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## RESEARCH ARTICLE

# DETERMINATION OF RACE PERFORMANCE'S FACTORS OF ARABIAN THOROUGHBRED TUNISIAN HORSES AND THE IMPACT OF INTRODUCTION OF OCCIDENTAL THOROUGHBRED 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 Thoroughbred 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 Thoroughbred 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 gender and age effects were statistically insignificant on racing performance. Race performance was significantly influenced by the distance and the origin of the father which affirms the improving role of the occidental horse in the Tunisian population.

## KEYWORDS

Arabian thoroughbred, racing performance, speed, variation's parameters, horse's 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 Thoroughbred (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 Thoroughbred 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 Thoroughbred 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). 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 thoroughbred 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 thoroughbred horses in racing and the impact of the infusion of occidental blood in Tunisia

## 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

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Arabian, thoroughbreds active at the racetrack of Ksar Said from 2010 until 2020. The study was conducted on 90 clinically healthy Tunisian Arabian 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 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 (Buxadera and Mota, 2008).

**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;  $\mu$  = 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  $4.31 \pm 1.46$  and varies from 2 to 10 years. The Tunisian horses studied had an overall speed of  $13.58 \pm 0.67$  m/s over an average distance of  $1694.29 \pm 231.28$  m with an average number of a racing season of 4.5 years and an average number of races run of  $32.01 \pm 16.68$ .

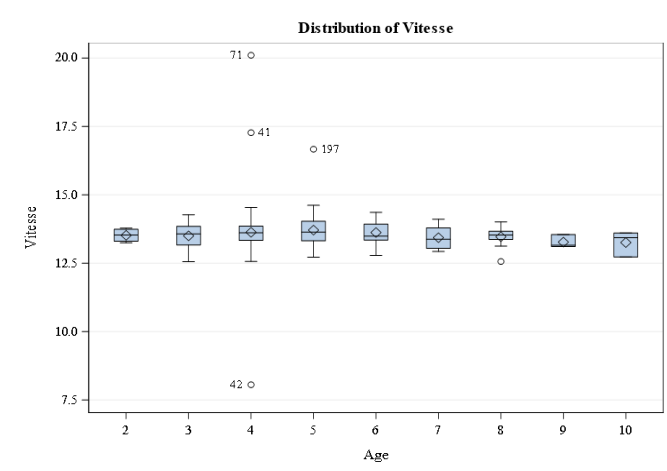
The average speed of the Tunisian Thoroughbred horses was  $13.58 \pm 0.67$  m/s over an average distance of 1694 m, it is close to the value found in Turkey by Yildirim ( $13.77 \pm 0.01$  m/sec) and lower than that found by Sobczyńska when the average speed of the Polish Thoroughbreds and the average distance of the races was 15.57 m/s and 1509.1 m, respectively

(Yildirim, 2018; Sobczyńska, 2011). The active Tunisian horses at the Ksar Said racetrack are aged between 2 and 10 years, this shows that thoroughbred horses generally complete their growth and development at the age of two years, in line with the statement that thoroughbred horses mature early (Yavuzkan Paksoy and Necmettin Ünal, 2019). Thoroughbred 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).

**Table 2: Characteristics of Tunisian thoroughbred 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

This is confirmed and explained by who revealed that the different body measurements of thoroughbred horses were similar at two and three years of age, despite a significant increase from one to two years of age (Anderson and McIlwraith, 2004). Kocher and Staniar also estimated that two-year-old horses should reach 95% of the adult value in terms of height at withers (Kocher and Staniar, 2013). Based on statistical analyses, the variation in velocity with age was not significant which is consistent with the results found (Sobczynska, 2003; Oliveira, 1989; 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 2: Age effect on horse speed**

These results are similar to the results of several surveys also observed that the maximum age was 4.45 years and the lowest age was two years for Thoroughbred racing performance in the U.S.A (Ekiz et al., 2005; Buxadera and Mota, 2008; Park et al., 2011; Gramm and Marksteiner, 2010). The fastest average speed in the Thoroughbred 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± 0.11m/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 who reported the significant sex on race speed (Mota et al., 2005). However, reported no significant effect of horse sex on racing time (Yeldimir, 2018; Bakhtiari and Kashan, 2009). 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 Akcapinar, 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<.0001).

The distances covered by the horses studied are between 1400 m and 2600 m, it is close to the range cited by who indicated that this breed was improved for speed at medium distance (1400-2400 m) (Taylor and Field, 2014). 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 (Takahashi, 2015; 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.

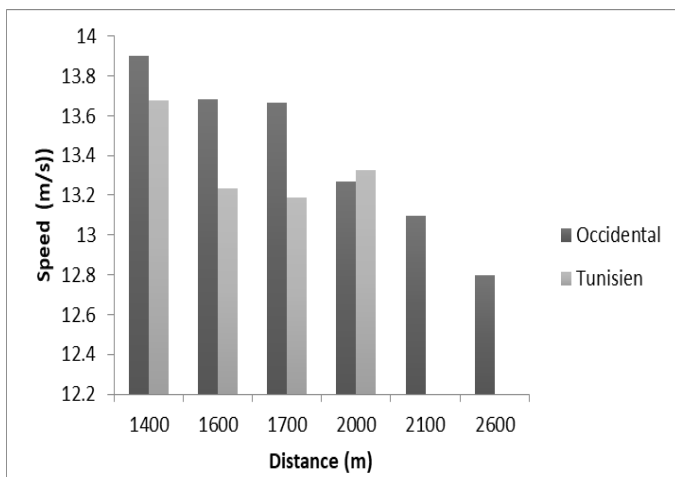
The sex and the number of racing seasons had no significant effect (P> 0.05) on the speed of the horses while the effect of the origin of the father was well pronounced (P <0.0001). The Tunisian horses had an overall speed (all distances combined) of 13.42 ± m/s lower than that of the horses born from 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.

**Table 3: Effects of the studied parameters on the speed of horses**

Parameters	n	LSM	SE	P-value	
<b>Origin</b>					
Tunisian	111	13.06 <sup>b</sup>	0.09	<.0001	
occidental	222	13.53 <sup>a</sup>	0.11		
<b>Sex</b>					
Male	237	13.38 <sup>a</sup>	0.11	0.0053	
Female	96	13.21 <sup>b</sup>	0.08		
<b>Age</b>					
2	4	13.50 <sup>ab</sup>	0.11	0.0036	
3	108	13.52 <sup>ab</sup>	0.14		
4	107	13.63 <sup>a</sup>	0.15		
5	62	13.71 <sup>a</sup>	0.16		
6	5	13.62 <sup>a</sup>	0.14		
7	8	13.46 <sup>ab</sup>	0.13		
8	13	13.43 <sup>ab</sup>	0.12		
9	3	13.27 <sup>b</sup>	0.11		
10	3	13.25 <sup>b</sup>	0.11		
<b>Distance</b>					
1400	49	13.85 <sup>a</sup>	0.10	<.0001	
1600	154	13.50 <sup>ab</sup>	0.06		
1700	49	13.54 <sup>ab</sup>	0.10		
2000	72	13.16 <sup>ab</sup>	0.09		
2100	3	13.04 <sup>ab</sup>	0.37		
2600	6	12.68 <sup>b</sup>	0.27		
<b>Race season</b>					
1	14	13.33 <sup>a</sup>	0.19	0.4019	
2	25	13.46 <sup>a</sup>	0.15		
3	56	13.39 <sup>a</sup>	0.11		
4	107	13.24 <sup>a</sup>	0.10		
5	36	13.24 <sup>a</sup>	0.12		
6	32	13.13 <sup>a</sup>	0.15		
7	45	13.41 <sup>a</sup>	0.14		
8	10	13.07 <sup>a</sup>	0.23		
9	8	13.36 <sup>a</sup>	0.23		
<b>Origine* Distance</b>					
1400	Tunisian	49	13.67 <sup>a</sup>	0.144	<.0001
	occidental		13.89 <sup>b</sup>	0.17	
1600	Tunisian	154	13.23 <sup>a</sup>	0.12	<.0001
	occidental		13.68 <sup>b</sup>	0.10	
1700	Tunisian	49	13.19 <sup>a</sup>	0.18	<.0001
	occidental		13.66 <sup>b</sup>	0.14	
2000	Tunisian	72	13.32 <sup>a</sup>	0.66	<.0001
	occidental		13.26 <sup>b</sup>	0.11	
2100	Tunisian	3	-	-	
	occidental		13.09	0.39	
2600	Tunisian	6	-	-	
	occidental		12.79	0.27	

<sup>a,b</sup>:The differences between the means of groups carrying various letters in the same column are significant (P<0.05)



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

#### 4. CONCLUSION

The racing performance of the Tunisian Thoroughbred horses showed significant differences over the different distances covered; the increase in distance negatively affects the speed of the horses. 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. For the effect of sex and age on the performance of horses, they are statistically insignificant.

#### 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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