Original Paper

Influence of indirect factors and its effect analysis on performance level of Slovak warmblood horse breed

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During their career, horses are affected by a large number of direct and indirect factors. The aim of our study was to determine the effect of indirect factors, such as year of start, sex, breed, number of starts, age and proportion of genes of Slovak Warmblood horse breed. For determination of indirect factors on performance level, results from test efficiency and final placement in showjumping category 4, 5 and 6 years old young horses were used. 540 horses of Slovak Warmblood breed were analysed between 2015–2019 and 1,155 data samples were collected. Based on the results of the linear model, parameters – the effect of gender and the influence of the gene proportion of Slovak Warmblood horse had statistically significant influence (p <0.05). High significant effect (p <0.001) on performance of Slovak Warmblood horse was observed in parameters – year of start, age during start and breed.

Keywords: horse, indirect factors, performance

1 Introduction

Systematic selection based on the gene pool and exterior of bred horses ensures and increase in the performance level of sport horses. The main goal of breeding is to obtain individuals that can achieve best sport results under certain environmental conditions (Krattenmacher el a., 2014) There are many factors that affect horse´s performance. According to model compiled by Stewart et al. (2010), the permanent environment of horses represents phenotypic variance of 11.5%. This represents the impact of housing, rearing, training, nutrition, influence of mother, etc. To sport placements in sports is influenced by many factors and heredity. Inheritance of placement in dressage and jumping competitions is relatively low ($h2$ = 0.05–0.10) Ricard et al. (2000). Schröder et al. (2012) and Luehrs-Behnke et al. (2002) estimate similar genetic correlations (0.78 and 0.80) between jumping with a rider during performance trials and competitions. Van Veldhuizen (1997) estimated the genetic correlation between the results of Dutch stallion performance test and competitions at 0.90. In the production of quality sport horses, data from jumping competitions are important as they serve as basis for genetic evaluation. In Germany, Belgium and Ireland, all horses in the competition are included, not only the horses finishing in the first places (Schubertová et al., 2014).

2 Material and methods

In our study, we analysed to determine the effect of indirect factors, such as year of start, sex, breed, number of starts, age and proportion of genes of Slovak Warmblood horses based on performance parameters in sports testing. The monitored specimen were warm-blood horses that participated in performance tests of warm-blood horses in the population of Slovak Warmblood horses and results from sports testing in show jumping category 4, 5 and 6 years old young horses. The basis for the elaboration was data obtained from a recognized breeding organization – Association

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of Horse Breeders in Slovakia, which maintains the breeding book of the Slovak Warmblood horse and from the results of the parkour jumping competitions of the Slovak Equestrian Federation for the range of 2015–2019. Total number of data collected in the database is 1,155 from 540 individual horses. To estimate the effect of indirect factors affecting performance, we compiled two model equations to independently assess the breed and the factor of the Slovak Warmblood horse gene proportion. These models were tested using the GLM (General linear model) procedure. Data obtained were processed using the linear GLM model in statistical programme UNISTAT 5.1.

Model equation:

$$y_{ijklmn} = \mu + a_i + b_j + c_k + d_l + f_m + e_{ijklmn}$$

where:

y_{ijklmn} – evaluated value; μ – overall mean; a_i – fixed effect gender (i = 1, 2, 3); b_j – fixed effect breed (j = 1–13); c_k – fixed effect age (k = 1–12); d_l – fixed effect year of start (l = 1–8); f_m – fixed effect number of starts (m = 3–9); e_{ijklmn} – random error

$$y_{opqrst} = \mu + a_i + b_j + c_k + d_l + f_m + e_{ijklmn}$$

where:

y_{opqrst} – evaluated value; μ – overall mean; a_i – fixed effect gender (i = 1, 2, 3); b_j – fixed effect proportion of genes SW (j = 1–9); c_k – fixed effect age (k = 1–12); d_l – fixed effect year of start (l = 1–8); f_m – fixed effect number of starts (m = 3–9); e_{ijklmn} – random error

3 Results and discussion

Based on our hypothesis, the factors – year of the start, sex, breed, number of starts and age in the year of the competition have a significant effect on performance of horses. Table 1 presents the results of the GLM model, which takes their impact on performance into account. Factors such as year of start, breed, number of starts and age show statistically significant effect on performance of horses in competitions. We found a weaker but still statistically significant influence in the "sex" parameter.

Table 1 Effect of observed factors on performance horses

Source of variability	Sum of squares	*df*	Mean square	*F*	Significance
Year of start	6,987.321	7	1,231.031	158.715	+++
Sex	43.952	2	21.826	3.591	+
Breed	321.165	12	27.657	4.533	+++
Number of starts	269.983	8	41.848	7.297	+++
Age	461.091	11	50.532	8.397	+++

Square R = 0.5921, adjusted R-square = 0.5016; Sig. +P <0.05; ++P <0.01, +++P <0.001

Results regarding the effect of age are in consent with other studies, that have usually found that performance increases with age (Kearsley el al., 2008; Koenen, 2002). The longevity of sport horses is an economic and ethical issue (Ricard and Blouin, 2011). Our results confirm that the age of horses is important in relation to performance, as it increases time that can be used for their primary purpose of competition. Longevity is therefore considered one of the most important characteristics by potential buyers on the market (Hennessy et al., 2008). Although we cannot influence the hereditary longevity, with rational approach in training and management of horse-athletes we can prolong the productive age and subsequently help the horses with their later application (Goščík, 2000). Due to the different proportion of genes in the pedigree of the monitored horses, in Table 2 we present the influence of the factors of the gene proportion of Slovak Warmblood horse and other standard factors. We recorded a statistically significant effect

in factors – year of start, number of starts and age. The effect of factors such as age and gene proportion of Slovak Warmblood horse is lower but statistically significant.

Table 2 The effect of observed parameters on horse performance

Source of variability	Sum of squares	df	Mean square	F	Significance
Year of start	6,908.870	7	1,021.132	159.632	+++
Sex	46.947	2	22.070	3.612	+
Number of starts	272.911	8	42.967	7.108	+++
Age	493.849	11	55.851	8.873	+++
Gene proportion	101.879	7	11.678	2.130	+

Square $R = 0.5933$, adjusted R-square = 0.5641; Sig. $+P < 0.05$; $++P < 0.01$, $+++P < 0.001$

Our results are in agreement with the claims of de Mare et al. (2017), which confirms the fact that each sport has its own set of essential factors. There is also a growing evidence that breed and age have an important impact on these performance parameters. Stallions and geldings perform better according to studies (Koenen et al., 2004). I tis important to take into account not only the characteristics of the individual horse but also other conditions such as riding, horses´ environment, economy situation of the team and individual goals of the season (Castejon-Riber el al., 2017). Due to long generation interval, genetic improvement in the horses requires a long time span, therefore the application of the genetic markers in selection schemes to improve the physical performance appear to be highly desirable (Schröder et al., 2012). Genetic evaluation based on competition results obtained during the competitive life period is often inadequate to analyse linear models without changes to normalize the distribution, and without the differences between individual competition groups even distribution (Stewart el al., 2010).

4 Conclusions

Based on our obtained results, we can state that the indirect factors selected by us significantly affect the sports horses´ performance level of Slovak Warmblood horse. The system by which the indirect performance characteristics is evaluated is not commonly used but our results point to a significant influence that have to be taken into account in the selection of sport horses.

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