Livestock Science 128 (2010) 36–45

Contents lists available at ScienceDirect

Livestock Science

journal homepage: www.elsevier.com/locate/livsci

Genetic evaluation of horses for performance in dressage competitions in Great Britain

I.D. Stewart [a,*], J.A. Woolliams [b], S. Brotherstone [a]

[a] Institute of Evolutionary Biology, University of Edinburgh, Kings Buildings, West Mains Road, Edinburgh, EH9 3JF, UK
[b] The Roslin Institute, Royal (Dick) School of Veterinary Studies, University of Edinburgh, Roslin, Midlothian, EH25 9PS, Scotland, UK

ARTICLE INFO

Article history:
Received 27 April 2009
Received in revised form 2 October 2009
Accepted 12 October 2009

Keywords:
Horse
Dressage
Genetic evaluation
Competition

ABSTRACT

Genetic evaluation of sport horses for dressage competition and estimation of breeding values are performed in many Northern European countries. To date, no such system has been used in GB. The aim of this study was to estimate genetic parameters for performance in dressage competition and then to predict breeding values for horses competing in dressage in GB using an animal model. The percentage of marks awarded was used as the performance measure. Random effects comprised additive genetic, horse permanent environment, class, event and class–event interaction. Horse gender, age, height and competition standard were included as fixed effects. In a second model, breed class was added as a fixed effect. Heritability (SE) of performance in the two models was 0.15 (0.018) (no breed) and 0.11 (0.036) (including breed). In both models age was significantly associated with performance ($P<0.001$), with performance peaking at age 10. Stallions performed significantly better than geldings. A significant association between performance and height was detected only in the model which did not include breed effects. The model including breed was considered to be the most appropriate, given the nature of the sport horse population in GB. It should be possible to predict breeding values of sufficient accuracy.

1. Introduction

Genetic evaluation of sport horses for adult dressage competition is performed in many countries. The approach can take different forms — either direct evaluation based on adult competition results, or using an indirect measure of performance from traits examined at young horse tests, or a combination of both. Most evaluations now use a combination of young horse and adult data, including the Swedish Warmblood (Thorén Hellsten et al., 2009), Royal Warmblood Studbook of the Netherlands (KWPN), Hannoverian, Oldenburg, and Trakenner (Janssens, 2008; Luehrs-Behnke et al., 2002). Estimated breeding values from many of these evaluations are routinely published, to inform and aid selection of sport horses for breeding to produce progeny with high performance ability. Success in breeding elite internationally competitive horses is evident among these studbooks, as demonstrated by the high representation of horses from these studbooks competing in the dressage event at the 2008 Olympic Games, with Hannoverian, KWPN, Oldenburg, and DWB being the most represented (FEI, 2008).

Dressage tests the gaits, ridability, athleticism and transition between movements of the horse under the rider. Horse and rider complete a series of predefined movements (a test) in an arena of a specific size which is scored by expert judges. Genetic evaluations based on performance in dressage competition use a variety of measures such as the rank (DWB, SF), highest level (KWPN) or earnings (SF), derived from an individual competition, or from annual or lifetime cumulative performances. The distribution of these measures is often inappropriate for analysis with linear models without transformations to normalize the distribution and make variances homogeneous between competitions/groups. Most protocols for routine competition evaluations exclude the highest levels of

* Corresponding author. Tel.: +44 131 650 5440; fax: +44 131 650 6564.
E-mail address: I.D.Stewart@sms.ed.ac.uk (I.D. Stewart).

1871-1413/$ – see front matter © 2009 Elsevier B.V. All rights reserved.
doi:10.1016/j.livsci.2009.10.011

competition, such as The Olympic Games and World Championships (Koenen, 2002).

There are advantages and disadvantages in using either adult competition results or young horse tests in evaluations. Competition data typically covers a large proportion of the population, even though only a selection of competition results may be recorded, whereas young horse data may be highly selected. There is a relatively short time period from birth to obtaining the data (3–6 years) in young horse tests compared to competition results, promoting selection with shorter generation intervals, which in turn gives more opportunity for generating genetic gain. However young horse traits will only be effective in selecting for later competition success if they are heritable and genetically correlated with later adult competition performance. An important practical consideration is the number of records available since this, along with the heritability, will determine the accuracy of prediction. British Dressage (BD), the governing body for the sport in Great Britain (GB), has collected data on competition results since 1978, while the young horse performance tests were introduced by the British Equestrian Federation (BEF) as recently as 2002, and are still developing. Therefore while the optimum system of genetic evaluations will make use of both sources, the priority in GB for introducing evaluations is to use competition data.

Most evaluations are conducted by studbooks and therefore refer to a relatively homogeneous gene pool, particularly for those that have remained closed for a long time period, and few evaluations include a number of breeds. An exception is the German national evaluation, which includes all Warmblood breeds. However breed is not explicitly included as an effect in the model and all the breeds are regarded as being sufficiently related to treat as a homogeneous group. In contrast, the GB dressage data relates to a large number of different breeds, including Warmbloods and native British ponies. Therefore evaluations based on GB competition data will need to encompass many breeds, and hence will differ from the single breed evaluations produced in other countries.

In general, the same methodology is used to perform routine evaluations across all countries (Koenen, 2002). Typically, mixed effects models, using Residual Maximum Likelihood (REML) are used to estimate variance components for random effects (e.g. additive genetic and horse permanent environment), while simultaneously assessing the effect of fixed variables on the horse's performance. After estimating these parameters Best Linear Unbiased Prediction (BLUP) animal models are used to compute breeding values for all animals in the pedigree. A pre-requisite for this analysis is sufficient genetic connectedness within the population, which is a function of the relationships between the horses (e.g. half-sibs, cousins) with records, and therefore an important aspect of developing genetic evaluations is accumulating the pedigree within the databases and ensuring its integrity.

No genetic evaluations for dressage performance have yet been developed in GB, excluding the dressage phase of eventing (Kearsley et al., 2008), and this study has the objective of developing appropriate models that can be used for routine calculation. It is also intended that the availability of predicted breeding values to horse breeders and owners should be as wide as possible. For these reasons, as argued above, development of the evaluation will need to be based initially upon competition data collected by BD. This is the first use of this data for genetic evaluations and the study needs to address the integrity of pedigree recorded, the options for traits upon which to base predicted breeding values, and the development of a parameterized model across multiple breeds.

2. Materials and methods

2.1. Structure of dressage competitions in GB

BD is responsible for regulating and recording results of dressage competitions in GB, and for recording results of British riders/horses competing internationally. In a competition, the horse and rider receive marks for completing a specific predefined series of movements, known as a test, with higher marks indicating a better quality of performance. A class is the term given to a particular type of test with further definitions, for example class E48SRQ refers to test 48 (which is elementary standard) performed as a summer-restricted-qualifier. A class is conducted over multiple locations and dates, and a specific location and date will be termed an event. At each event, a number of different classes will be run. Classes are grouped into standards, so that standards are an attribute of the test rather than the horse. There are 12 competition standards in the BD data, among which 5 display explicitly a grading in ability (in decreasing order: Advanced, Advanced Medium, Medium, Elementary and Novice), 3 are concerned with young riders (Under-21 Young Riders, Under-21 Juniors and Under-21 Ponies), with 4 others (Freestyle, Area Festival, Medium Elite and Horse Trials).

2.2. Databases and data structure

National and international competition results from 1978 onwards were obtained from BD including all BD affiliated competitions. This was combined with pedigree data obtained from the National Equine Database (NED) which contains records for all horses with a passport and pedigree data for some studbooks. All horses born or resident in the UK on or after 2004 are required to have a passport. Pedigree data for some horses preceding the introduction of passports were available. The initial dataset was formed including all competition records since 1978 that satisfied the following criteria: i) the horse was registered to a studbook with pedigree data available in NED, and ii) as a general rule (although not completely adhered to) the horse had scored points for performance, which corresponds to a percentage mark of 60% or greater. BD routinely only record competition results in the database where the horse scores points i.e. gains 60% or more. Note that although BD only collects data on GB horses, i.e. excluding Northern Ireland, NED covers all of the UK, and so estimated breeding values (EBVs) from Northern Irish horses may be predicted from the analysis.

2.3. Data handling

Initially, competition records without details of the event, age or gender of the horse, or where both parents were unknown were discarded (leaving 183,551 from an original 222,369 records). Data was then cleaned to address a number of quality issues. Firstly a simplified model for the classes and