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AUTHORS: Hanousek, K., Salavati, M., Fouladi-Nashta, A.

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The effect of horse gender on British Eventing competition performance: An observational study between 1998-2016

Katherine Hanousek[1], Mazdak Salavati[2], Ali Fouladi-Nashta[1]*

1. Comparative Biomedical Sciences Department, Royal Veterinary College, Hawkshead Campus, North Mymms, AL9 7TA, United Kingdom 2. Pathobiology and Population Sciences Department, Royal Veterinary College, Hawkshead Campus, North Mymms, AL9 7TA, United Kingdom

** Correspondence: khanousek5@rvc.ac.uk Tel: 07919976665*

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Abstract:

To test the hypothesis that gender affects horse score in eventing competition, data on the scores and points awarded to 681 horses was collected from the British Eventing website. Equal numbers of mares, geldings and stallions were used, all foaled during or after 1994 and aged four to ten years. The study included five levels of competition (BE90, BE100, Novice, Intermediate and Advanced) and investigated differences in mean phased scores, total scores, and rank in competition. Additionally, the mean and median 'BE points per competition' of each gender was compared. Significant differences in performance between genders were found at all levels except Advanced. Differences were highlighted in average phased and total scores, rank, and median points per competition. There was an overall pattern of stallions and geldings outperforming mares, though this was not found to be true at all levels. The only area in which mares were found to perform significantly better than geldings or stallions was show-jumping time penalties at BE90.

Introduction:

The aim of this study was to compare the eventing performance of stallions, geldings, and mares in equal numbers to test the hypothesis that gender affects the performance of horses in British Eventing (BE) competition. Sexual dimorphism is present in horses (Marlin, 2014) and gender differences in sport exist in other species (Holden, 2004) and in other equestrian sports (Entin, 2007). Therefore, there is a chance that gender differences can be observed in eventing, particularly between stallions and mares but also between stallions and geldings.

Eventing consists of three disciplines, dressage, show-jumping and cross country, the scores from which are added on a cumulative penalty basis, meaning that the horse finishing on the lowest penalty score wins. In both show-jumping and cross country time penalties can be incurred. Jumping penalties can also be incurred for refusals in both phases, and for knocking down fences in show jumping (*British Eventing*, 2009). Elimination from competition can be due to several reasons, some of which are indicative of the horses' performance, such as refusing fences. Other reasons for elimination such as taking the wrong route on the course are not directly indicative of horse performance (Seo *and others*, 2016). British Eventing points are also awarded to horses in Novice classes and above: the number of points a horse gains depends on its rank in the competition. Winners receive the most points, and more points are given out for classes with more competitors. Points are also awarded to unplaced horses which have no show-jumping penalties and no cross country jumping penalties (Seo *and others*, 2016). Horses can compete in classes ranging from BE90, BE100, Novice, Intermediate and Advanced, in increasing order of difficulty (*British Eventing*, 2009).

Although there is generally a preference among riders to compete with geldings (Marlin, 2014), there has been relatively few studies focused on the impact of horse gender on performance in eventing competition(Whitaker and Hill, 2004; Posta *and others*, 2014). Comparing mares and geldings in eventing, Whitaker *and others* (2008) found no significant difference between genders for mean phased and final penalty scores, median rank or points. However, they didn't have enough stallions within the dataset for comparative statistical analysis.

Materials and Methods:

Data collection

The sample population of horses *(n = 681)* consisted of 227 mares, geldings and stallions who competed in BE events in the years 1998-2016. All horses were foaled during or after 1994. To obtain a similar sample size in the three groups all stallions with relevant data recorded on the British Eventing website (*British Eventing*, 2009) were included and mares and geldings were randomly selected. Only scores gained when the horse was between four and ten years old (inclusive) were used. Eliminations and retirements were not used in the analysis of scores and rank, as these are not always indicative of horse performance. Competitions where the horse was eliminated were used in the analysis of points. Only classes BE90, BE100, Novice, Intermediate and Advanced were used. The data collected from this population included the following categories: Dressage penalty scores (DR), Show-jumping jump penalty scores (SJJ), Show-jumping time penalty scores (SJT), Cross country jump penalty scores (XCJ), Cross country time penalty scores (XCT), Total score (sum of all penalties), Final rank in competition, Number of BE points awarded to individual and Number of competitions attended where the individual could have gained BE points (including those where the horse was eliminated).

Analysis of scores and rank

For each class the phased scores, total score, and rank were divided by the maximum achieved in that section to scale the scores and make them comparable. The scores were then tested for the homogeneity of variance and as values for some of the categories were significant the data was tested with a Kruskal-Wallis test. For every horse in the sample population which had BE points *(n = 296)* the number of points that individual gained and the number of competitions that individual attended where it could have gained points were both recorded; this included all competitions at Novice and above, including competitions where the horse was eliminated. This meant an average of 'points per competition' could be calculated for each horse. BE points and number of competitions were recorded for the entire career of the horse, regardless of age, but still foaled during or after 1994 and competing between the years of 1998 and 2016.

Results:

A total of 1541 scores were taken from the sample population. The number of scores collected for each class varied (Fig. 1), with the most in BE100 *(n = 539*) and the least in Advanced *(n = 49)*. The correlation coefficient between rank and total score was found to be 0.663 indicating a strong positive correlation. Better performing horses would be ranked higher, and given a lower rank number (as the best rank is 1). Therefore, lower rank numbers (indicating better performance) were correlated with lower total score (also indicating better performance).

Phased and total scores

Table 1 shows the mean phased and total scores for horses in each class. In rank, phased, and total scores, a lower number indicates better performance. At BE90 mares have fewer SJJ and SJT penalties than geldings and stallions, and stallions have more than mares and

geldings. Geldings also have fewer XCJ penalties at BE90 than stallions and mares. Stallions have fewer XCJ and XCT penalties than mares and geldings at BE100. At Intermediate level there is a difference between the DR penalties of geldings and mares, with geldings incurring fewer penalties. Geldings also have fewer XCJ penalties at Intermediate, and mares have a high number of total penalties and XCT penalties. At Advanced level the SJJ and SJT penalties vary with mares incurring the least penalties, and geldings the most. Conversely, mares have higher average XCJ and XCT penalties than both geldings and stallions, and stallions have the least total penalties at this level. Table 2 summarises the results by specifying all areas in which the differences between genders were found to be statistically significant. Significantly different results were found in various phases at all levels except Advanced. At BE90 mares and geldings performed significantly better than stallions at SJT. Stallions performed significantly better than mares and geldings in XCT and final rank at BE100 level. Stallions also had a significantly better rank than mares at Novice level. At Intermediate geldings had significantly better DR scores than stallions, and significantly better XCT and total scores than mares. Stallions performed significantly better than mares at SJJ at Intermediate, and both geldings and stallions had better final rank than mares. Stallions also had a significantly greater median number of points per competition than mares.

Table 1.

Class	Gender	DR	SJJ	SJT	XCJ	XCT	Total
BE90	Gelding	**34.5** ± *0.4*	**3.0** ± *0.3* *	**0.7** ± *0.2**	**4.2** ± *0.9**	**5.3** ±*0.8*	**47.7** ±*1.8*
	Stallion	**34.1** ± *0.5*	**3.9** ± *0.5* *	**1.0** ± *0.3**	**7.6** ± *1.5*	**6.4** ±*0.8*	**52.9** ±*2.4*
	Mare	**34.1** ± *0.4*	**2.6** ± *0.3* *	**0.3** ±*0.1* *	**6.1** ± *1.1*	**5.1** ±*0.6*	**48.2** ±*1.8*
BE100	Gelding	**33.0** ± *0.4*	**3.2** ± *0.3*	**0.3** ±*0.1*	**5.0** ± *1.1*	**5.2** ±*0.5*	**46.7** ±*1.6*
	Stallion	**33.0** ± *0.4*	**3.7** ± *0.4*	**0.3** ±*0.1*	**3.6** ± *0.9**	**3.8** ± *0.5**	**44.5** ±*1.5*
	Mare	**32.9** ± *0.4*	**3.2** ± *0.3*	**0.2** ±*0.1*	**5.7** ± *1.1*	**4.9** ±*0.5*	**46.9** ±*1.7*
Novice	Gelding	**34.1** ± *0.6*	**3.9** ± *0.4*	**0.3** ±*0.1*	**4.4** ± *1.0*	**9.5** ±*0.8*	**52.2** ±*1.9*
	Stallion	**33.8** ± *0.5*	**3.9** ± *0.4*	**0.1** ±*0.0*	**4.6** ± *1.2*	**10.0** ±*0.9*	**52.4** ±*2.2*
	Mare	**34.8** ± *0.5*	**3.0** ± *0.4*	**0.1** ±*0.0*	**4.1** ± *1.1*	**10.5** ±*0.9*	**52.6** ±*1.9*
Intermediate	Gelding	**34.2** ± *0.9**	**5.7** ± *0.7*	**0.6** ±*0.2*	**3.0** ± *1.1**	**12.5** ±*1.5*	**55.9** ±*2.7*
	Stallion	**36.7** ± *1.0*	**4.6** ± *0.7*	**0.5** ±*0.2*	**4.6** ± *1.6*	**12.9** ±*1.3*	**59.3** ±*2.7*
	Mare	**38.6** ± *1.8**	**5.9** ± *0.7*	**0.6** ±*0.3*	**5.5** ± *1.6*	**17.1** ±*1.7* *	**67.7** ± *3.8**
Advanced	Gelding	**42.8** ± *2.5*	**7.4** ± *1.5**	**2.9** ± *2.0**	**3.0** ± *1.6*	**18.3** ±*2.0*	**74.3** ±*5.1*
	Stallion	**42.1** ± *2.5*	**5.8** ± *1.2* *	**1.5** ± *0.8**	**3.0** ± *1.6*	**15.2** ±*2.7*	**67.6** ± *4.8**
	Mare	**42.2** ± *3.8*	**4.0** ± *1.3**	**0.4** ± *0.3**	**11.7** ± *9.4**	**25.8** ±*8.1* *	**84.2** ±*17.3*

*Table 1: The mean phased and total scores of horses competing in different classes of British Eventing. Mean phased and total scores of horses followed by the standard error in italics. Sorted by ascending order of total score in each class: Dressage penalty scores (DR), Show-jumping jump penalty scores (SJJ), Show-jumping time penalty scores (SJT), Cross country jump penalty scores (XCJ), Cross country time penalty scores (XCT), Total (sum of all penalties). Significant difference marked with *.*

Table 2.

Class	Phase	Significant differences ($p < 0.05$)	Best performance	Worst performance
BE90	SJT	M<S, G<S	M	S
BE100	XCT	S<G, S<M	S	G/M
	Rank	S<G, S<M	S	G/M
Novice	Rank	S<M	S	M
Intermediate	DR	G<S	G	S
	SJJ	S<M	S	M
	XCT	G<M	G	M
	Total	G<M	G	M
	Rank	G<M, S<M	G/S	M
BE points per competition		S>M	S	M

Table 2: The areas of British Eventing competition where the differences in performance of mares (M), geldings (G), and stallions (S) were statistically significant. Lower penalties indicate better performance in all areas except BE points per competition.

Rank in competition

At BE100 stallions had lower (better) average rank than both geldings (*p = 0.005)* and mares *(p = 0.005)*. Stallions also had a lower average rank than mares *(p = 0.004)* in Novice. At Intermediate mares had a higher (worse) average rank than both geldings *(p = 0.026)* and stallions *(p = 0.026)*. Although there is a noticeable difference in average rank, particularly between mares and stallions at Advanced (Fig. 2), this was not found to be significant.

Average points per competition

While stallions do have a higher (better) mean number of points per competition than both mares and geldings, the difference was not found to be significant. Mares have a lower (worse) median value for points per competition (Fig. 3) than both stallions *(p = 0.009)* and geldings, though the difference between mares and geldings was not significant.

Discussion:

Overall, stallions or geldings were found to have performed significantly better than mares in at least one category at all levels except BE90, where mares had fewer SJT penalties than stallions, and Advanced where there were no significant differences in any scores. At BE100 stallions performed better than mares and geldings in both XCT and rank, but there was no significant difference between mares and geldings, and at Intermediate geldings

performed significantly better than stallions in DR. Stallions also had a higher median BE points per competition than mares. Using a sample population made up of equal numbers of mares, geldings, and stallions intentionally ignores the imbalance in the representation of genders in the competing population, allowing the impact of gender performance to be explored in a situation where there is no imbalance. Whitaker, Olusola and Redwin (2008) suggested controlling for horse age, and all scores in this study were taken from horses between four and ten years of age on the day of competition.

Total scores and rank

A large proportion (63 %) of the total score comes from the dressage phase (Whitaker and Hill, 2004) which is the most inconsistent phase due to the nature of the judging (Stout, 2005), and the phase in which the rider has the greatest effect (Stone, 1935). Therefore, the total score may not be a reliable measure of performance. Horses competing against one another at a competition will all have the same dressage judge (Seo *and others*, 2016) which will limit the impact of a particularly harsh or lenient judge within that class. This means that while the dressage judge's subjectivity may be evident in the horse's dressage score and therefore total score, it should not be reflected in the rank of horses as they are all judged by the same person. The correlation coefficient for total score and rank indicated a strong positive correlation (0.663), which suggests that the variation in judges may not have a huge impact on total score. In terms of total score and rank mares tended to perform worse than both geldings and stallions (table 2). Significant differences were found between mares and geldings at Intermediate for both total score and rank, and between mares and stallions for rank in BE100, Novice and Intermediate. At BE100 stallions also had better rank than geldings. This is supported by a previous study of horses at BE100 where stallions performed better in mean total score than both mares and geldings (Whitaker and Hill, 2004), although it should be noted that stallions formed 0.5 % *(n = 4)* of the population studied. Overall, this suggests that mares perform worse than their male competitors at these levels. Interestingly, at the lowest level of competition (BE90), stallions perform marginally worse on average, but this difference was not significant. At Advanced mares perform the worst, and stallions perform the best in terms of both total score and rank; this difference was also not found to be significant but this could be due to the small number scores collected at this level (n = 49). This agrees with a previous study into horses competing at Advanced where gender was found not to play a significant role (Deuel and Russek-Cohen, 1995), though this study was performed on horses competing at world championship events. It has also been suggested that the effect of the rider is greatest at Advanced (Kearsley *and others*, 2008) which would limit the influence of horse gender on performance at this level. As the three phases contribute to different proportions of the score and the effect of the rider varies across the phases, it is worth considering them each individually.

Dressage

The dressage phase is designed to test trainability and obedience in the horse (Marlin, 2014). As geldings have been shown to be more trainable than mares (Duberstein and Gilkeson, 2010) and stallions more rideable than mares when assessed in a dressage scenario (König von Borstel and Glißman, 2014) it seems likely that mares may perform worse than males. Previous research on this topic is limited but stallions have been shown to perform better than mares in dressage by Wallin, Strandberg and Philipsson (2003). In a study

conducted by Busschers and Van Weeren (2001) it was found that mares were significantly (2.2 times) more likely to be classified as lame than geldings after flexion tests and studies into behaviour have found mares to be more aggressive, tense, and excitable than geldings which were more affable and less skittish (Duberstein and Gilkeson, 2010). However, the only significant difference in dressage performance found in this study was at Intermediate, where geldings performed better than stallions. In the dressage phase the strong influence of the rider (Kearsley *and others*, 2008) and possibly the subjectivity of judging (Whitaker and Hill, 2005) may decrease the likelihood of finding differences.

Show-jumping

At BE90 mares and geldings both incurred fewer penalties than stallions in SJT (table 2). This was unexpected as it is the only area in which mares have performed significantly better than either stallions or geldings, and stallions are generally considered to be faster than mares (Velie, Hamilton and Wade, 2015). It is possible that mares incur fewer time penalties in this category due to a different attribute, such as accuracy or sensitivity to the rider, rather than speed, particularly at BE90 where the show-jumping course is not very long or tightly timed (Seo *and others*, 2016). It should also be noted that SJT accounts for approximately 2.6 % of final penalties (Whitaker and Hill, 2004) and is therefore unlikely to be a major factor when evaluating performance.

Previous study into show-jumping has shown that stallions have a significantly higher rate of clearing jumps than both mares or geldings, and that mares most frequently refuse jumps (Maršálek, Sedláčková and Secká, 2006). Stallions have also been found to incur lower cumulative penalties in show-jumping competitions (Wallin, Strandberg and Philipsson, 2003). It has also been demonstrated that male horses have better visuo-spatial ability than females (Murphy, Waldmann and Arkins, 2004), which is consistent with findings in other species (Halpern, 2012).

At Intermediate mares performed worse than stallions in SJJ (table 2), which is consistent with previous comparison of stallions and mares (Wallin, Strandberg and Philipsson, 2003; Maršálek, Sedláčková and Secká, 2006). The influence of the rider is considered to be the lowest in the show-jumping phase (Kearsley *and others*, 2008), but there is no consistent pattern for which gender performs the best in SJJ and SJT across the classes.

Cross Country

As the cross country course is long and involves sections of galloping it is the greatest test of speed and endurance in eventing (Marlin, 2014). In racing, thoroughbred males have been shown to have significantly superior running ability (Velie, Hamilton and Wade, 2015) as have Standardbred trotters and pacers (Knight and Thomson, 2011; Couroucé-Malblanc and Hinchcliff, 2014). It is therefore not surprising that males outperform mares in XCT (table 2). At BE100 stallions incurred fewer penalties than both geldings and mares, with mares collecting the most. At Intermediate geldings outperformed mares. As with show-jumping there is no consistent pattern for performance in XCJ (table 1), and no significant differences were found in XCJ. This is supported by physiological differences in the genders: stallions have been found to have a greater ratio of type IIA/IIB fibres compared with mares (Leisson, Jaakma and Seene, 2008; Leisson *and others*, 2013) and stallions have also been shown to

have greater aerobic capacity and fitness (Mukai *and others*, 2003; Stefánsdóttir *and others*, 2014).

Points per competition

Due to the way in which BE points are awarded in competition, the number of points collected by an individual depends on the length of their career, as each competition attended is an opportunity to gain points. Calculating an average 'points per competition' by collecting the number of competitions attended where the horse could potentially have gained points removes the effect of the length of career. This is particularly relevant, as highlighted by Whitaker, Olusola and Redwin, (2008), in mares and stallions which may end their career early or take breaks for breeding duties. It is also important as age was not controlled for when gathering data for points, so career lengths of horses sampled will vary. Competitions where the horse was eliminated were counted as it can be indicative of horse performance but could not be considered in the analysis of scores. There was no difference between mean 'points per competition' across the genders, but stallions did have a significantly higher median than mares. This supports the overall pattern of stallions performing better than mares.

Castration of the stallion

There is reason to believe that castration of the stallion may impact their eventing performance. Although a lot of the studies into gender differences in equestrian sports, physiology, and behaviour have compared either mares and geldings or mares and stallions, there have been observed differences in horses after castration (Crowell-Davis *and others*, 1995). Entin (2007) studied racing thoroughbreds and found that not only were stallions faster than geldings and mares, the speed of geldings was also equivalent to that of mares. In pre-pubescent colts castration is associated with significantly less aggression (Crowell-Davis *and others*, 1995). Stout (2005) states that the most common reason for castration of a stallion is to suppress aggression or sexual behaviour, which can be distracting and dangerous. This could explain why there are fewer stallions than mares or geldings in the competing population, as highlighted by Whitaker, Whitaker, Olusola and Redwin (2008) although it could also be related to the role of a stallion as a breeding animal.

Stallions were found to outperform geldings at BE100, with significantly fewer XCT penalties and significantly better rank. However, geldings outperformed stallions at Intermediate where geldings were found to have significantly fewer DR penalties than stallions. As these were the only significant differences between stallions and geldings, there was overall no suggestion of the castration of the stallion having an impact on eventing performance.

Conclusion

Using equal numbers of each gender in this study allowed for effective comparison as no one was under-represented, as they have been in previous studies. Regardless of which variable one considers the best measure of horse performance, there is a distinct pattern for stallions and geldings to outperform mares. Stallions performed significantly better than mares in various categories at BE100, Novice, Intermediate and median points per competition. Geldings performed significantly better than mares at Intermediate level (XCT, total, rank), and significantly better than stallions at Intermediate in DR. Stallions performed

better than geldings at BE100 level in XCT and rank. At BE90 mares performed significantly better than stallions in SJT, and at Advanced no significant differences were found. Overall, this supports the hypothesis that gender affects performance in eventing competition, though the impact of the rider and environmental influences should always be considered.

References:

British Eventing (2009). Available at: http://www.britisheventing.com/ (Accessed: 3 January 2017).

Busschers, E. and Van Weeren, P. R. (2001) Use of the Flexion Test of the Distal Forelimb in the Sound Horse: Repeatability and Effect of Age, Gender, Weight, Height and Fetlock Joint Range of Motion, *Journal of Veterinary Medicine Series A*. Blackwell Science Ltd., **48**(7), pp. 413–427. doi: 10.1046/j.1439-0442.2001.00373.x.

Couroucé-Malblanc, A. and Hinchcliff, K. W. (2014) Veterinary aspects of racing and training horses used for harness racing (trotters and pacers), in *Equine Sports Medicine and Surgery*. Elsevier, pp. 1037–1055. doi: 10.1016/B978-0-7020-4771-8.00049-1.

Crowell-Davis, S. ., Pope, J. ., Caudle, A. . and Heusner, G. . (1995) The effect of early prepubertal castration on the behavior of colts, *Applied Animal Behaviour Science*. Elsevier, **46**(1–2), p. 135. doi: 10.1016/0168-1591(96)81091-4.

Deuel, N. R. and Russek-Cohen, R. (1995) Scoring analysis of three world championship three-day events, *Journal of Equine Veterinary Science*. Elsevier, **15**(11), pp. 479–486. doi: 10.1016/S0737-0806(06)81821-6.

Duberstein, K. J. and Gilkeson, J. A. (2010) Determination of sex differences in personality and trainability of yearling horses utilizing a handler questionnaire, *Applied Animal Behaviour Science*, **128**(1), pp. 57–63. doi: 10.1016/j.applanim.2010.09.012.

Entin, P. (2007) Do racehorses and Greyhound dogs exhibit a gender difference in running speed?, *Equine and Comparative Exercise Physiology*, **4(3/4)**, pp. 135–140. doi: 10.1017/S1478061507851036.

Halpern, D. F. (2012) Emprirical Evidence for Cognitive Sex Differences, in *Sex differences in cognitive abilities*. IV. Psychology Press, pp. 128–145.

Holden, C. (2004) An Everlasting Gender Gap?, *Science*, **305**(5684), pp. 639–640. doi:

10.1126/science.305.5684.639.

Kearsley, C. G. S., Woolliams, J. A., Coffey, M. P. and Brotherstone, S. (2008) Use of competition data for genetic evaluations of eventing horses in Britain: Analysis of the dressage, showjumping and cross country phases of eventing competition, *Livestock Science*, **118**(1), pp. 72–81. doi: 10.1016/j.livsci.2008.01.009.

Knight, P. and Thomson, P. (2011) Age at first start and racing career of a cohort of Australian Standardbred horses, *Australian Veterinary Journal*. Blackwell Publishing Asia, **89**(9), pp. 325–330. doi: 10.1111/j.1751-0813.2011.00816.x.

König von Borstel, U. and Glißman, C. (2014) Alternatives to Conventional Evaluation of Rideability in Horse Performance Tests: Suitability of Rein Tension and Behavioural Parameters, *PLoS ONE*. Edited by M. Hausberger. Public Library of Science, **9**(1), p. e87285. doi: 10.1371/journal.pone.0087285.

Leisson, K., Alev, K., Kaasik, P., Kaart, T., Jaakma, Ü. and Seene, T. (2013) MyHC and MyLC isoforms in Akhal-Teke horses of different gender and genetic background, *Livestock Science*, **157**(1), pp. 263–270. doi: 10.1016/j.livsci.2013.05.028.

Leisson, K., Jaakma, Ü. and Seene, T. (2008) Adaptation of Equine Locomotor Muscle Fiber Types to Endurance and Intensive High Speed Training, *Journal of Equine Veterinary Science*, **28**(7), pp. 395–401. doi: 10.1016/j.jevs.2008.05.007.

Marlin, D. J. (2014). *Exercise Physiology of Eventing*. [Online] Available at: http://davidmarlin.co.uk/portfolio/exercise-physiology-of-eventing/ [Accessed 21/01/2017].

Maršálek, Sedláčková and Secká (2006) The influence of the age, sex and performance level of horses on their success in the show jumping competition, *Journal of Central European Agriculture*, **6**(4). doi: 10.5513/JCEA.V6I4.334.

Mukai, K., Takahashi, T., Hada, T., Eto, D., Kusano, K., Yokota, S., Atsushi, H. and Ishida, N. (2003) Influence of Gender and Racing Performance on Heart Rates during Submaximal Exercise in Thoroughbred Racehorses, *Journal of Equine Science*, **14**(3), pp. 93–96. doi: 10.1294/jes.14.93.

Murphy, J., Waldmann, T. and Arkins, S. (2004) Sex differences in equine learning skills and visuo-spatial ability, *Applied Animal Behaviour Science*, **87**(1), pp. 119–130. doi: 10.1016/j.applanim.2003.12.002.

Posta, J., Rudiné Mezei, A., Mihók, S. and Mészáros, G. (2014) Evaluation of the length of competitive life in Hungarian sport horses, *Journal of Animal Breeding and Genetics*, **131**(6), pp. 529–535. doi: 10.1111/jbg.12108.

Seo, J. W., Couteau, E., Umek, P., Hernadi, K., Marcoux, P., Damnjanovit, M., Milosevit, I. and Vukovie, T. (2016) *BRITISH EVENTING - MEMBERS' HANDBOOK 2016*.

Stefánsdóttir, G. J., Ragnarsson, S., Gunnarsson, V. and Jansson, A. (2014) Physiological response to a breed evaluation field test in Icelandic horses., *Animal : an international journal of animal bioscience*, **8**(3), pp. 431–9. doi: 10.1017/S1751731113002309.

Stone, C. P. (1935) Sex difference in the running ability of thoroughbred horses., *Journal of Comparative Psychology*. Williams & Wilkins Company, **19**(1), pp. 59–67. doi: 10.1037/h0061600.

Stout, T. A. E. (2005) Modulating reproductive activity in stallions: A review, *Animal Reproduction Science*, **89**(1–4), pp. 93–103. doi: 10.1016/j.anireprosci.2005.06.015.

Velie, B. D., Hamilton, N. A. and Wade, C. M. (2015) Performance selection for Thoroughbreds racing in Hong Kong - RVCUL, *Equine Veterianry Journal*, **47(1)**, pp. 43–7. Available at: https://primo-44rvc.hosted.exlibrisgroup.com/primo_library/libweb/action/display.do?frbrVersion=18&tabs=detailsTab&ct=display&fn=search&doc=TN_medline24467785&indx=2&recIds=TN_medline24467785&recIdxs=1&elementId=1&renderMode=poppedOut&displayMode=full&frb (Accessed: 5 February 2017).

Wallin, L., Strandberg, E. and Philipsson, J. (2003) Genetic correlations between field test results of Swedish Warmblood Riding Horses as 4-year-olds and lifetime performance results in dressage and show jumping, *Livestock Production Science*, **82**(1), pp. 61–71. doi: http://dx.doi.org/10.1016/S0301-6226(02)00307-X.

Whitaker, T. C., Olusola, O. and Redwin, L. (2008) The influence of horse gender on eventing competition performance, *Comparative Exercise Physiology*, **5**(2), p. 67. doi: 10.1017/S1478061508017039.

Whitaker, T. and Hill, J. (2004) Scoring analysis of completing pre-novice event horses at six selected events, *Equine and Comparative Exercise Physiology*. Cambridge University Press, **1**(3), pp. 185–192. doi: 10.1079/ECEP200417.

Whitaker, T. and Hill, J. (2005) Dressage scoring patterns at selected British Eventing novice events, *Equine and Comparative Exercise Physiology*. Cambridge University Press, **2**(2), pp. 97–104. doi: 10.1079/ECP200554.

Figure 1: Distribution of all British Eventing scores taken from a random sample of 681 horses. Graph shows the gender distribution of penalty score at different classes of British Eventing competitions from 1998 to 2016.

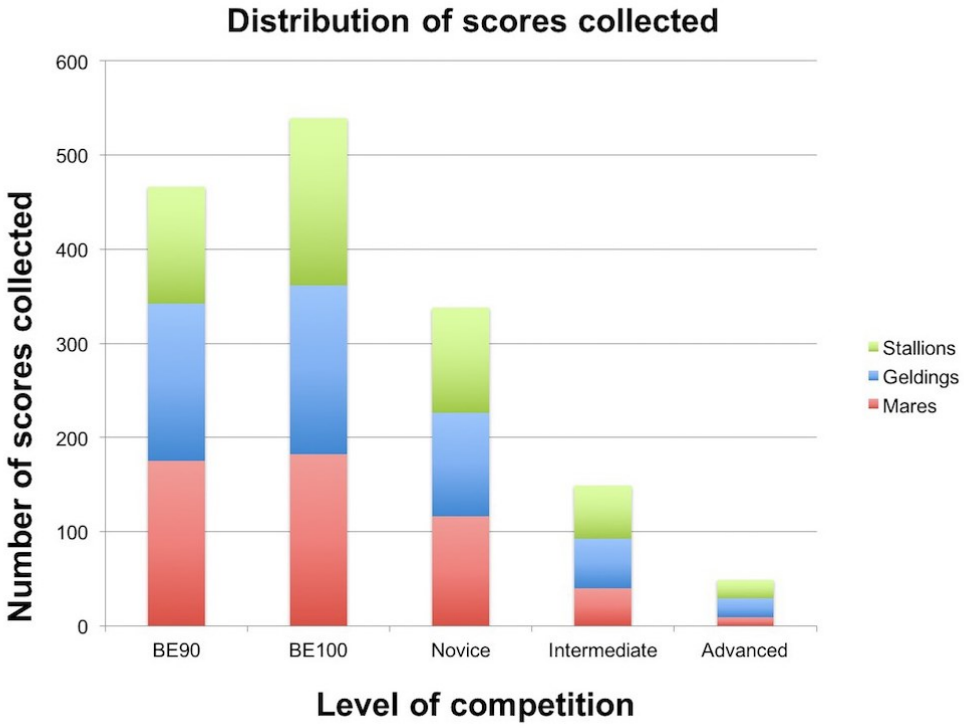

Figure 2: Average rank of horses at different levels of British Eventing competition, by gender. Graph shows the gender distribution of average ranks achieved in different classes of British Eventing competition from 1998 to 2016. Significant difference ($P<0.05$) shown using small letters (a, b).

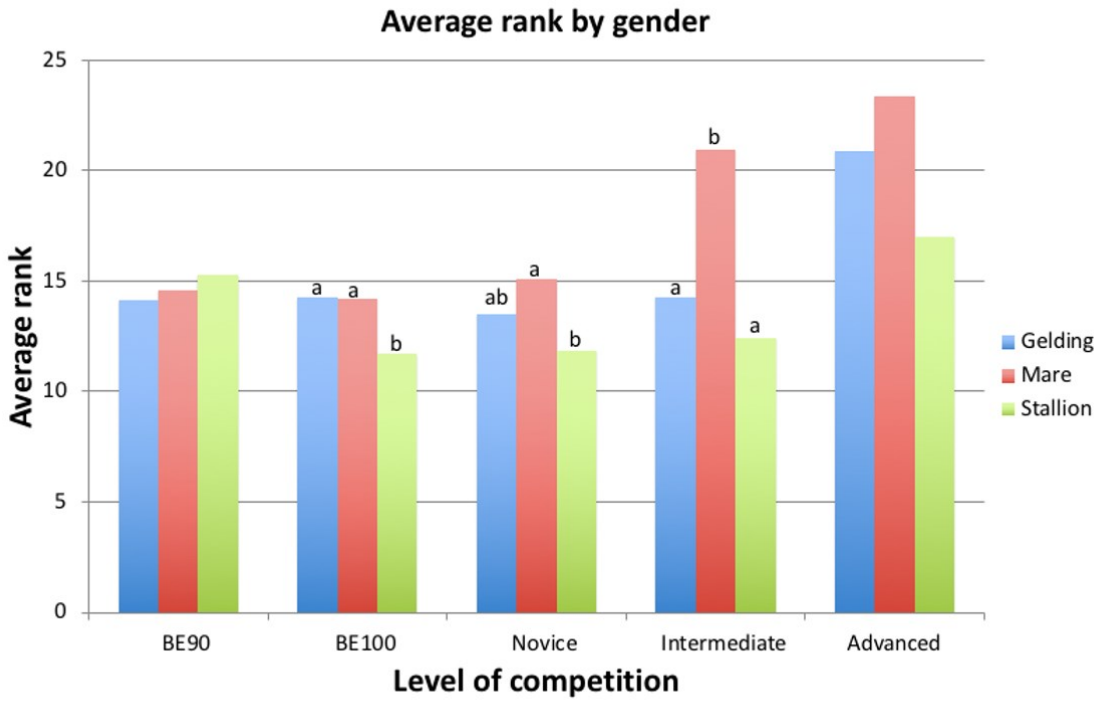

Figure 3: Median number of British Eventing points scored per competition, by gender. Graph shows the gender distribution of median penalty scores in all classes of British Eventing competition from 1998 to 2016. Significant difference (P<0.05) shown using small letters (a, b).