The Veterinary Journal 197 (2013) 273–279

Contents lists available at SciVerse ScienceDirect

The Veterinary Journal

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

Impact of health disorders and culling reasons on functional and biological longevity in Warmblood breeding stallions

U. König von Borstel *, V. Bernhard

Georg-August Universität Göttingen, Department of Animal Science, Albrecht-Thaer-Weg 3, 37075 Göttingen, Germany

ARTICLE INFO

Article history:
Accepted 21 February 2013

Keywords:
Longevity
Survival analysis
Stallion
Health disorders
Breeding

ABSTRACT

The objective of this study was to compare the impact of health disorders and reasons for culling on the functional and biological longevity of warmblood breeding stallions using semi-parametric survival analysis accounting for competing risks. Complete breeding records were collected from 455 warmblood stallions serving between 1975 and 2010 at Marbach State Stud in Germany. The median length of life (18.0 years) was twice as long as the median length of service (9.0 years). However, both figures increased significantly over the time period examined (e.g., functional longevity increased from 5 years in the 1970s to 8 years in the 1980s to 12 years in the 1990s).

Compared to disorders of the musculoskeletal system, hazards for termination of functional life were higher for infectious diseases with a hazard ratio (HR) of 3.5, and for dissatisfaction with performance (HR, 2.0). Hazards were lower for disorders of the respiratory system (HR, 0.78), followed by accidents (HR, 0.58), disorders of the reproductive system (HR, 0.51), sale for non-breeding purposes (HR, 0.40), disorders of the gastrointestinal system (HR, 0.36), unknown reasons (HR, 0.32) and disorders of the cardiovascular system (HR, 0.25). For biological life, the relative importance of these disorders was similar.

Factors linked to demand for stallions such as coat colour and several parameters of the stallions' genetic merit (negative influence) and own performance (positive influence) in dressage and particularly in show-jumping influenced ($P < 0.05$) or tended to influence ($P < 0.1$) functional, but not biological longevity. Furthermore, hazards for both functional and biological life declined with rising stud fees (both HR, 0.99; $P < 0.0001$). A more direct consideration of both functional and biological longevity in breeding programmes might help to further enhance both figures, and therefore welfare of the horses.

Introduction

Both functional and biological longevity in riding horses are important for economic as well as animal welfare and ethical reasons. Data on functional longevity of riding horses (i.e. the number of years participating in, or registered for competition) are readily available from equestrian federations. Analysis of such data revealed that on average, horses' sport careers are rather short, with a range of between 3 and 5 years of competition (Lindner and Offeney, 1992; Friedrich et al., 2011; Ricard and Blouin, 2011). In addition to absolute length of sport careers, analysing these data may yield some important information regarding the impact of factors such as gender, rider level, age at first start or breed (Ricard and Fournet-Hanocq, 1997).

However, such data do not generally contain information on the detailed reasons for termination of the sport career. Disease or injury to an equine athlete are as likely to contribute to termination of a career as owner-based reasons such as lack of time or money for continuation of equestrian competitions. More commonly data from the Thoroughbred (Jeffcott et al., 1982; Rossdale et al., 1983; Johnson et al., 1994; Olivier et al., 1997; Wilsher et al., 2006) or Standardbred (Jorgensen et al., 1997; Hayek et al., 2005; Arnason, 2006) racehorse populations are available, but there are profound differences in type of use, housing, management, and thus risk factors for race horses compared to riding horses.

Occasionally, data from horses delivered to abattoirs (Wesson and Ginther, 1981) or to veterinary hospitals (Baker and Ellis, 1981) are available to investigate the impact of various health conditions on longevity in riding horses. However, considerable bias may be present in such data, of which referral bias can be minimised using data obtained via questionnaires (Wallin et al., 2000; Ireland et al., 2011), or from insurance companies (Gutekunst, 1977; Köning, 1983; Hommerich, 1995; Egenvall et al., 2006). Generally, these studies revealed disorders of the musculoskeletal system (41–61%) as the main reasons for death or euthanasia followed by disorders of the respiratory system (9–17%) and the gastrointestinal system (6–14%) (Clausen et al., 1990; Lindner and Offeney, 1992; Wallin et al., 2000). However, data from questionnaires and

* Corresponding author. Tel.: +49 551 3910139.
E-mail address: koenigvb@gwdg.de (U. König von Borstel).

1090-0233/$ - see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.tvjl.2013.02.026

Table 1a

Overview of collected information (categorical variables), the consideration of variables in different models for analysis and the influence of these factors on demand for stallions (i.e. number of first matings/inseminations per year, which corresponds to the number of different mares covered). LS-mean-values represent least square means, i.e. marginal means which are an estimate of the means after adjustment of other influencing factors (see Table 1b for linear factors included in addition to the below factors in the respective models). Presented values and SEs are from analyses of untransformed data, level of significance from transformed data. Different letters (a, b, c) indicate statistically significant differences within factor at $P < 0.05$ after adjustment for multiple comparisons.

Factor – levels	Descriptive statistics		Models (total N)	Influence on demand	
	% of stallions	(n)		P-value	LS-mean ± SE
Breed type			A1–3 (455)	$P = 0.0022$	
Other warmblood[A]	29.0	(132)			25.3 ± 1.7^{a}
Hanoverian	20.4	(93)			24.2 ± 1.7^{a}
Trakehner	17.1	(78)			$23.3 \pm 1.7^{a,c}$
Württemberger	33.4	(152)			$19.5 \pm 1.4^{b,c}$
Decade			A1–3	$P = 0.0007$	
1970s	22.0	(100)			$20.0 \pm 1.7^{a,b}$
1980s	25.7	(117)			18.8 ± 1.4^{a}
1990s	21.8	(99)			$24.6 \pm 1.8^{b,c}$
2000s	30.6	(139)			28.9 ± 2.2^{c}
Coat colour			A1–3	$P = 0.0527$	
Bay	35.0	(159)			$22.0 \pm 1.4^{a,b}$
Liver chestnut	3.7	(17)			$21.6 \pm 3.2^{a,b}$
Chestnut	23.1	(105)			20.0 ± 1.5^{a}
Brown	22.2	(101)			$24.4 \pm 1.9^{a,b}$
Black	10.1	(46)			26.9 ± 2.1^{b}
Grey	5.9	(27)			$23.5 \pm 1.8^{a,b}$
Culling reason			A1–3	$P = 0.0001$	
Voluntary	70.3	(320)			20.1 ± 1.2^{a}
Involuntary	24.8	(113)			26.0 ± 1.5^{b}
Type of service[B]			A1–3	$P < 0.0001$	
Natural service	79.4	(–)			22.1 ± 0.9^{b}
Fresh semen	11.5	(–)			37.1 ± 1.6^{a}
Frozen semen	9.2	(–)			10.0 ± 1.9^{c}
Type of PT[C]			B1–3 (369)	$P > 0.1$	
70-day PT	73.4	(334)			/
30-day PT	5.9	(27)			/
Qualification via sport	1.8	(8)			/

[A] The group 'other warmblood' is comprised of breeds represented at lower frequencies such as the Holsteiner ($n = 43$), Westphalian ($n = 32$), Oldenburger ($n = 27$), other German warmblood breeds ($n = 13$) or other European warmbloods (together $n = 13$).
[B] Information collected yearly per stallion; values refer to the number of records rather than the number of stallions as stallions may provide e.g. simultaneously fresh and frozen semen.
[C] PT, performance test ('30/70-day' refers to the length of time spent on station for performance testing. Stallions passing the 70-day PT are evaluated in a larger number of traits and obtain full licensing, while those passing the 30-day PT require additional qualifications via sport or additional on-station testing).

insurance companies also provide potential for information bias (Egenvall et al., 2009b). For example, there may be larger incentives for owners of insured horses to euthanase their horse.

The objectives of the present study were therefore to use complete life histories to assess the relative importance of various health disorders as well as factors linked to demand for and performance of stallions on the length of biological as well as functional life of sport horse breeding stallions.

Material and methods

Data

Information on number of years in service and length of life of a total of 455 stallions serving between 1975 and 2010 at Marbach State Stud, Germany, was obtained from the stud's breeding records. Stallions were either housed at the stud or their semen was sold via the stud but they were housed for parts or the entire time of their service at other stables within Germany. All data were extracted from the detailed text of the studbooks and breeding records and copied manually by one person into a spread sheet. In addition to longevity, these data also included the reasons for death or termination of the breeding service at the Marbach Stud, as well as all variables listed in Tables 1a and 1b. Breeding values (BVs) were obtained from the Yearbooks of the German Equestrian Federation (e.g. FN, 2010). Stud fees were converted into Euros[1] if stated in Deutsche-Marks.

Reasons for termination of the breeding service were divided into two categories, voluntary (sold for breeding or non-breeding purposes) and involuntary (infertility, accidents and diseases leading to death or euthanasia). The latter were further grouped into the following categories adapted from Butler and Armbruster (1984) and Björnsdóttir et al. (2003): (1) disorders of the respiratory system (e.g. heaves, bronchitis); (2) disorders of the cardiovascular system (e.g. thrombosis, heart failure); (3) disorders of the reproductive system (all reasons leading to castration); (4) disorders of the musculoskeletal system (e.g. laminitis, navicular disease, bone spavin); (5) disorders of the gastrointestinal system (e.g. colic, rupture of colon); (6) infectious diseases (e.g. tetanus, rabies); (7) trauma/accidents resulting in fatal injuries; (8) temperamental disorders (dangerous or undesired behaviour leading to castration or culling); (9) dissatisfaction with performance (e.g. castration due to non-medical reasons); (10) unknown reasons (e.g. the horse was found dead and detailed reasons were not investigated, or the horse was sent to slaughter, and no detailed reasons were given).

Statistical methods

All analyses were conducted with SAS 9.2. Data distributions were checked using the procedure UNIVARIATE and log transformed, if necessary (service fee, number of first inseminations) to achieve an approximate normal distribution. Predicted versus residual values plots from mixed model analysis (see below) were used to screen variables for violation of the linearity assumption. Longevity data were considered censored, if the stallions left the stud alive (biological longevity) or if they left the stud as an entire male, for example for use in sport or for use as a breeding stallion elsewhere (functional longevity). Semi-parametric survival analysis (proc PHREG based on the Cox proportional hazards model, (Cox, 1972, 1975)) accounting for right censoring was used to assess the appropriateness of the proportional hazards assumption as well as to calculate the impact of influencing factors on longevity.

The adequacy of the Cox regression model was assessed based on martingale residuals. If the proportional hazards assumption was not fulfilled, partial, quadratic transformations were used to achieve proportionality. The model was chosen to allow for modelling of potentially time-dependent, influencing factors. However, since data were recorded on a discrete scale (only the year, not the exact date of first and last service was known) there were numerous ties in the data set, requiring

[1] €1 = approx. US$1.25, £0.80 at 13 June 2012.