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Genetic parameters of finish time in Korean Thoroughbred racehorses

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ABSTRACT

This study was conducted to estimate the annual genetic and environmental trends of Thoroughbred racehorses. A total of 208,043 records collected from horses that raced at Gwacheon racecourse were analyzed. The average generation intervals of the sires of offspring and the dams of offspring were 10.82 and 10.31 years, respectively. The effects of the contemporary groups accounted for more than approximately 44% of the total variation in finish time and were the most important environmental effects in the genetic evaluation model. The range of estimated heritabilities and repeatabilities were from 0.06 to 0.30 and from 0.31 to 0.59, respectively. The estimate of heritability was highest at the racing distance of 1000 m (0.30), and decreased as the racing distance increased. Of the total variance components, the proportion of variance due to the jockey was from 0.02 to 0.06, and it was larger in longer distance races than in shorter ones. According to the results, racehorses accounted for 94.8%, and the jockey for only 5.2%, of finish time. As the racing distance increased, the percent contribution of the jockey also tended to increase. The phenotypic and environmental improvements were −2.140 and −1.492 s over 16 years studied, respectively. On the other hand, genetic gains in racing performance of home-produced and imported racehorses in the same period were −0.459 and −0.369 s, respectively. The genetic improvement of racehorses in racing performance was very consistent, resulting in average gains of −0.029 and −0.031 s per year in home-produced and imported racehorses, respectively.

1. Introduction

The horse racing industry in Korea officially began in 1922, and on October 1st 1998, Korea, along with Turkey, became the 50th country in the world whose stud book was officially approved by the International Stud Book Committee (ISBC). Official approval of Korean Thoroughbred from the ISBC allowed equal exchange with other countries. Furthermore, the groundwork was laid not only for the global image of the Korean Racing Authority as a horse registration and horse racing enforcement organization to be improved, but also for increasing the social recognition of horse racing and horse culture as pedigree sports. As a part of national animal improvement projects, the quality of racehorses has increased and superior racehorse lineages have been produced. In the future, Korea will strive to participate in host Part II of the International Federation of Horseracing Authorities (IFHA).

In foreign countries, racehorse earnings are considered to be one of the most important traits for the evaluation of the individual (Klemetsdal, 1994; Langlois and Blouin, 2004, 2007), and in developed countries, including the USA, the Average Earning Index (AEI) determines the ranking of racehorses. When evaluating racing ability, however, traits such as earnings, placing order and winning rate are not normally distributed, and horses without earnings or winnings can be excluded from analysis. Since Thoroughbred racehorses are reproduced by natural mating, the number of progeny is relatively small compared with that of other animals. Therefore, the distribution of records is biased and environmental effects can't fully explain trends in highest or

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average AEI, which are important evaluation traits (Tolley et al., 1983; Buttram et al., 1988a).

Finish time in each race is the only direct measure of speed and is a suitable quantitative measure that can be used to evaluate the genetic racing performance of horses. Therefore, finish time for racing distance is apparently a well-defined and clear character (Ekiz et al., 2005; Ekiz and Kocak, 2007; Buxadera and Mota, 2008). It has already been reported that the use of repeated racing records is rational when measuring racing ability changes under the current Korean horse racing system (Park and Lee, 1999).

Currently, animal models using BLUP (Best Linear Unbiased Prediction) theory are utilized for the genetic evaluation of most domestic animals at the national level. Many researchers have reported that animals can be improved through the selection of economically important traits. However to achieve this, the establishment of desirable improvement traits and goals must take precedence.

The objective of this study was to provide basic information for the establishment of improvement goals by analyzing the annual genetic improvement of finish time in the racing records of Korean Thoroughbred racehorses.

2. Materials and methods

2.1. Description of the data

The data used in this study were 208,043 finish time records collected from 9934 Thoroughbred racehorses that raced at Gwacheon racecourse in Korea from 1990 to 2006, and was provided by the Korea Racing Authority (KRA). Finish times that were distributed outside 3.5 standard deviations from the mean at each distance were eliminated from the data, as they may represent possible injuries of the racehorses during the race or unavoidable mistakes made by the jockey. Table 1 shows the distributional properties for data structured by distance. Distribution of finish times by racing distance was slightly rightward, but most cases showed a normal shape. As the race distance increased, the standard deviation of finish time, horse weight and age increased. While, the number of records decreased due to the smaller number of longer distance races under the group winning system.

Of the total records, castrated (gelding), stallion and mare comprised 28.7, 20.3 and 51.0%, respectively; and the average number of start per year was 7.5. Racehorses from 3 to 5 years of age comprised 74.5% of the total records, while 3.9% (8091) were 2-year-old horses. Those of 6 and more than 7 years of age comprised 11.4% and 10.25%, respectively. In order to examine the relationship between the number of starts and the finish times by racing distance, finish time records were subdivided in to three groups of 1, 2–9, and 10 or more records.

2.2. Statistical model

The analytical Repeatability Animal Model used for estimating the genetic parameters and expected breeding values (EBVs) was as follows:

$$y_{ijklmno} = \mu + d_i + s_j + m_k + YMDR_l + j_m + a_n + p_n + e_{ijklmno}$$

where, $y_{ijklmno}$ = finish times (s), μ = overall mean, d_i = fixed effect of the ith racing distance (i = 1000 m, 1200 m, 1400 m, 1700 m, 1800 m, 1900 m, 2000 m), s_j = fixed effect of the jth sex (j = gelding, stallion, mare), m_k = fixed effect of the kth year of age (k = 2, 3, …, more than 7 years), $YMDR_l$ = fixed effect of the lth contemporary group (l = 1, 2, …, 19,039), j_m = random effect of the mth jockey (m = 1, 2, …, 214), a_n = random additive genetic effect of the nth animal (n = 1, 2, …, 19,062), p_n = permanent environmental effect of individual animals (n = 1, 2, …, 9934), and $e_{ijklmno}$ = a random residual effect. Var (a) = $A\sigma^2_a$, Var(pe) = $I\sigma^2_{pe}$, and Var(e) = $I\sigma^2_e$, where A = numerator relationship matrix and I = identity matrix.

In the model, contemporary group refers to racehorses that ran together in the same race, and effect of contemporary group for finish time was calculated using the SAS (1999) program. Variance components, genetic parameters and breeding values were estimated by the restricted maximum likelihood method for one trait animal model using the derivative-free process (DF-REML 3.1 program) (Meyer, 1998). The overall trends on finish time were calculated using the method suggested by Wilson and Willham (1986).

3. Results

Thoroughbred racehorses exhibited a long generation interval from 10.21 to 10.83 years (Table 2). The average generation intervals of sires and dams of offspring were 10.82 and 10.31 years, respectively. The effect of the contemporary groups accounted for more than 43.9% (1200 m) of the total variation in finish time (Table 3). The heritability estimate was highest at the 1000 m distance (0.30), and the range of

Table 1
Distributional properties for data structure by racing distance.

Racing distance (m)	Number of[a]						Finish time (s)	Age (year)	Horse mean weight (kg)
	Records	Races	Jockeys	Racehorses	Sires	Dams			
1000	50,051	4549	178	8948	2451	6150	65.39 ± 1.54	3.8	445
1200	49,514	4514	185	8539	2428	5975	78.99 ± 1.69	4.1	447
1400	42,804	3892	209	7199	2213	5193	92.16 ± 1.96	4.5	449
1700	20,733	2010	179	5112	1834	3841	116.24 ± 2.18	4.9	452
1800	21,387	1955	193	4060	1575	3127	122.91 ± 2.31	5.2	454
1900	12,291	1114	161	2614	1236	2117	129.67 ± 2.32	5.6	457
2000	11,263	1005	176	1846	975	1487	136.11 ± 2.43	6.0	461
Overall	208,043	19,039	214	9934	2746	6860	–	4.5	450

[a] Total number of jockeys, racehorses, sires and dams used across all distances (not the column sum).