RESEARCH ARTICLE

DETERMINATION OF RACE PERFORMANCE'S FACTORS OF ARABIAN PUREBRED TUNISIAN HORSES AND THE IMPACT OF INTRODUCTION OF OCCIDENTAL PUREBRED HORSES INTUNISIA

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ABSTRACT

The aim of the study is to investigate the effects of age, sex, running distance and origin of horse on racing speed for Purebred Arabian horse in Tunisia. Although the occidental type is known to be more successful in racing than the Tunisian type, we undertook this study to try to confirm or deny this supremacy for a sample of racehorses born in Tunisia from occidental father. A total of 333 racing records were considered for race performance. The effects of environmental factors on (sex, age, father's origin, race distance, number of race seasons) race performance were analyzed using the least-squares method (LSM). The racehorses studied were all Arabian Purebred horses in operation at the racecourse of Ksar Said from 2010 to 2020. They are 180 horses, 90 horses born of a Tunisian father, and 90 horses born in Tunisia of the occidental father. These horses are the best and most successful in their category. The study revealed that the age effects was statistically insignificant on racing performance. Race performance was significantly influenced by the gender, the distance and the origin of the father which affirms the improving role of the occidental horse in the Tunisian population.

KEYWORDS

Arabian purebred, racing performance, speed, environmental parameters, origin

1. INTRODUCTION

The Arabian horse is considered an international transboundary horse due to its blood accessibility in all continents through various horse breeds (Khadka 2015). Horse racing serves as a performance test to evaluate the speed and endurance of horses. Globally, the breed most widely used for racing is the Purebred (Klecel, et al., 2021). Arabian horses are generally considered to be one of the oldest and most influential horse breeds in the world (Ropka-Molik et al. 2019; Glazewska 2010). The Purebred Arabian horse is the ultimate racehorse, especially in flat racing. Its strength, intelligence, elegance, and robustness make this animal a cultural jewel and give it great economic and cultural importance throughout the world. Nowadays, horse breeding is mostly undertaken for sport and recreation purposes (Taylor and Field, 2014). The performance of the horse in racing is measured in various forms. In flat racing, to assess racing performance, the most widely used measure is speed (m/sec) (Paksoy and Ünal, 2019). In horses, racing performance is a quantitative trait. Therefore, genetic and environmental factors control this trait (Takahashi, 2015; Paksoy and Ünal, 2010). Many factors influencing the racing performance of Purebred Horses (e.g. Breeding, nutrition, exercise, race distance, race track, sex, weight, age, age of dam, and racetrack) have been discussed in some studies (Ekiz and Kocak, 2007; Buxadera and Mota, 2008; Bakhtiari and Heshmat, 2009; Paksoy and Ünal, 2010; Park et al. In Tunisia, the Arabian horse is a priceless asset that is an integral part of our heritage and its breeding represents an important component in agricultural production

and the national economy and promotes alternative tourism. However, it is important to note that despite the incentives taken in favor of this sector studies have highlighted a certain regression of the performance of the horses, especially in comparison with levels recorded in occidental countries, this finding has prompted professionals to propose the use of infusion of occidental blood in the Tunisian population. Stallions and frozen semens have been imported. This opening should allow us to join the pack of countries that have built a reputation in Arabian purebred racing. However, the impact of the introduction of foreign blood in the Tunisian population of Arabian horses has not been studied. Through this study, we will investigate some factors that are supposed to influence the performance of Arabian purebred horses in racing and the impact of the infusion of occidental blood in Tunisia in order to help the decision about the continuation in this import policy which aims to improve the genetic potential of Tunisian horses but it is one of the first causes of the decline of local Tunisian breed in the absence of conservation measures.

2. MATERIALS AND METHODS

2.1 Data and animals

Data used in the present study was provided by the technical service of the Horse Racing Society in Ksar Said, Tunisia. The racehorses studied were all Arabian, purebred active at the racetrack of Ksar Said from 2010 until 2020. The study was conducted on 90 clinically healthy Tunisian Arabian

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horses (Tunisian type) and 90 clinically healthy occidental fathers born in Tunisia (Occidental type). The animals have an age varying from 2 to 10 years old. A total of 333 race records have been considered for performance in a race. These horses are all winners of group races and they are the best and most successful in their category. The performance parameters are recorded on Historical Cards of the horses. The historical sheets are individual documents for each horse that has run at the racecourses of the Horse Racing Society. This document is used to register the name of the horse, sex, date of birth, and origins mainly the name of its mother and father. It is also used to capture the racing career data of the horse, including the names of the races run, their category, date, distance, and times achieved as well as the ranking and earnings per race. However, the time achieved during the race is recorded only for the first horse.

2.2 The Parameters studied and statistical analysis

The parameters used to assess the performance of the horses were the speed over the different distances covered (Buxadera and Mota, 2008) and the factors influencing the performance in races studied were the sex, age, the origin of the father, distances covered, and the number of racing seasons. The characteristics of the data used in the analyses are presented in Table 1.

Table 1: Descriptive statistics for the horses used in the study		
Information on class levels		
Class	Levels	Values
Origin	2	occidental/ Tunisian
Sex	2	Male/ female
Age	9	2 3 4 5 6 7 8 9 10
Season	9	1 2 3 4 5 6 7 8 9
Distance	6	1400,1600,1700,2000,2100,2600

The race speed of the horses was determined according to the distance in each run was calculated individually.

Data analysis was performed using the SAS statistical package (SAS Institute Inc. 2012). The distributions of the evaluated traits were used to assess according to the Kolmogorov-Smirnov test. The mean (M) value and standard error of the mean (SE) were calculated. Two sets of analyses were carried out. A descriptive exploratory analysis was carried out to summarize the main characteristics of the horses. An analysis of variance was carried out to identify factors influencing racing performance using the GLM procedure of SAS. The following general linear model analyzed the effects of studied factors on racing performance:

$$Y_{ijklmn} = \mu + S_i + D_j + O_k + A_l + R_m + e_{ijklmn}$$

Where:

Y_{ijklmn} = dependent variable; μ = overall mean; S_i = effect of the horse's sex (male, female); D_j = effect of the race distance in meters (1400, 1600, 1700, 2000, 2100, 2600); O_k = effect of the father's origin (Tunisian, occidental); A_l = effect of the horse's age at the time of the race (2, 3, 4, 5, 6, 7, 8, 9, 10); R_m = effect of number of racing seasons (1, 2, 3, 4, 5, 6, 7, 8, 9, 10) and e_{ijklmn} = random error effect.

Results were expressed as means $\pm$ SD. Results with an associated probability less than or equal to 0.05 were considered significant.

3. RESULTS AND DISCUSSION

3.1 Characteristics of the horses

Data characteristics (mean, standard deviation, minimum, and maximum) were shown in Table 2. The average age of the horses was 4.31 ± 1.46 and varies from 2 to 10 years. The Tunisian horses studied had an overall speed of 13.58 ± 0.67 m/s over an average distance of 1694.29 ± 231.28 m with an average number of a racing season of 4.5 years and an average number of races run of 32.01 ± 16.68 .

Table 2: Characteristics of Tunisian purebred horses				
Parameters	Mean	Min	Max	SD
Age (years)	4.31	2	10	1.46
Time (s)	125.25	79.60	248.20	20.15
Distance (m)	1694.29	1400	2600	231.28
Speed (m/s)	13.58	8.05	20.10	0.67
Number of race seasons	4.5	1	9	1.84
Number of racing	32.01	1	100	16.68

The average speed of the Tunisian Purebred horses was 13.58 ± 0.67 m/s over an average distance of 1694 m, it is close to the value found in Turkey by Yildirim (2018) (13.77 ± 0.01 m/sec) and lower than that found by Sobczyńska (2011) when the average speed of the Polish Purebreds and the average distance of the races was 15.57 m/s and 1509.1 m, respectively. The active Tunisian horses at the Ksar Said racetrack are aged between 2 and 10 years, this shows that purebred horses generally complete their growth and development at the age of two years, in line with the statement that purebred horses mature early (Yavuzkan Paksoy and Necmettin Ünal, 2019). Purebred horses start their racing career one year earlier (two years) than other breeds used in flat racing in many countries (Yavuzkan Paksoy and Necmettin Ünal, 2019). This is confirmed and explained by Anderson and McIlwraith (2004) who revealed that the different body measurements of purebred horses were similar at two and three years of age, despite a significant increase from one to two years of age. Kocher and Stanier (2013) also estimated that two-year-old horses should reach 95% of the adult value in terms of height at withers. Based on statistical analyses, the variation in velocity with age was not significant which is consistent with the results found by Sobczyńska (2003), Oliveira (1989), and Mota et al. (1998). This could be partly because in the mentioned study there was only the race time of the winners and not all the participants in the race or also the retirement of less performing horses at an early age. However, even though the age effect on speed in the present study was not statistically significant, the differences between the mean speeds as a function of age are existing (Figure 1). Indeed, the average speed was 13.50 m/s at the age of 2 years and increases progressively until it reaches its peak at the age of 5 years (13.71 m/s) then it decreases again to 13.25 m/s at the age of 10 years.

Figure 1: Age effect on horse speed

These results are similar to the results of several surveys (Ekiz et al., 2005; Buxadera and Mota, 2008; Park et al., 2011) also Gramm and Marksteiner (2010) observed that the maximum age was 4.45 years and the lowest age was two years for purebred racing performance in the U.S.A. The fastest average speed in the purebred in Japan was at 5 years of age (Oki et al 1994). The increase in racing performance with age may be related to an adaptation of horses to racing conditions and training. Young horses may exhibit behaviors that can impair racing performance before and during the race (Mota, 2008).

3.2 Environmental factors affecting race performance

The Least Squares Means (LSM) and standard errors of the studied effects

for racing performance were presented in Tables 3. In the evaluation of the entire data set, statistically significant differences were found in all of the fixed effects ($P < 0.001$). In the study, significant ($P < 0.0001$) differences between the occidental and Tunisian blood horses were found. Tunisian blood horses showed lower speed (13.06 m/s); however, they still fell within the reference range. These findings were described in previous studies (Paksoy and Ünal 2010; Paksoy et al., 2018). Such results indicate significant differences in effort and various racing predispositions observed in racing breeds, which are most likely conditioned by different genetic backgrounds (Ropka-Molik et al., 2019). This would confirm what is known by professionals in this sector that the occidental horse is more successful in races than the Tunisian and we will be tempted to assert the improving role of the occidental horse.

The effect of the sex of the horse was found to be significant on race performance or race speed ($P = 0.0053$). We observed that the race speed of the male horses was found to be higher (13.38 ± 0.11 m/s) than the female horses (13.21 ± 0.08 m/s). Similar to the results of this study, some researchers stated that male horses were faster than females (Ekiz et al., 2005; Mota et al., 2005; Buxadera and Mota, 2008; Park et al., 2011). The significant superiority of males found in the current study agrees with reports of Mota et al. (2005) who reported the significant sex on race speed. However, Yeldimir (2018) and Bakhtiari and Kashan (2009) reported no significant effect of horse sex on racing time. In the same context, researchers reported that male horses exhibited better racing performance than female horses in horse races due to both morphological and physiological characteristics (Mota et al., 2005; Özbeyaz and Akçapınar, 2003).

The present study indicates that the age of the horse had mixed effects on race performance, in our study we reported that higher speeds were recorded for the horse from 4 to 6 years old (13.63 ± 0.14 and 13.71 ± 0.09 m/s). However, the lowest values were reported for a horse having more than 9 years (13.27 ± 0.14 m/s). The middle values were observed for 2 and 3 and 7 and 8, respectively (ranging from 13.43 ± 0.23 to 13.50 ± 0.11). Some researchers suggested that age represents the influence of accumulated training effects and racing experience upon racing performance (Sobczyńska, 201; Ekiz et al., 2005; Bakhtiari and Kashan, 2009). The same authors reported that the racing performance would improve with progressing age. The studies on the effect of the Race distances on the horses' race performance were confirmed as significant ($P < 0.001$). The distances covered by the horses studied are between 1400 m and 2600 m, it is close to the range cited by Taylor and Field (2014) who indicated that this breed was improved for speed at medium distance (1400-2400 m). The average speed is faster in shorter distance races and slower in longer distance races. Increasing race distance negatively affected race performance which is consistent with the study conducted by Takahashi (2015) and Özen and Gürçan (2016). The number of laps on the track affected race performance, as races up to 1500 m may include a single turn, while tracks from 1600 to 2600 m include two turns. Race speed tends to decrease during turns. This is because horses that have to make a greater effort are forced to slow down to keep up over time. This result can be considered as a result of the selection and maintenance-feeding operations carried out over the years. In the present study, the effect of the race distance on race performance or speed was significant for each track type ($P < 0.001$).

The results of the present study did not confirm the significance of the race season therefore, was excluded from the model analysis.

The effect of the interaction Distance*origin of the horse showed that the Tunisian horses ran most often short distances of 1400 m, 1600 m, and 1700 m. They participate less in long races 2000 and 2100 m. On the other hand, the horses born of an occidental father had participated in many races over distances of 2000, 2100, and 2600. The results of the statistical analysis show a significant difference between the horses born of Tunisian fathers and the horses born of western fathers for the overall average speed and the speeds on all the distances covered except the distance 2000 m where the Tunisian horses were faster than the horses born of a western father (figure 2). This could be related to the fact that Tunisian horses race less over long distances during the same racing season, so they would be fresher, less stressed, and less exposed to fatigue. Several authors report that fatigue can lead to overwork if the necessary measures are not taken, and overwork, which is a serious pathological condition, would be detrimental to sports performance in the short and medium-term (Boivin, 1989; Denois, 1995). On the other hand, this difference could be linked to the number of races used to calculate the speed, which is lower than the actual number of races run by the horses. We are limited to the races won by the horse concerned because we do not have information on the time of the sewing when the horse is classified.

Table 3: Effects of the studied parameters on the speed of horses					
Parameters		n	LSM	SE	P-value
Origin					
Tunisian		111	13.06 ^b	0.09	<.0001
occidental		222	13.53 ^a	0.11	
Sex					
Male		237	13.38 ^a	0.11	0.0053
Female		96	13.21 ^b	0.08	
Age					
2		4	13.50 ^{ab}	0.11	0.3638
3		108	13.52 ^{ab}	0.14	
4		107	13.63 ^a	0.15	
5		62	13.71 ^a	0.16	
6		5	13.62 ^a	0.14	
7		8	13.46 ^{ab}	0.13	
8		13	13.43 ^{ab}	0.12	
9		3	13.27 ^b	0.11	
10		3	13.25 ^b	0.11	
Distance					
1400		49	13.85 ^a	0.10	<.0001
1600		154	13.50 ^{ab}	0.06	
1700		49	13.54 ^{ab}	0.10	
2000		72	13.16 ^{ab}	0.09	
2100		3	13.04 ^{ab}	0.37	
2600		6	12.68 ^b	0.27	
Race season					
1		14	13.33 ^a	0.19	0.4019
2		25	13.46 ^a	0.15	
3		56	13.39 ^a	0.11	
4		107	13.24 ^a	0.10	
5		36	13.24 ^a	0.12	
6		32	13.13 ^a	0.15	
7		45	13.41 ^a	0.14	
8		10	13.07 ^a	0.23	
9		8	13.36 ^a	0.23	
Origine* Distance					
1400	Tunisian	49	13.67 ^a	0.144	<.0001
	occidental		13.89 ^b	0.17	
1600	Tunisian	154	13.23 ^a	0.12	<.0001
	occidental		13.68 ^b	0.10	
1700	Tunisian	49	13.19 ^a	0.18	<.0001
	occidental		13.66 ^b	0.14	
2000	Tunisian	72	13.32 ^a	0.66	<.0001
	occidental		13.26 ^b	0.11	
2100	Tunisian	3	-	-	
	occidental		13.09	0.39	
2600	Tunisian	6	-	-	
	occidental		12.79	0.27	

^{a,b}: The differences between the means of groups carrying various letters in the same column are significant ($P < 0.05$)

The age and the number of racing seasons had no significant effect ($P > 0.05$) on the speed of the horses while the effect of the origin of the father was well pronounced ($P < 0.0001$). The Tunisian horses had an overall speed (all distances combined) of 13.42 ± m/s lower than that of the horses born from a western father who had an overall average speed of 13.66 ± m/s. The performance in races was significantly influenced by the

distance covered during the race ($P<0.0001$). Indeed, horses born of an occidental father are more successful than those born of Tunisian father over all distances except for the 2000 m distance category, the horses of Tunisian father were faster than those of occidental father.

Figure 2: Variation of the speed according to the origin of the father and the different distances covered

4. CONCLUSIONS

The racing performance of the Tunisian Purebred horses showed significant differences over the different distances covered; the increase in distance negatively affects the speed of the horses. male horses were faster than females and the effect of sex was significant in this study. For the effect of season number and age on the performance of horses, they are statistically insignificant. For the origin of the father, the effect on the performance was highly significant, horses born in Tunisia of an occidental father had higher speeds than horses born of Tunisian sire over the different distances. The introduction of the occidental type would then be beneficial to the performance of Tunisian horses. This import policy aims to improve the genetic potential of Tunisian horses, could call into question the survival of the local Tunisian breed in the absence of conservation measures.

AUTHORS CONTRIBUTIONS

I.B and H.O :Constructing hypothesis for research; I.B , F.L and B.B : Data collection; N.M and I.B: Data analysis and interpretation of the results; A.T and N.M : supervising the course of the article; I.B and N.M: construction of the whole or body of the manuscript; N.M and A.T: Reviewing the article before submission not only for spelling and grammar but also for its intellectual content.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this paper.

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REFERENCES

- Anderson TM, McIlwraith CW.,2004. Longitudinal development of equine conformation from weanling to age 3 years in the Thoroughbred. *Equine Vet J*.36:563–70. <https://doi.org/10.2746/0425164044864507>.
- Bakhtiari J, Heshmat G.,2009. Estimation of genetic parameters of conformation traits in Iranian Thoroughbred horses. *Livest Sci*. 123:116–20. <https://doi.org/10.1016/j.livsci.2008.10.014>.
- Bakhtiari J, Kashan NEJ.,2009. Estimation of genetic parameters of racing performance in Iranian Thoroughbred horses. *Livest Sci*. 120:151–7. <https://doi.org/10.1016/j.livsci.2008.05.007>.
- Boivin R., 1989. Physiologie de l'exercice musculaire chez le cheval. *Revue Med Vet*. 140, 909-920.

- Buxadera AM, da Mota MDS.,2008. Variance component estimations for race performance of thoroughbred horses in Brazil by random regression model. *Livest Sci*. 117:298–307. <https://doi.org/10.1016/j.livsci.2007.12.027>.
- Denoix J.M., 1995. Médecine sportive et affections locomotrices chez le cheval. *Point Vet*. 27, (171); 35-42.
- Doğukan; GÜRCAN Ö.,2016. Determination of factors affecting the length of racing career of Arabian horses in Turkey. *Ankara Üniversitesi Vet Fakültesi Derg*. 63:303–9. https://doi.org/10.1501/vetfak_00000002744.
- Ekiz B, Kocak Ö, Yilmaz A.,2005. Phenotypic and genetic parameter estimates for racing traits of Thoroughbred horses in Turkey. *Arch Anim Breed*. 48:121–9. <https://doi.org/10.5194/aab-48-121-2005>.
- Ekiz B, Koçak Ö.,2007. Estimates of genetic parameters for racing times of thoroughbred horses. *Turkish J Vet Anim Sci*.31:1–5.
- Głazewska I. Speculations on the origin of the Arabian horse breed.,2010. *Livest Sci*.129:49–55. <https://doi.org/10.1016/j.livsci.2009.12.009>.
- Gramm M, Marksteiner R.,2010. The effect of age on thoroughbred racing performance. *J Equine Sci*. 21:73–8. <https://doi.org/10.1294/jes.21.73>.
- Khadka R.,2010. Global Horse Population with respect to Breeds and Risk Status. *Swedish Univ Agric Sci*:81.
- Klecel W, Drobik-Czwaro W, Martyniuk E.,2021. 36 Factors influencing racing performance in Polish Thoroughbreds and Purebred Arabian horses. *J Equine Vet Sci*.100:103499. <https://doi.org/10.1016/j.jevs.2021.103499>.
- Kocher A, Burton Stanier W.,2013. The pattern of thoroughbred growth is affected by a foal's birthdate. *Livest Sci*.154:204–14. <https://doi.org/10.1016/j.livsci.2013.03.008>.
- Mota MDS, Abrahão AR, Oliveira HN.,2005. Genetic and environmental parameters for racing time at different distances in Brazilian Thoroughbreds. *J Anim Breed Genet*. 122:393–9. <https://doi.org/10.1111/j.1439-0388.2005.00551.x>.
- Mota MDS, Oliveira HN, Silva RG.,1998. Genetic and environmental factors that affect the best time of Thoroughbred horses in Brazil. *J Anim Breed Genet*.115:123–9. <https://doi.org/10.1111/j.1439-0388.1998.tb00335.x>.
- Oki H, Sasaki Y, Willham RL.,1994. Genetics of racing performance in the Japanese Thoroughbred horse: II. Environmental variation of racing time on turf and dirt tracks and the influence of sex, age, and weight carried on racing time. *J Anim Breed Genet*. 111:128–37. <https://doi.org/10.1111/j.1439-0388.1994.tb00446.x>.
- Oliveira L.F.S.,1989., Fatores que influem no desempenho e selec,ão de cavalos de corrida da rac,a P.S.I. Master's thesis in Agronomy, Escola Superior de Agricultura "Luiz de Queiroz". Universidade de Sa'õ Paulo, Sa'õ Paulo, p. 181.
- Özbeyaz C, Akçapınar H.,2003. At yetitiriciliği ders notları. Ankara Üniversitesi Veteriner Fakültesi, Ankara.
- Paksoy Y, Ünal N.,2010. The factors affecting horse racing performance. *Journal of lalahan livestock research institute*.50:91-101.
- Paksoy Y, Ünal N.,2019. Multivariate analysis of morphometry effect on race performance in Thoroughbred horses. *Rev Bras Zootec*.48:1–11. <https://doi.org/10.1590/RBZ4820180030>.
- Park JE, Lee JR, Oh S, Lee JW, Oh HS, Kim H.,2011. Principal components analysis applied to genetic evaluation of racing performance of Thoroughbred race horses in Korea. *Livest Sci*.135:293–9. <https://doi.org/10.1016/j.livsci.2010.07.014>.
- Ropka-Molik K, Stefaniuk-Szmukier M, Musiał AD, Velie BD., 2019. The Genetics of Racing Performance in Arabian Horses. *Int J Genomics*;2019. <https://doi.org/10.1155/2019/9013239>.
- Sobczynska M.,2003. Selected environmental factors influencing racing time, rank at the finish, and earnings by Thoroughbred in Poland. *PraceiMaterialyZootechniczne*, 61, 49–59.

Sobczyńska M.,2011. Environmental factors affecting the speed of Thoroughbred horses competing in Poland. Anim Sci Pap Reports. 29:303–12.

Takahashi T.,2015. The effect of age on the racing speed of Thoroughbred racehorses. J Equine Sci. 26:43–8. <https://doi.org/10.1294/jes.26.43>.

Taylor, R. E. and Field T. G. 2014. Scientific animal production.10th ed. Pearson Education Limited, England.

Wittman C, van der Hoek W.,2012. Introduction chapter. Synthese.189:1–3. <https://doi.org/10.1007/s11229-012-0184-x>.

YILDIRIM F.,2018. Safkan Arap Atlarının Yarış Performansına Bazı Çevresel Faktörlerin Etkisi. Kocatepe Vet J . <https://doi.org/10.30607/kvj.450350>.