Original paper

GENETIC AND PHENOTYPIC VARIABILITY FOR RACING PERFORMANCE OF TROTTER HORSE IN SERBIA

Štrbac Lj., Trivunović S.*

University of Novi Sad, Faculty of Agriculture, Department of Animal Science, Trg Dositeja Obradovića 8, 21000 Novi Sad, Serbia
*Corresponding author: ljuba.strbac@stocarstvo.edu.rs

Abstract

Horse race results in studbooks are supposed to give information to manage the selection of trotters based on the analysis of genetic and phenotypic parameters. The objectives of this study was to estimate genetic and phenotypic variability of three racing traits (number of starts, race time and best racing time) of trotter horses in Serbia. The data were obtained from the Trotting Association of Serbia and consisted of 2252 observations. The model included effect of sex, year of birth, season, year of race, distance and race track as fixed effects and sire as random effect. The BLUP sire model was applied to the genetic evaluation of measured traits. Average mean of number of starts, race time and best racing time was 64, 83.15 and 79.28, respectively. Of all tested fixed effects only distance was not statistically significant for number of starts and season for best racing time. However, a statistically highly significant influence of all tested fixed effects on racing time was shown. Heritability estimates were 0.28 for number of starts, 0.19 for racing time and 0.35 for best racing time. The low heritability estimates for number of starts and racing time indicate that selection based on horse phenotypic value induces small genetic change in these traits while middle level of heritability for best racing time indicates that animal's phenotype is a good indicator of genetic merit or breeding value.

Key words: *heritability, racing performance, trotter*

Introduction

Trotter racing is a form of horseracing in which the horses race in a specified gait (trot). Trot is a two-beat gait in which the diagonal limbs move together synchronously (Thiruvenkadan et al., 2009). Horse race results in studbooks are supposed to give information to manage the selection of trotters based on the analysis genetic and phenotypic parameters. Research on the basis of trotting performance was previously done by Minkema (1978), Langlois (1982, 1984a) and Tolley et al. (1985). Later, Ricard et al. (2000) and Thiruvenkadan et al. (2009) also compiled the performance of trotters. In this review, a detailed description of different breeds involved in trotting races has been presented along with description of genetic parameters, breeding evaluation and genetic improvement of the trotters. Trotting performance was mostly measured by time traits, earnings, perfect gaits, number of starts, rank in races and qualification status. Hintz (1980) reviewed the heritability estimates of trotters and reported that log of earnings is highly heritable (0.41) while time, best time and earnings are moderately heritable (0.34, 0.25 and 0.20, respectively). In order to avoid bias in estimation of genetic parameters the effect of some environmental factors should be considered in the statistical model. Most often these are age, sex, year, racing distance, racetracks, track condition, temperature, class of race, starting method, season etc. According to Štrbac and Trivunović (2013) sex, age, season, racetrack and distance have highly significant effect on race time of trotters. Similar results were obtained by Rohe et al. (2001) and Bugislaus et al. (2006). The objective of this study was to estimate genetic and phenotypic variability of three racing traits (number of starts, race time and best racing time) of trotter horses in Serbia.

Material and methods

Individual race records of trotters in Serbia were used in this analysis. Based on information from the Trotting Association of Serbia, data consisted of 2252 observations. Performance data were used in analysis. These included number of starts, race time and best racing time. The model used contained fixed effect of sex, year of birth, season, year of race, distance, racetrack and sire as random effect. Statistical analysis was conducted using the software Statistica 12. Estimation of genetic parameters was conducted using the LSMLMW (Harvey, 1990), intra-class correlation (half-sibs) method. The statistical model was:

$$Y_{ijklmnop}=\mu+S_i+B_j+Se_k+R_l+D_m+Rt_n+Si_o+e_{ijklmnop},$$

Where:

Y: measured traits,

μ: general average,

S: the effect of sex (i=1..3),

B: the effect of year of birth (j=1...13),

Se: the effect of season (k=1,2),

R: the effect of year of race (l=1...15),

D: the effect of distance (m=1...3),

Rt: the effect of racetrack (n=1...29),

Si: the effect of sire (o=1...8),

e: random error is an error term under usual assumptions for ANOVA (the error distributed normally with mean = 0 and constant variance).

Results and discussion

The means and variability of the three measured traits for the trotter horse in Serbia are shown in Table 1. The average number of starts, racing time (s/km) and best racing time (s/km) were 64.85, 83.15 and 79.25, respectively.

Table 1. *Mean and variability of measured traits*

Traits	N	Mean	SD	CV
Number of starts	2252	64.85	35.23	54.33
Racing time, s/km	2252	83.15	3.44	4.14
Best racing time, s/km	2252	79.28	1.70	2.14

N – number of horses; SD – standard deviation; CV – coefficient of variation

Langlois and Vrijenhoek (2004) stated that the career total number of starts observed in French trotters was 30.3. The number of starts might be regarded as a possible indicator of the soundness of a horse's basic conformation (Thiruvenkadan et al., 2009). It can be considered according to the age or for the whole career. Racing time has frequently been used as a measure of racing performance in trotters. A natural choice to measure a performance trait for a racing horse is to measure its ability to run fast (Thiruvenkadan et al., 2009).

Table 2 shows the effect of sex, year of birth, season, year of race, distance, racetrack and sire on number of race, racing time and best racing time. Of all tested fixed effects only distance was not statistically significant for the number of starts and season for best racing time, while a statistically highly significant influence of all tested fixed effects on racing time was shown.

Table 2. *The effect of studied factors on measured traits*

Traits	Number of race		Racing time		Best racing time	
Source variability	F	P	F	P	F	P
Sex	29.989	0.0000**	21.617	0.0000**	124.868	0.0000**
Year of birth	94.981	0.0000**	59.174	0.0000**	77.036	0.0000**
Season	9.335	0.0023**	22.143	0.0000**	0.005	0.9463ns
Year of race	17.953	0.0000**	39.287	0.0000**	2.742	0.0005**
Distance	0.189	0.8274ns	28.236	0.0000**	6.480	0.0016**
Racetrack	4.922	0.0000**	14.113	0.0000**	3.644	0.0000**
Sire	12.793	0.0000**	8.527	0.0000**	15.620	0.0000**
R^2	*0.578*		*0.419*		*0.498*	

The racing records reflect the speed capacity of a horse when many favourable environmental conditions are met, it is the sum of the effects of many genetic and environmental factors (Arnason, 2001). When trotting performance is measured, the horse’s age, sex, birth year, race distance, racetrack, track conditions, prize money, racing season and year are often taken into estimation of breeding value. Age and gender effects are mostly investigated and they will be examined further, as well as the year of racing with the genetic progress. Effect of racing distance on the speed is observable in countries having a wide range of distances in races. Accordingly this effect can bias the estimation of the effect of age because younger horses race on shorter distances (Thiruvenkadan et al., 2009). Racetrack effect results from some physical conditions such as the type of ground (grass being slower than the sand), shape of the curves and evenness and length of the straight lines (Thiruvenkadan et al., 2009). Highly significant effect of all mentioned on trotting horse speed was found by Bugislaus et al. (2006), Rohe et al. (2001), Katona and Distl (1989) and Štrbac and Trivunović (2013). It is thought that by using individual race information, enviromental factors (rather than just pure genetic factors) will be able to be estimated much more accurately and information from each record will be more appropriately weighted in the final breeding value.

Heritability is one of the most important concepts in animal breeding. There are several working definitions, as heritability is used to help plan breeding programs, determine management strategies, estimate breeding values of individual animals and predict response to selection (Štrbac and Trivunović, 2014). An intensive selection of stallions on the basis of phenotypic racing performance has been practised in many trotter populations for quite a long time. Improvements have been observed in different trotter populations and this is attributed to both genetic and environmental changes. Studies devoted to the estimation of the heritability of the traits linked to racing performance are fundamental for the development of consistent genetic breeding programs. The heritability estimates, genetic and phenotypic correlations are shown in Table 3. Heritability estimates were 0.28 for number of starts, 0.19 for racing time and 0.35 for best racing time. The low heritability estimates for number of starts and racing time indicate that selection based on horse phenotypic value induces small genetic change in these traits while middle level of heritability for best racing time indicates that animal's phenotype is a good indicator of genetic merit or breeding value. There was a negative genetic correlation between time traits and number of starts as was expected because a decrease in the time traits is always related to the improvement in the performance results in races.

Table 3. *Heritability estimates (on the diagonal), genetic (below diagonal) and phenotypic correlation (above diagonal) for measured traits*

Parameters	Number of race	Racing time	Best racing time
Number of race	**0.28**	0.07	0.12
Racing time	-0.55	**0.19**	0.36
Best racing time	-0.40	0.92	**0.35**

Heritability estimates of racing performance range from low to moderate, and traits used in genetic evaluation of trotters are racing time, earnings, percentage of placings, and number of disqualifications in races (e.g., Ojala, 1987; Klemetsdal, 1994; Pösö and Ojala, 1997; Arnason, 1999; Thuneberg Selonen et al., 1999; Bugislaus et al., 2005; Langlois and Blouin, 2007). Klemetsdal (1994) observed that the heritability estimates in Norwegian Trotters for transformed number of starts in 3, 4 and 3 to 6 years of age were 0.02, 0.07 and 0.10, respectively. Arnason et al. (1989) also reported low heritability estimates for number of starts in 3-, 4-, 5- and 6-year-olds and the estimates were 0.07, 0.04, 0.02 and 0.07, respectively, in Swedish Standard bred Trotters. The heritability of the time traits was to the range found in the reviewed bibliography, 0.08–0.50 (Ojala and van Vleck, 1981; Ojala, 1987; Arnason, 1999; Bugislaus et al., 2005; Gomez et al., 2010). The genetic correlations between number of starts and the other traits according to Thiruvenkadan et al. (2009) were generally fairly low.

Conclusion

Selection of stallions on the basis of phenotypic racing performance has been practised in Serbian trotter populations for quite a long time. Knowledge about the genetic and phenotypic parameters of the trotter horse in Serbia represents an actuality issue if we take into account that such studies are inexistent. In addition, selection and genetic improvement must be based on the analysis of the heritability and average values of racing performance in horse populations used in the race and breeding. The analysis of heritability of the racing performance in the Serbian population of trotters indicates that best racing time has the highest level (0.35). In animal breeding, the knowledge about genetic parameters of the traits that we are interested in is the first prerequisite in establishing a selection programme. Therefore, this traits should be main selection criterion in breeding programme. Because of a high genetic correlation between racing time traits (0.92), direct selection could also result in adequate selection accuracy for racing success for these traits, but modern animal breeding requires dynamic breeding schemes in which it is necessary to use genetic evaluation of breeding animals.

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