 \pm 0.17a	33.17 \pm 0.25a	32.29 \pm 0.34a	10.75 \pm 0.23a	10.12 \pm 0.26a	13.68 \pm 1.4a	12.01 \pm 0.24a	4.86 \pm 0.12a	4.51 \pm 0.13a	4.8 \pm 0.08a	4.52 \pm 0.1a	8.65 \pm 0.42a	8.36 \pm 0.08a	4.81 \pm 0.57a	4.53 \pm 0.11a
Above 9 years.	8.5 \pm 0.09c	12.16 \pm 0.4a	11.92 \pm 0.22a	10.51 \pm 0.21b	8.45 \pm 0.24a	8.05 \pm 0.22a	33.35 \pm 0.28a	32.17 \pm 0.31a	10.25 \pm 0.34a	9.66 \pm 0.33a	12.68 \pm 0.2a	11.62 \pm 0.26a	5.04 \pm 0.18a	4.55 \pm 0.15a	4.71 \pm 0.13a	4.39 \pm 0.13a	8.8 \pm 0.5a	8.19 \pm 0.13a	4.64 \pm 0.43a	4.31 \pm 0.14a

Table (5): Hooves measurements (cm) ($M \pm SE$) according to sex.

Sex	HL		HW		HH		HC		TL		QL		HeL		HeH		FL		FW	
	Fore	Hind	Fore	Hind	Fore	Hind	Fore	Hind	Fore	Hind	Fore	Hind	Fore	Hind	Fore	Hind	Fore	Hind	Fore	Hind
Male	8.1 \pm 0.14a	12.4 \pm 0.35a	11.9 \pm 0.29a	109.7 \pm 0.22a	8.64 \pm 0.24a	8.35 \pm 0.22a	33.19 \pm 0.25a	32.25 \pm 0.32a	10.54 \pm 0.28a	9.9 \pm 0.33a	12.84 \pm 0.23a	12.12 \pm 0.27a	4.94 \pm 0.14a	4.5 \pm 0.14a	4.77 \pm 0.12a	4.54 \pm 0.11a	8.6 \pm 0.14a	8.3 \pm 0.18a	4.74 \pm 0.12a	4.47 \pm 0.12a
Female	8.17 \pm 0.07a	12.1 \pm 0.44a	12.0 \pm 0.21a	11.1 \pm 0.21a	8.55 \pm 0.18a	8.38 \pm 0.12a	33.2 \pm 0.29a	32.11 \pm 0.39a	10.65 \pm 0.24a	10.11 \pm 0.26a	12.59 \pm 0.15a	11.78 \pm 0.24a	5.05 \pm 0.13a	4.67 \pm 0.13a	4.74 \pm 0.09a	4.43 \pm 0.1a	8.65 \pm 0.12a	8.23 \pm 0.13a	4.62 \pm 0.1a	4.31 \pm 0.12a

No significant differences between all

Discussion

The results in current study agree with the results of (13) who demonstrated that Al-Saklawi has the highest hoof measurements in general. Present investigations of all local Iraqi Arabian sub-breeds agree with (14) who revealed that the cold-blood horses have the biggest capsules, widest hooves and fore limbs hooves are wider than that of hinds, while the Arabians hooves are the smallest, the mean toe length in hind hooves in comparison with fore hooves is slightly higher in Arabians while that mean is lower in the cold blood breeds. The mean rear hoof width in comparison to fore hoof width is slightly higher in Arabians than in other breeds. The higher incidence of chronic lameness in fore limbs and fore hoof injuries occur because forelimbs subject to greater kinematic stress and ground reaction forces, which lead to injuries in navicular bone (15) and deep flexor tendon (16) and also (17) revealed that the laminitis is more common in the front hooves than that in hind hooves. (18) revealed that the body weight and proportions differ between various breeds of horses, so the front limb load differs, it is relatively lower in warm-blood Arabian horses than in cold-bloods, so the horses with shorter trunk are less sensitive to injuries in forelimbs than horses with taller trunk, and (19) showed the injuries in navicular bone of fore limb occur in higher degree in early maturing horses, like thorough breeds, as opposed to lately maturing ones, for example Arabian sub-breeds. (12) revealed that the hoof width represent the best dimension for the hoof size, and the ratio of hoof width to chest circumference represent the more dependent measure of the hoof and horse size, but Arabian mares differ from other breeds, having relatively larger chest circumference and shorter toes (20). (21) revealed that the bone dimension correlated with the hoof size some American breeds are selected for aesthetic reasons because they have small feet, but the hooves are lengthened in show breeds to get flashy gaits. The lengthening of the hoof increases the vertical velocity of hoof and maximum height of the hoof in flight and delays the break over (22). The method of trimming to

get maximum hoof length in some breeds proportionate with horse body weight to prevent horse abuse (23). The present results in the study disagree with the results of (2) who demonstrated that the toe to heel length (HL) ratio approximates 2:1 in both hooves (fore and hind limbs). Also the (HL) of the forelimb is highest than that of hind limb, this result disagree with the results of this study, while the (HW) is accompanied with the results of this study, so this is other results which mentioned above represent evidences that the Iraqi Arabian horses are nearly pure Arabian horses. (24) and (25) revealed that the changes in ratio of heel to toe heights will effect on the forces applied on the foot, so experimentally the raising of heels led to lower stress while lowered heels result in higher stress in the hoof capsule. According to (14), the heel length is about one-third of the toe length, while (3), found that the ratio of toe to heel length is 2:1 in rear hoof and 3:1 in fore hoof, whereas (2) demonstrate that the ratio in length between toe and heel is 3:1 in fore hoof and 2:1 in rear hoof in tow cold-blood breeds, whereas in Arabians is (1,8 in front foot and 1,9:1 in rear hoof) and this refer that the cold- blood breeds have short heel, while the heel length is near to toe length in Arabian breeds and this agree with our study which represent another evidence that the Iraqi Arabian horses are nearly pure Arabian horses. By viewing the hoof from solar surface, it is found that the rear hoof is wider at heel buttress relative to front hoof. There are incorrect thought for centuries that the normal hoof angle is 45 degrees in fore hoof angle, while in fact the mean is 54 degrees (26), While (5) found that the narrower rear hoof has larger buttress distance relative to hoof width, in comparison to fore hooves so the posterior portion of the rear hoof is slightly wider relative to front hoof, which result in more peer-shaped rear hoof solar side of capsule which is important in kinematics of the rear limb which act as an engine showing more stability and power for pushing off to the suspension phase, while the fore hoof is more round and wider at middle portion result in better support at

landing due to (18) reveal that the shorter rear hoof solar length and smaller hind hoof width which result in smaller solar surface in the rear hoof than that in the fore hoof, and this proportionate to the lesser body weight percentage carried by the rear hooves. The fore hoof has shorter frog and heel length and different hoof angles and wider frog than rear hooves (4). The front limbs carrying more weight represented by horse head and neck, in a warm-blood horse loaded with 57% (mares) to 58.7% (stallions) body mass (18). During movement, the fore limbs mainly absorb the shock of landing, while the rear limbs are more active in pushing the horse forward. The results shows no significant differences between different hooves measurements according to the age except (HL) of the fore limb. Above 9 years record the highest value of (HL) of the fore limb, may be due to direct relationship between hoof measurements and the age. Few significant difference is found in the ratios between particular age groups indicate that the age hardly affects the relative hoof size since (4) years old. So the results of the study agree with the results of (20) who found that the relative size is rather constant

since the age of 4-6 years and revealed that the age affects the hoof solar size to height at withers ratio in horses since four to nine years old, and also he found that the hoof to body dimension ratios were similar in consecutive age groups, also (8) showed that the hoof continues to increase in size until the age of six years and revealed that the age of animals should be taken into account in analysis of the hoof size relative to the body size in various breeds of horses so he demonstrated that the size of the hoof raises up to the age of six years and larger hooves in older horses grow slower, the hoof wall length grows 0.2 mm daily in adults and 0.5 mm in suckling. The recent results disagree with (2) who revealed that the ratio in the hoof dimensions have not shown any considerable changes since the age of four years. The results show that the sex have no any effect on the hoof parameters. This fact indicate that all the sub-breeds of Arabian horses have no genetic variations, and these results agree with (20) who demonstrated that the sex dimorphism in horses is not distinct, so it may be expected that in females the ratios of the hoof size to the horse body size approximate those of males.

References

- 1-Leach DH, Crawford WH (1983) Guidelines for the future of equine locomotion research. *Eq. Vet. J.* 15(2):93-102.
- 2-Stachurska A, Kolstrung R, Pieta M, Silmanowicz P, Klimorowska A (2008) Differentiation between fore and hind hoof dimensions in the horse (*Equus Caballus*). *Arch. Tierz, Dummerstorf* 51:6:531-540.
- 3-Hertsch B, Hoppner S, Dallmer H (1996) The hoof and how to protect it without nails. *Salzhausen-Putensen*, 14(in German).
- 4-Kolstrung R, Silmanowicz P, Stachurska A (2004) Horse hoof care and shoeing. *Warszawa* (in polish).
- 5-Back W (2001) Intra-limb coordination: the forelimb and the hind limb. In: Back W, Clayton H.M.(Eds.) *Equine Locomotion*. London 95-133.
- 6-Kaneps AJ, Turner T A (2004) Diseases of the foot. In: Hinchcliff K W, Kaneps A J and Geor R J (Eds.): *Equine Sports Medicine and Surgery*. Edinburgh, 260-289.
- 7-Melo UP, Ferreira C, Santiago R M F W, Palhares M S, Maranhao R P A (2006) *Equilibrio do casco*. *Ciencia Animal Brasileira*, 7 (4): 389-398.
- 8-Butler D, (1995) The principles of horse shoeing 11.Laporte,137-138.
- 9-Duero B J, Bovenhuis H, Back W (2009) a-Heritability of foot conformation and its relationship to sport performance in a Dutch warm blood horse population. *Equine Veterinary journal* 41(2):139-143.
- 10-Back W, Schamhard H, Hartman W, Barneveld A (1995) Kinematic differences between the distal portion of the forelimbs and hind limbs of horses at the trot. *American Journal of Veterinary Research* 56(11):1522-1528.
- 11-Gustas P, Johnston C, Roepstorff L, Drevemo S, Lanshammar H (2004) Relationships between fore and hind limb ground reaction force and hoof deceleration patterns 36 (8):737-742.
- 12-Stachurska A, Kolstrung R, Pieta M, Silmanowicz P, Klimorowska A (2008) Differentiation between fore and hind hoof dimensions in the horse (*Equus caballus*). *Archiv. fur Tierzucht* 51(6):531-540.
- 13-Allowi L D, AL-Khauzai Amir I. Towfik, Abdul-Satar S Hamza (2014) Study the effect of some factors on the conformation of Iraqi Arabian horses. *Kufa Journal for Veterinary Medical Sciences* 5(1): 85-97.
- 14-Turner TA (2003) Objective assessment hoof balance. *Equine podiatry*. Noethern Virginia.

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- 15-Viitanen M, Bird J, Smith R, Tulamo RM, May S A (2003) Biochemical characterization of navicular hyaline cartilage, navicular fibro cartilage and the deep digital flexor tendon in horses with navicular disease. *Res. Vet. Sci.* 75:113-120.
- 16-Dyson S, Murray R, Schramme M, Branch M (2003) Lameness in 46 horses with deep digital flexor tendonitis in the digit: diagnosis confirmed with magnetic resonance imaging. *Equine Vet. J.* 35: 681-690.
- 17-Strasser H (2002) Who's Afraid of Founder. *Laminitis Demystified: Causes, Prevention and Holistic Rehabilitation* Selfpublished.
- 18-Sasmowski E, Hulewicz A, Pietrzak S, Maciag J, Kraska R (1984) Variability of gravity center and its connection with rider's seat *Ann. UMCS,EE,II* 26: 243-258.
- 19-Blendinger W (1980) *Gesundheitspflege und Erste Hilfe für das Pferd*. Berlin und Hamburg.
- 20-Stachurska A, Kolstrung R, Pieta M, Silmanowicz P (2011) Hoof size as related to body size in the horse (*Equus caballus*). *Animal Science Papers and Reports* 29(3): 213-222.
- 21-Butler D (1995) The principles of horseshoeing II. *LaPorte*, 137-138.
- 22-Balch O, Clayton H, Lanovaz J (1994) Effect of increasing hoof length on limb kinematics of trotting horses. *Proceedings of Annual Convention of the American Association of Equine Practitioners* 40, 43.
- 23-Lessiter F (1996) Cheek shoeing rules and regulations from 191 horse organization. *American Farrier's Association* 22 (6): 260-277.
- 24-Ellashar E, Mcguigan M P, Wilson A M (2004) Relationship of foot conformation and force applied to the navicular bone of sound horses at the trot. *Equine Vet. J.* 36:431-435.
- 25-Hinterhofer C, Stanek C, Haider H (2000) The effect of flat horses shoes, raised heels and lowered heels on the biomechanics of the equine hoof assessed by finite element analysis (FEA). *J. Vet. Med. A Physiol. Pathol. Clin. Med.* 47:73-82.
- 26-Clayton H M (1990) Effect of an acute hoof wall angulation on the stride kinematics of trotting horses. *Equine Vet. J.* 9(suppl.): 86-90.