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Original Article

Early Selection According to Repeatability of Body Measurements of Turkish Arabian Foals

Süleyman Çilek

Abstract

In this study, body measurements of Turkish Arabian foals at different ages was obtained from Anadolu state farm in Turkey which included body length, cannon bone circumference, heart girth and withers height measurements. Effects of sex, birth month, birth year and age of foal at different growth periods on withers height, body length, heart girth and cannon bone circumference were significant (p<0.05). Effects of environmental factors on all body measurements were standardized additively. Using intra-class correlation method, repeatability was 0.55 for wither height, 0.47 for heart girth, 0.26 for cannon bone circumference for forelimb and 0.31 for body length. According to moderate level results of repeatability for especially heart girth and wither height measurements, selection of Turkish Arabian foals may be conducted at an early age according to body measurements at 6 months of age.

Keywords: body measurement, early selection, repeatability, Turkish Arabian foals, wither height

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บทคัดย่อ

การคัดเลือกลูกม้าอาหรับตุรกีโดยการวัดร่างกายแบบวัดซ้ำ

Süleyman Çilek

ในการศึกษานี้ ทำการตรวจวัดร่างกายของลูกม้าอาหรับตุรกี ที่อายุต่างๆ จากฟาร์มรัฐ Anadolu ประเทศตุรกี ได้แก่ ความยาวลำตัว เส้นรอบวงกระดูกหน้าแข้ง เส้นรอบอก และความสูงของตะโหงก พบว่าเพศ เดือนเกิด ปีเกิด และอายุของลูกม้าในช่วงเวลาการเจริญเติบโตที่แตกต่างกันมีผลต่อความสูงของตะโหงก เส้นรอบอก และความยาวรอบกระดูกหน้าแข้งอย่างมีนัยสำคัญ ($p<0.05$) ผลของสภาพแวดล้อมที่มีต่อค่าต่างๆ ของการวัดร่างกายมีผลในเชิงบวก จากวิธีการวัดค่าความสัมพันธ์ภายในคลาสเดียวกัน ค่าการวัดซ้ำคือ 0.55 0.47 0.26 และ 0.31 สำหรับความสูงของตะโหงก เส้นรอบอก เส้นรอบวงกระดูกหน้าแข้งของขาหน้า และความยาวลำตัวตามลำดับ จากผลของการวัดซ้ำที่ให้ค่าปานกลาง โดยเฉพาะอย่างยิ่งสำหรับเส้นรอบอก และความสูงของตะโหงก ชี้ให้เห็นว่าการคัดเลือกลูกม้าอาหรับตุรกีสามารถดำเนินการได้ตั้งแต่อายุยังน้อย โดยดูจากค่าของการวัดร่างกายในลูกม้าอายุ 6 เดือน

คำสำคัญ: การวัดขนาดร่างกาย การคัดเลือกเบื้องต้น การวัดซ้ำ ลูกม้าอาหรับตุรกี ความสูงของตะโหงก

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Introduction

Arabian horse has been bred in Arabian half island and Turkey since 2000 BC. Moreover, in origin and breeding of first thoroughbred horses, a lot of Turkish Arabian stallions in Turkey were used, for example, Byerler Turk, Darley Arabian and Godolphine Arabian (Arpacik, 1994; Çilek 2009).

Body measurements of horse can be useful to show their characteristics and general body conformation. Body conformation is useful in the evaluation and comparison of breeds. Beauty of sport horses and their performance are affected by their body conformation. Part of the beauty of the Arabian horse depends on its body conformation, body measurements and the relationships among the body dimensions (Sadek et al., 2006). Besides, wither height of mature horse is positively correlated with racing performance and stride length (Smith et al., 2006).

In Turkey, most of Arabian foals are reared at state farms and sold to horse breeder at auction during their two yearling years. Arabian horses begin their racing careers for speed in 3 years of age. Thus, direct measures of racing performance are not available at the time of purchase. Instead of assessing body measurements at 2 years old, horse breeders subjectively evaluate foals according to body conformation of foals and records of race performance of relatives (foal's mother and father). For centuries, Turks have wanted to breed offspring of stallion's famous race winner and beautiful body structure.

Previous studies were done for the estimation of heritability of body measurements for horse (Pretorius et al., 2004; Bakhtiari and Heshmat, 2009; Gómez et al., 2009). However, there are few studies on repeatability of body measurements for horse. Zechner et al. (2001) reported that repeatability of body measurements based on two repetitions of 100 horses were 0.95 for height at withers and cannon bone circumference for forelimb, and 0.45 for chest girth. Repeatability indicates the possibility of foals to retained its high body measurement at first measurement age until following ages (Ariturk and Yalcin, 1966). Therefore, repeatability of body measurement for foals before auction (2 years old) should be very well known and selection of foals may be objectively done according to this knowledge at early ages. This study aimed to determine the repeatability of body measurements of Turkish Arabian horses.

Materials and Methods

Body measurement records were taken from Anadolu state farm, belonging to the Ministry of Agriculture. Body length, cannon bone circumference, heart girth, and withers height measurements were taken. At least two measurements for each foal were taken at 6 month, 12 months and 24 months of age. Circumference of cannon bone forelimb was the smallest circumference of the cannon bone of forelimb. Heart girth (circumference of chest) was circumference measured from the base of the withers down to behind the front legs, then under the belly and up the opposite side to where it started. Circumference of cannon bone forelimb and heart girth was measured by using plastic measuring tape. Withers height was distance from the highest point of the processus spinali of the second to the sixth

thoracic vertebra to the floor. Body length was distance from the most cranial point of the sternum to the most caudal point of the pin bone. Body lengths and withers heights were measured with measuring stick (Arpacik, 1994; Pretorius et al., 2004). Differences between fillies and colts for means of all the measurements were estimated by using t test in Minitab packet programme (Minitab, 1998).

In calculation of repeatability, a total of 293 records for cannon bone circumference, heart girth, and withers height and 100 records for body length were used. Body measurements of foals which had at least two repetitions were used in calculations. After effects of environmental factors on body measurements were standardized, repeatability was estimated by using intra class correlation method in Minitab package programme (Minitab, 1998; Arıtürk and Yalçın, 1966; Çilek 2002). Standard deviation of repeatability (Sr) was estimated using formula as follow (Arıtürk and Yalçın, 1966; Çilek 2002)

$$r = \frac{ó^2_a}{ó^2_a + ó^2_i}$$

Abbreviations in the formula above means; r: repeatability, σ^2a: between groups (foals) variance, σ^2i: within groups (foals) variance

$$k = \frac{\Sigma n - \frac{\Sigma n_i^2}{\Sigma n}}{N-1}$$

k: average record number for each foal, n_i: record number for any foal, Σn: total record number, N: total foal number (group)

$$S_r = \sqrt{\frac{(1-r)[1+(k-1)r]}{1/2\, k(k-1)(N-1)}}$$

Abbreviations in the formula above means; r: repeatability, k: average record number for each foal, N: total foal number

Table 1 Descriptive statistics of body measurements (cm)

Variable	Foal sex	n	Mean	Median	SD	SE Mean	Importance level
6 months of age							
Withers Height	Filly	68	129.4	129.0	4.1	0.5	*p*=1.0
	Colt	70	129.4	129.0	3.8	0.5	
Heart Girth	Filly	68	141.8	142.0	4.9	0.6	*p*=0.3
	Colt	70	140.9	141.5	6.0	0.7	
Cannon Bone Circumference	Filly	68	16.4	16.0	0.8	0.1	*p*=0.6
	Colt	70	16.3	16.0	0.9	0.1	
Body Length	Filly	20	120.9	121.0	2.8	0.6	*p*=0.7
	Colt	23	121.3	121.0	4.8	1.0	
12 months of age							
Withers Height	Filly	63	141.8	141.0	4.2	0.5	*p*=0.9
	Colt	58	141.9	142.0	3.7	0.5	
Heart Girth	Filly	63	157.5	156.0	7.4	0.9	*p*=0.1
	Colt	58	155.2	154.0	7.3	0.9	
Cannon Bone Circumference	Filly	63	18.0	18.0	0.6	0.1	*p*=0.6
	Colt	58	18.0	18.0	0.7	0.1	
Body Length	Filly	18	133.4	132.5	5.4	1.3	*p*=1.0
	Colt	19	133.5	133.0	3.3	0.8	
24 months of age							
Withers Height	Filly	10	148.6	148.0	3.7	1.2	*p*=0.3
	Colt	24	149.8	150.0	2.5	0.5	
Heart Girth	Filly	10	170.0	171.5	3.5	1.1	*p*=0.8
	Colt	24	170.5	170.0	4.1	0.8	
Cannon Bone Circumference	Filly	10	18.5 b	18.5	0.5	0.2	*p*=0.001 ***
	Colt	24	19.5a	20.0	0.8	0.2	
Body Length	Filly	10	138.3	137.5	3.4	1.7	*p*=0.4
	Colt	10	139.6	140.5	2.0	0.6	

Results

Foal number, median, standard deviation and standard error of body measurements according to sex of foals are presented in Table 1. Even though there was no statistically important difference, colts had generally bigger body measurements than fillies. Differences between sexes of foals were statistically significant for cannon bone circumference at 24 months of age (p=0.001). Effects of birth year and age of foal at different growth periods on cannon bone circumference were significant (p<0.001). Effects of birth month, sex, birth year and age of foal at different growth periods on withers height were significant (p<0.05). Effects of birth month, birth year and age of foal at different growth periods on heart girth were significant (p<0.05). Effects of birth month and age of foal at different growth periods on body length were significant (p<0.05). Effective factors on all body measurements were determined additively by using general linear model in Minitab packet programme (Minitab, 1998). Standardization was done by additive adjustment factors. Body measurement records were standardized to birth month, sex, birth year and age of foal, then repeatability of body measurements were estimated.

Average record number for each foal (k) was 2.1. Total variance (σ^2t= 19.1) between groups variance (σ^2a= 10.5) were calculated by using mean squares within groups and between groups in Table 2. Then, repeatability or intra class correlation was calculated as r= 0.55±0.06 by dividing r= σ^2a/σ^2t. Standard deviation of repeatability (SDr=0.06) was calculated. Average record number for each foal (k) was 2.1. Total variance (σ^2t= 38.9) between groups variance (σ^2a= 18.2) were calculated by using mean squares within groups and between groups in Table 2, then, repeatability or intra class correlation was calculated as r = 0.47± 0.06 by dividing r = σ^2a / σ^2t. Standard deviation of repeatability (SDr= 0.06) was calculated.

Table 2 Variance analyze of body measurements

Source	DF	Means of Squares (MS)	F
Withers Height			
Between foals	137	30.7	$\sigma^2_i + k\sigma^2_a$
Within foals	155	8.6	σ^2_i
Total	292		
r	0.55±0.06		
Heart Girth			
Between foals	137	59.0	$\sigma^2_i + k\sigma^2_a$
Within foals	155	20.7	σ^2_i
Total	292		
r	0.47±0.06		
Cannon Bone Circumference			
Between foals	137	1.2	$\sigma^2_i + k\sigma^2_a$
Within foals	155	0.7	σ^2_i
Total	292		
r	0.26±0.08		
Body Length			
Between foals	45	21.5	$\sigma^2_i + k\sigma^2_a$
Within foals	54	11.0	σ^2_i
Total	99		
r	0.31±0.13		
Average record number (k)	2.1		

Total variance (σ^2t= 0.94) between groups variance (σ^2a= 0.24) were calculated by using mean squares within groups and between groups in Table 2, then, repeatability or intra class correlation was calculated as r= 0.26±0.08 by dividing r= σ^2a/σ^2t. Standard deviation of repeatability (SDr = 0.08) was calculated. Total variance (σ^2t=16) between groups variance (σ^2a= 5) were calculated by using mean squares within groups and between groups in Table 2, then, repeatability or intra class correlation was calculated as r= 0.31±0.13 by dividing r= σ^2a/σ^2t. Standard deviation of repeatability (SDr= 0.13) was calculated. In this study, results of repeatability of body measurements for horse were summarized in Table 3.

Table 3 Repeatability of body measurements

Some Body Measurements	Record number	r
Withers Height	293	0.55±0.06
Heart Girth	293	0.47±0.06
Cannon Bone Circumference	293	0.26±0.08
Body Length	100	0.31±0.13

Discussion

Previous reports showed that repeatability of body measurements was at high level or at moderate level by using different number of records in different species, and breeds (Williams et al., 1979; Zechner et al., 2001; Şireli and Ertuğrul, 2005; Schroderus and Ojala, 2010; Suontama et al,. 2011). Differences of repeatability may be associated with both different breeds and different environmental conditions because of difference in genotypic variations, phenotypic variations, and variation within animal populations and between animal populations in different regions.

Repeatability was 0.31 for body length, 0.26 for cannon bone circumference, 0.47 for withers height, and 0.55 for heart girth. The estimation for heart girth was similar to previous research (Zechner et al., 2001). But repeatability estimations for cannon bone circumference, body length and withers height were lower than values reported by Zechner et al. (2001). As a result of the small record number for estimating repeatability, estimations may be less than values in previous report (Zechner et al., 2001). Moreover, there is inverse relation between hybrid vigour and heritability or repeatability. However, Arabian horses were bred as pure for centuries, and bred at same environmental conditions in Anadolu

state farm; it is expected to have low repeatability for body measurements.

Repeatability was found at middle level for cannon bone circumference and body length. However, Repeatability was found at a bit higher level for withers height and heart girth. According to these results, selection of Arab breed foals may be conducted at an early age according to withers height and heart girth measurements at 6 months and later ages. Body measurements of Arabian foals increase with age until 3 years old and their racing careers begin at 3 years of age (Arpacık, 1996). As withers height of horse is positively correlated with racing performance, it is preferred that mature horses have high withers height. As repeatability was high level for withers height, foals may be evaluated according to measurement records at 6 month of age in selection. Foals which are expected to have a bigger withers height at mature age can be determined at 6 months of age. At auction, when comparing with the colts at the same age, foals which have bigger measurement are preferred. Foals with high body measurement weaning or 6 months of age have a high possibility to continue this advantage in the following ages. Buyers and sellers can evaluate according to body measurements at 6 months of age before foals are sold at auction during their two yearling years.

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