

Quantitative study for race times in thoroughbreds on dirt and turf tracks in Brazil

Estudio cuantitativo de los tiempos en las carreras de purasangre en pistas de tierra y césped en Brasil

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ABSTRACT

This study was conducted to estimate the genetic parameters for race times on turf and dirt tracks of Thoroughbred race horses. Data used were recorded by the Turftotal Ltd. for 343,419 racing performance of 26,713 animals, from January 1992 to January 2003. The model used in analysis included random animal and permanent environmental effects, and age, post position at start, sex and race as fixed effects. The variance and covariance components and the breeding value were estimated using the MTGSAM software. Heritability estimates were 0.29 for time on dirt track and 0.25 for time on turf track, indicating a moderate association between the animals' breeding values and their phenotypic values. Although genetic and environmental variances were smaller in turf tracks, their repeatability was equal to that of dirt (0.56), in terms of the highest estimated phenotypic variance for the latter type of track. The genetic correlation between times on different tracks was high (0.70). Considering the mean breeding value of the progeny of 465 stallions with 10 or more offspring, Spearman's correlation was 0.80, indicating that most Thoroughbred stallions produce offspring suited to both dirt and turf racing tracks.

Key words: Genetic parameters, horserace, race time, turf and dirt tracks

RESUMEN

Este estudio fue conducido para estimar los parámetros genéticos de los tiempos de carrera en pistas de tierra y césped de caballos purasangres. Los datos utilizados fueron registrados por Turftotal Ltd. para 343.419 desempeños en carreras de 26.713 animales, entre enero de 1992 y enero de 2003. El modelo utilizado en el análisis incluyó animales aleatorios y efectos ambientales permanentes, y la edad, puesto en la posición de partida, sexo y raza como efectos fijos. Los componentes de varianza y covarianza y el valor genético se estimaron usando el programa MTGSAM. Los estimados de heredabilidad fueron 0,29 para el tiempo en pista de tierra y 0,25 para el tiempo en pista de césped, indicando una asociación moderada entre los valores genéticos de los animales y sus valores fenotípicos. A pesar de que las varianzas genética y ambiental fueron menores en las pistas de césped, su repetibilidad fue igual a aquella de las pistas de tierra (0,56), en términos de la más alta varianza fenotípica estimada para el último tipo de pista. La correlación genética entre los tiempos en las diferentes pistas fue alta (0,70). Considerando el valor genético promedio de la progenie de 465 sementales con 10 o más hijos, la correlación de Spearman fue 0,80, indicando que la mayoría de los sementales purasangres producen descendientes adecuados para ambas pistas de carrera (tierra y césped).

Palabras clave: parámetros genéticos, carreras de caballo, tiempo de carrera, pistas de tierra y césped.

INTRODUCTION

Thoroughbred racing in Brazil occurs on both dirt (approximately 62%) and turf tracks (Turftotal, 2005). Although racing on dirt tracks are more numerous, those of greatest standing and economically most important occur on turf. Thus, unlike in some European countries, where the animals normally race on turf, and in the United States, where there is a preference for dirt tracks, in Brazil, breeders

usually seek horses with good performances on both types of surface.

Genetic parameter estimates for race times on these surface types have been shown to be variable in the literature. While Moritsu *et al.* (1998) reported higher heritability estimates for race times on turf, Oki *et al.* (1995) reported the opposite. Genetic correlations between race times at different distances on dirt and turf track have been moderate and

favorable (Oki *et al.* 1995). However, in Brazil, the genetic variability for race times on both these track types is unknown, as is the existing relationship between them, and these are fundamental steps for the elaboration of consistent programs for genetic improvement.

In this context, the study was conducted to estimate the genetic parameters for race times in Thoroughbreds on dirt and turf tracks, with the aim of assisting selection programs in animals of this breed.

MATERIAL AND METHODS

The data used in this study were provided by the company Turftotal Ltd. and comprised of 343,419 race time observations for 26,713 animals (14,073 male and 12,640 female) of the Thoroughbred, over 12 years (from January 1992 to January 2003), on the principal Brazilian race tracks (Cidade Jardim - São Paulo State, Gávea - Rio de Janeiro, Tarumã - Paraná and Cristal - Rio Grande do Sul). The total number of animals in the relationship matrix was 37,444. Table 1 illustrates the descriptive analysis of this information.

Each race included a minimum of four animals and the mean number of start per horse was 10.7 (range 1 to 121). With regard to the 26,713 animals evaluated, 5,753 only ran on dirt tracks, 1,744 only ran on turf and the rest (19,216) ran on both types of surface. The first race was on dirt surface for 65.3% of the animals.

The SAS statistical software (1999) was used to set up the files, to determine consistency and to perform descriptive analysis of the traits. The model used to estimate the (co)variance components necessary to obtain the genetic parameters (heritability, repeatability and correlations) of the traits was the same used by Mota *et al.* (2005), but in a two-trait animal model, and included the random animal and permanent effects, and the fixed effects of

post position at start (1 to ≥ 11), age (3 years or younger, 4, 5 and older than 5 years), sex (male or female) and race (1 to 42.035).

In matrix terms:

$$y = X\beta + Za + Zp + e$$

where:

y = vector of time records on turf and dirt tracks;

β = vector of fixed effects of race, sex, age and post position at start, as associated with records in y by X ;

a = vector of the additive genetic effects as associated with the records in y by Z ;

p = vector of the permanent environmental effects as associated with the records in y by Z ;

e = vector of residual effects;

X and Z = incidence matrices relating a particular record to a particular animal.

The program used to obtain (co)variance components and breeding values of the animals was the MTGSAM (Multiple - Trait Gibbs Sampler for Animal Models), described by Van Tassel and Van Vleck (1995). Inferences regarding parameter dispersion were realized using the distributions obtained *a posteriori* via the Gibbs sampler. For the additive genetic, permanent environmental variances and residual variances non-informative (Flat) *a priori* distributions were used. The Fortran Gibanal program, version 2.4 (VanKaam, 1998), was used to analyze the Gibbs series, with the aim of defining the burn-in period, series parameter spacing and total number of samples to be used.

The Gibbs sampling scheme considered the series size of 505,000, with a burn-in of 5,000 and spacing to 500, resulting in 1000 available samples for *a posteriori* distribution evaluation.

Table 1. Number of observations, number of races, number of animals, mean number of animals per race and mean, minimum and maximum values for distances, according to track type.

Track	N° of observations	N° of races	N° of animals	Mean animals/race	Distance (m)		
					Mean	Min.	Max.
Dirt	226.917	28.990	24.969	8.7	1319	600	3200
Turf	116.502	13.045	20.960	9.8	1379	1000	3500

The heritabilities were estimated from the ratio between the additive genetic variance (σ^2_A) and the phenotypic variance (σ^2_P), and repeatability was calculated by dividing the sum of the additive genetic variance and the environmental variance (σ^2_{EP}) by the phenotypic variance.

To calculate the efficiency of “n” records in relation to a single record, the expression described by Cardellino and Rovira (1989) was used:

$$E_n = E_1 \sqrt{\frac{n}{1 + (n - 1) * t}} \quad \text{where:}$$

E_n = efficiency when “n” records are realized;
 E_1 = efficiency when only 1 record is realized;
 n = number of records realized;
 t = repeatability of the trait analyzed.

An evaluation of rank correlation was made between the stallion’s breeding values based on the progeny’s racing time (s) on two kinds of racing tracks.

RESULTS AND DISCUSSION

Table 2 shows the components of variance, heritability and repeatability of the studied traits.

All estimated variances were higher for dirt

Table 2. Mean and respective standard errors (SD), mode, highest *a posteriori* density intervals with 90% probability (HPD90%), minimum (Min.) and maximum (Max.) values of the genetic additive (σ^2_A), permanent environmental (σ^2_{EP}), residual (σ^2_R) and phenotypic (σ^2_P) variances, heritability (h^2) and repeatability (t) for race times on dirt and turf tracks.*

Track type / Item	Mean	SD	Mode	HPD. 90%	Min.	Max.
Dirt Track						
σ^2_A	0.93	0.03	0.93	0.87 to 0.99	0.82	1.09
σ^2_{EP}	0.86	0.025	0.86	0.81 to 0.91	0.77	0.94
σ^2_R	1.43	0.004	1.43	1.43 to 1.44	1.42	1.45
σ^2_P	3.23	0.03	3.20	3.19 to 3.28	3.16	3.32
h^2	0.29	0.01	0.29	0.27 to 0.31	0.26	0.33
t	0.56	0.004	0.56	0.55 to 0.56	0.54	0.57
Turf Track						
σ^2_A	0.61	0.03	0.61	0.56 to 0.66	0.52	0.71
σ^2_{EP}	0.72	0.02	0.72	0.68 to 0.76	0.66	0.79
σ^2_R	1.07	0.004	1.07	1.06 to 1.08	1.05	1.08
σ^2_P	2.40	0.02	2.41	2.37 to 2.44	2.34	2.46
h^2	0.25	0.05	0.25	0.23 to 0.27	0.22	0.28
t	0.56	0.005	0.56	0.55 to 0.56	0.54	0.57

* the convergence criteria used was 10^{-9}

tracks, in relation to turf, where the greatest difference was verified between the phenotypic variances. The estimates for heritability were of medium magnitude both for dirt (0.29) and for turf (0.25), indicating a moderate association between the animals’ breeding values and their phenotypic values (performances), and the possibility of a slightly less effective response to selection if applied to the latter trait (Figure 1).

Oki *et al.* (1995), evaluating race time at five distances on dirt and six on turf, also reported a higher heritability for the first type of track surface (mean equal to 0.16) in relation to the second (mean equal to 0.13). However, all estimated variances (additive genetic, permanent environmental, residual and phenotypic) by these authors were inferior to those found in this study. In contrast, Moritsu *et al.* (1998), working with rating scores for Thoroughbreds in Japan, estimated greater heritability for turf tracks (0.29) in relation to those with dirt (0.18). In Arabian horses, Ekiz *et al.* (2005), studying race times at different distances on dirt and turf tracks, estimated heritability varying from 0.17 to 0.30, amplitude which include the values observed in the present study.

Although the genetic additive and permanent environmental variances were lower on turf, the repeatability was equal to that for dirt (0.56) in terms of the highest estimated phenotypic variance for the

latter type of track. This means that the relation intensity between time measurements taken over an individual animal's lifetime is similar for both types of track surface, indicating that, independent of the track type, a single performance of an animal is a moderate indicator of its production capacity. The repeatability estimates agree with that reported by Tolley *et al.* (1983), Saastamoinen and Ojala (1991) in Trotters, Oki *et al.* (1995) in Thoroughbred and Villela *et al.* (2002) and Corrêa and Mota (2007) in Quarter Horse – a mean value of 0.56. In contrast, Ekiz *et al.* (2005) and Mota *et al.* (2005) observed inferior repeatabilities in Arabian (0.29 to 0.46) and Thoroughbreds (mean value of 0.32) horses.

Considering that the mean number of starts per animal was 10.7, a 29% higher efficiency (in relation to a single start) would be achieved if breeders considered this mean starting number before culling the animals.

The genetic correlation between race times in different track types was high (0.70), showing that animals genetically superior for turf racing tend to have higher genetic values for dirt as well, although correlations less than 0.80, according to Robertson (1959), indicate the presence of genotype x environmental interaction, that is, the animals' genotypes express themselves in a distinct way depending on the track surface. Considering that the genetic and permanent environmental correlations between these two characteristics were high (0.70 and 0.67, respectively) and that the residual correlation was slightly negative (-0.03), resulting in a moderate phenotypic correlation (0.38), performances in both types of track surface fundamentally depend on the action of the same group of genes and the effects of the permanent environment (breeder, trainer, injuries,

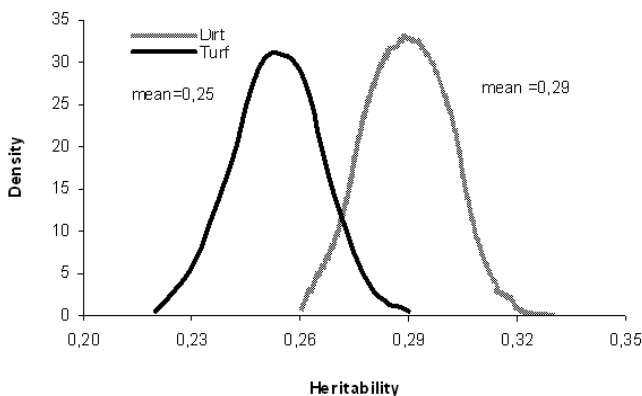


Figure 1. Distribution of heritability estimates for race time in dirt and turf tracks.

etc.). With regard to the mean breeding value of the progeny of 465 stallions with ten or more offspring, for dirt and turf tracks, Spearman's correlation was 0.80, indicating that most Thoroughbred stallions in Brazil produce offspring suited to both dirt and turf racing tracks (Figure 2). This result is in agreement with the report by Moritsu *et al.* (1998) in Thoroughbreds in Japan, although the authors found that Spearman's correlation was lower (0.50), evaluating progeny of 116 stallions.

The correlation between predicted mean breeding values for race times on turf and on dirt was high, although there was considerable variation in animal classification depending on the criterion used. Figure 3 presents the mean breeding values for race times on turf tracks when the selection was performed using the predicted mean breeding value for time on turf surfaces as criterion, and when using predicted

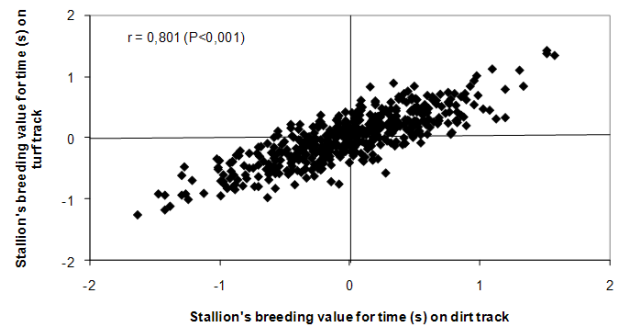


Figure 2. Correlation between the stallion's breeding values based on the progeny's racing time (s) on two kinds of racing tracks. r = Spearman's rank correlation coefficient

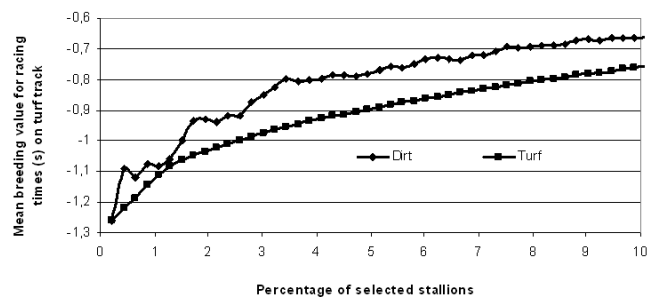


Figure 3. Mean breeding value for race times on turf tracks when the selection is based on the same predicted breeding values for times on turf and when it is based on the breeding values for times on dirt tracks, in terms of the percentage of stallions selected, if up to 10% of the sires (46 stallions) with more than 10 progeny were selected.

breeding value on dirt tracks. There was a reduction in the response to selection in time for turf tracks if the selection was based on times for dirt tracks. This difference, depending on the fraction selected, reached more than 1 tenth of a second in terms of the mean breeding value.

CONCLUSIONS

The results found in this study indicate that there is sufficient additive genetic variability for race time selection in Thoroughbred horses in Brazil, on both dirt and turf tracks, with a slight superiority for the former.

Additionally, although Thoroughbred horse breeders desire animals with superior performance on both track types (dirt and turf) and that this, in general, occurs, it is important that judicious appreciation be made during the selection of genetically superior animals, for both track types, principally with those that form the top ten, with the aim of maximizing genetic gains.

LITERATURE CITED

- Cardellino, R. and J. Rovira. 1989. *Mejoramiento genético animal*, Ed. Agropecuária, Hemisfério Sur, Montevideo, Uruguai, 253 p.
- Corrêa, M. J. M. and M. D. S. Mota. 2007. Genetic evaluation of performance traits in Brazilian Quarter Horse. *Journal of Applied Genetics* 48:145-151.
- Ekiz, B.; O. Koçak and H. Demir. 2005. Estimates of genetic parameters for racing performances of Arabian horses. *Turkey Journal of Veterinary and Animal Science* 29: 543-549.
- Moritsu, Y.; A. Terai and T. Tashiro. 1998. Relationship between sire Breeding Values for the Rating Score on Turf and Dirt Racing Tracks in Thoroughbred Racehorses. *Journal of Equine Science* 9: 82-92.
- Mota, M. D. S.; A. R. Abrahão and H. N. Oliveira. 2005. Genetic and environmental parameters for racing time at different distances in Brazilian Thoroughbreds. *Journal of Animal Breeding and Genetics*, 122: 393-399.
- Oki, H.; Y. Sasaki and R. L. Willham. 1995. Genetic parameter estimates for racing time by restricted maximum likelihood in the Thoroughbred horse of Japan. *Journal of Animal Breeding and Genetics*, 112: 146-150.
- Robertson, A. 1959. The sampling variance of the genetic correlation coefficient. *Biometrics*, 15: 469-472.
- Saastamoinen, M. T. and M. J. Ojala. 1991. Influence of birth-month on age at first start and racing performance in young trotters. *Acta Agriculture Scandinavia*, 41: 437-445.
- SAS - Statistical Analysis System 1999: SAS User's guide: Statistical, version. 8. Cary: SAS Institute Inc, 956 p.
- Tolley, E.A.; D. R. Notter and T. J. Marlowe. 1983. Heritability and repeatability of speed for 2 and 3 year old Standardbred racehorses. *Journal of Animal Science*, 56: 1294-1305.
- Turftotal Ltd., 2005. Thoroughbred data control company. Retrieved January 15 2005, from www.turftotal.com.br (in Portuguese).
- VanKaam, J. B. C. H. M. 1998. Gibanal program. Retrieved November 28 2005, from www.student.Wau.nl/~janthijs/breedingsite/edagibanal.html.
- Van Tassel, C. P. and L. D. Van Vleck. 1995. A manual for use of MTGSAM. A set of FORTRAN programs to apply Gibbs sampling to animal models for variance component estimation [DRAFT] U.S. Department of agriculture, Agriculture. Agricultural Research Service.
- Villela, L. C. V.; M. D. S. Mota and H. N. Oliveira. 2002. Genetic parameters of racing performance traits of Quarter horses in Brazil. *Journal of Animal Breeding and Genetics*, 119: 229-234.