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Genetic Correlation of Conformation and Race Performance Traits in Iranian Arab Horse Population

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Abstract: Six conformation traits (withers height, body length, hind and fore limb circumference, heart girth circumference and chest depth) were recorded in 240 randomly selected horses. Three race performances (best racing time in distance of 1250 meters (BT1250), best racing time in distance of 1750 meters (BT1750) and best place in distance of 1250 meters (BP1250)) were recorded with race-meeting CD films. Genetically correlations of these traits were estimated with multi traits animal model according Derivative Free-Restricted Maximum Likelihood (DF-REML). Highest and lowest genetic correlations were between, heart girth circumference with BP1250 (-0.848±0.092) and fore limb circumference with BT1250 (-0.062±0.008). In conclusion genetic correlation of conformation traits with race performance traits were high and horses could be selected in early stage of life with conformation traits then it will decrease generation interval and increase genetic gain.

Key words: Arab horse · Conformation traits · Performance traits · Genetic correlation

INTRODUCTION

A horse has been reared for racing, farm animal management, work and etc so the conformation of horses were shaped according the aim of rearing. Conformation of horse includes shape and visible parts which consist of many measurable traits [1-3]. Conformation is the suitable index for selection or elimination of horses also joins with correct and rhythmic moving is the major factor in determination of horse price. Conformation traits have a genetic correlation with other traits especially performance traits, so horse's performance traits can be assessed according their conformation traits in early life time [4] and generation interval will be decrease. Correct and rhythmic moving is important factor in race horses. Suitable performances in race-meeting depend on conformation of legs and shoulder status [5-7]. 8-10 percent of trotter horses and 4-20 percent of riding horse's race-meeting performance is predictable by their body conformation [5]. The positive and highly genetic correlations between conformation and race-meeting traits were reported in previous studies e.g. correlation of legs hardness and number of starts were reported 0.46 [8]. Simplicity measurement, cheap recording tools and use of these traits for indirect assessment of other traits are the three obvious advantages of conformation traits [5]. In overall animals were comparing and assessed according scored (objective) and measured conformation traits. Scored traits were assessed and record with eye according the expert opinion but measurable traits record different parts of body with suitable tools like ruler, tape and photography.

One of the Iranian horse races is Arab horse which their ancestor pedigrees confirm with DNA test by World Arabian Horse Organization (W.A.H.O.). This breed is universally famous according their intellect, good habits, high tolerance and especial conformation. Most of breeders don't familiar with advantage of pure Arab horse breed. Horse races recently were imported and breeders produce crossbred horses. The number of crossbred horses is increase that may be danger problem for purebred of Iranian Arab horse. One of the main problems in horse breeding is generation interval and we can use correlated traits in early life time so scientific and suitable investment program should be taken for conservation of this breed and reaching to universally standards.

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This study was performed to design suitable statistical models for unbiased estimation of phenotypical and genetically correlation between some conformation and performance traits.

MATERIALS AND METHODS

Sample Size Estimation of Body Conformation Traits: The suitable sample size should determine for statistically criteria. Iranian Arab horse population is about 2500. Sample size was determined with this formulate [1,9]:

$$N= (Z_{\beta}+Z_{\alpha/2})^2 (C.V)^2$$

Where,

N: Sample size,

α: Probability of type I error,

β: Probability of type II error,

Z: Normal distribution area withα and β,

C.V.: Coefficient of variation.

Calculation the suitable sample size according this formula need to known the traits mean and C.V. so 13 horse randomly selected and the mean also variance of these traits (Withers height, body length, hind and fore limb circumference, heart girth circumference and chest depth) were calculated. The C.V. shows distribution around the mean and it is unitless so comparable between traits. The traits which had wide C.V. (distribution around mean) were considered as basis of sample size calculation.

As shown in Table (1) body length had the highest C.V. between recorded traits so the information of this trait was used for sample size calculation. In statistical calculation the importance of type 1 error is high.) Probability of type 1 error (α) and probability of type 2 error (β) acceptance were considered 0.05 and 0.20 respectively.

$$\text{So, } Z_{(0.05/2)}=1.96, Z_{0.20}=0.85$$

Sample size was determined basis of the model:

$$N= (Z_{\beta}+Z_{\alpha/2})^2 (C.V)^2 = (1.96+0.85)^2 (5.45)^2 =234.53$$

Recording Body Conformation Traits: At least 240 horses randomly selected from horse breeding centre and horse clubs then conformation traits were recorded.

Performance of horse in race- meeting is affected by different factors mainly body conformation and physiological factors. Conformation traits (Fore and hind limb circumference, Withers height, body length, heart girth circumference and chest depth) were selected according scientific literature and expert opinion. Fore and hind limb circumference directly related to hurting problems of horse so the horses which have a weak fore and hind limb circumference is harmed more than others. Withers height affect length of step and speed. Horse speed related to the strength and consistency of fore and hind limb. Heart girth circumference and chest depth are important traits in providing oxygen and nutrients for racing horse [10]. These traits were recorded according manual on the left side of horses, when they placed in flat and hard place, the used tools was measure tape and ruler. Conformation traits recorded in three provinces (Tehran, Yazd and Khozestan breed centre) in two years (2006 and 2007).

Recording Performance Traits: Photo finish set should use for time of running distance and it has been used in recent years but it doesn't used in this research data. CD and notebook of racing was available. The name, father, mother, owner, sex, breeding place of horse and sometime couch name, cover color and weight of rider were recorded in notebook. Performance data were recorded according racing films and notebooks of 2001 until 2007. Iranian Arab horses racing are doing in three groups, summer (Tehran) winter (Khuzestan) and country. Horses had repeated measurement traits so three traits (best racing time in distance of 1250 meters (BT1250), best racing time in distance of 1750 meters (BT1750) and best place in distance of 1250 meters (BP1250)) that had many observations were selected as a performance traits that they related to race-meeting performance [5,8] (Table 3). The best performance of those traits for each horse was considered.

Xing Empeg player software package [10] was used to record performance traits. Each rider was wearing a different color cover and each horse had a number covering her body so each horse was distinguishable with its body number cover and rider cover. Post position has highest 12 places that each horse individually and randomly placed in each time.

Iranian Arab Horse Ancestor Pedigree: Ancestor pedigree information is presented in Table 2. Pedigree file were prepared with two ancestor book which provided by Iranian rider federation [11,12]. Ancestor books have only confirmed horse information by WAHO with DNA test.

Table1: Mean, standard error and C.V. of recorded traits

Traits	Mean	Standard error	C.V.
Withers height	150.13	5.46	3.64
Body length	151.71	8.24	5.45
Hind limb circumference	21.15	0.79	3.75
Fore limb circumference	18.70	0.89	4.78
Heart girth circumference	166.81	7.10	4.26
Chest depth	71.32	2.71	3.80

Table 2: Pedigree information of Iranian Arab horse

No. animals in total	No. sires in total	No. dams in total	No.animal with progeny	No.animal without progeny	No.animal with unknown sire	No. animal with unknown dam	No. base animals	No. base sires	No. basedams
2522	413	870	1283	1239	1	5	566	209	357

Table 3: Mean and standard error of conformation and performance traits

	BP1250	BT1750	BT1250	B.L.	C.D.	FLC	BLC	W.H.	HGC
No.	211	71	201	241	240	241	240	242	240
Mean	1.65	129.7	88.29	148.54	70.22	18.34	20.19	149.17	169.5
S.E.*	0.11	0.71	0.25	0.46	0.21	0.06	0.06	0.33	0.50

S.E.: standard error, B.L.: Body length, C.D.: Chest depth, F.L.C.: Fore limb circumference, B.L.C.: Back limb circumference, W.H.: Whither height and H.G.C.: Heart girth circumference

The available information of these books is name, father, mother, birth date and sex of horse. Data of 15 generation were studied and birth date of oldest horse was 1952 that it was first horse with serial number one. Pedigree files had the name of horse and the name of her/his father and mother name so for statistical analysis the alphabet were convert to number with Matvec software package [13].

Statistical Model: Suitable statistical models should design to estimation of variance components and genetically parameters so general linear models procedures were used to determine the effects of fixed effects and covariates on traits with SAS software package [14].

Effects for Body Conformation Traits in Statistical Model: Fixed effects on conformation traits were age, sex, body color, strain and rearing province. Fixed effects were divided as age (one until eight and more than eight years old), sex (male and female), body color (6 levels), strain (Vazne Khersan, Koheilan, Obayan, Saglavi, Hamdani, Hadban, Jelfan, Moangi and Showeyman [15] and rearing provinces (9 levels). Covariates were inbreeding coefficient and effects of owner. Different rearing methods of owner can be affect traits but inclusion this effect as fixed will decrease mean square of experimental error in ANOVA and will increase probability of type II error because the number of owner is high so considered as covariate.

Effects for Performance Traits in Statistical Model: Fixed effects on performance traits were post position (12 levels), age at racing time (three until eight and more than eight years old) and other effects like body conformation traits. Covariates of performance traits were inbreeding coefficient, owner and weight of rider. Quality of racing condition, land of racing, number of contributed horse and other unknown effects were different in each race that can affect performance traits. Total numbers of racing were 258.

Animal Model: Multi traits animal model according Derivative Free-Restricted Maximum Likelihood (DF-REML) [16] were used to calculation genetically correlation of body conformation traits with performance traits. A convergent iteration criterion was 10^{-8}. Multi traits animal model was:

Table 4: Genetically and phenotypical correlation of conformation and performance traits

	BP1250		BT1750		BT1250	
	Phenotypical	Genetically	phenotypical	genetically	phenotypical	genetically
B.L.	-0.170±0.016	-0.539±0.085	0.200±0.083	0.548±0.127	-0.084±0.009	-0.127±0.019
W.H.	-0.069±0.008	-0.673±0.096	0.210 ±0.078	0.624 ±0.106	-0.045±0.006	0.159±0.021
H.G.C.	0.026±0.005	-0.848±0.092	-0.064±0.009	0.397±0.094	-0.323±0.087	-0.341±0.095
C.D.	0.053±0.007	-0.752±0.089	-0.258±0.086	-0.467±0.122	0.071±0.006	-0.123±0.032
F.L.C.	-0.036±0.006	-0.385±0.056	0.025±0.009	-0.299±0.098	-0.077±0.008	-0.062±0.008
B.L.C.	-0.189±0.030	-0.668±0.082	0.181±0.097	-0.321±0.099	-0.035±0.005	-0.557±0.048

B.L.: Body length, W.H.: Whither height, H.G.C.: Heart girth circumference, F.L.C.: Fore limb circumference, F.L.C.: Fore limb circumference and B.L.C.: Back limb circumference.

$$\begin{pmatrix} y_1 \\ y_2 \\ . \\ y_n \end{pmatrix} = \begin{pmatrix} X_1 & 0 & . & 0 \\ 0 & X_2 & . & 0 \\ . & . & . & . \\ 0 & 0 & . & X_n \end{pmatrix} \begin{pmatrix} b_1 \\ b_2 \\ . \\ b_n \end{pmatrix} + \begin{pmatrix} Z_1 & 0 & . & 0 \\ 0 & Z_2 & . & 0 \\ . & . & . & . \\ 0 & 0 & . & Z_n \end{pmatrix} \begin{pmatrix} a_1 \\ a_2 \\ . \\ a_n \end{pmatrix} + \begin{pmatrix} e_1 \\ e_2 \\ . \\ e_n \end{pmatrix}$$

Where

Y_1, Y_2 ... and Y_n: Vector of first, second and n^{th} trait observation,

X_1, X_2... and X_n: Fixed effect coefficients matrix of first, second and n^{th} trait,

Z_1, Z_2... and Z_n: Random effect coefficient matrix of first, second and n^{th} trait,

b_1, b_2... and b_n: Undetermined vector of fixed effects of first, second and n^{th} trait,

a_1, a_2... and a_n: Ndetermined vector of random additive genetic effects of first, second and n^{th} trait,

e_1, e_2... and e_n: Andom residual effects of first, second and n^{th} trait.

Animals that have racing performance, hadn't conformation traits so additive relationship information was used to determine the genetically correlation of performance and conformation traits.

RESULTS

Means and standard error of conformation traits were shown in Table (3). Iranian Arab horse is a small breed that these results are in agreement with others [6,7].

The genetically and phenotypical correlation of three performance with six conformation traits were shown in Table (4). As results show many conformation traits had a high and positive correlation with performance traits, which means according suitable breeding program, animals can be assets in early stage of their life then may be decrease generation interval and increase genetic gain.

DISCUSSION

A few reports were performed in regard to the correlation of conformation and performance traits [5,8]. Genetic correlation between whither height with best racing time of determined distance and with earning per start were -0.14±0.03, 0.13±0.03, respectively also correlation best racing time of determined distance with body length and earning per start -0.11±0.03 and 0.02±0.03 respectively in Finn horse breed [8] only correlation body length with best racing time of determined distance is in agreement with this research. Difference the results of this research in addition of gene frequency difference may be related to the effect of rider and use of racing CD films instead of photofinisher set. A good rider may be achieved best rank with week genetically potential horse. Due to the lack of information the effect of rider has not been considered in this research.

Assessment of horse in early stage of life is important factor for breeder. According the high genetic correlation of conformation traits with performance traits, these traits may be used for indirect assessment of horse performance. Therefore horses can be selected according to the conformation in early stage then generation interval decrease and genetic gain increase.

Suggestions:

- In all performance record should considered that earning is more important than record performance for rider, owner and coach (in Iran conditions).
- In different racing-meeting the time and earning registries only for three first horses suggested for other usage like scientific, time and rank place of all horse registered.
- Photofinisher set use in all race-meting for accurate performance of horses.

- Film, CD and note book of all race-meeting should keep.
- Conformation traits of this study have a high correlation with performance traits and had low recording error so suggested in mating program should be considered.

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