Faults in International Showjumping are not random

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ABSTRACT

Performance analysis (PA) involves the systematic observation and analysis of factors identified to enhance performance to improve athlete decision-making in a specific sport. PA is commonplace in human sports, yet despite potential advantages, its application remains limited in equestrianism. This study aimed to evaluate if factors anecdotally associated with performance in elite showjumping influenced competitive success. 250 combinations attempting 3052 jumping-efforts across 2nd round European FEI Nations Cup 2017 competition were analysed. Types of fault (e.g. pole down, refusal etc) were recorded as well as characteristics of the jump (e.g. jump type, approach angle). Combinations jumped clear at the majority of attempts (93.6 %; n=2857) with faults only occurring at 6.4% of jumps (n=195). The most common faults were: knock-downs (5.5 %); time penalties (0.8 %); faults at water jumps (0.3 %); refusal (0.2 %). Faults were distributed across all fence types, however were more common at upright fences (49 %) and within combination fences (41 %). A linear relationship was found between jumping-effort number and number of fences knocked-down ($r = 0.7$; $P < 0.001$). There were 2.8 times more knock-downs for the second half of the course (efforts 9 - 15) compared with jumping-efforts 1 - 7 ($P < 0.05$). Faults were 4 times more likely at jumping-efforts 3, 4, 5 and 8 in the first half of the course ($P < 0.03$) which increased to being 9 times more likely in the 2nd half of the courses (jumping-efforts 9, 10, 11, 12, 13 and 14; $P < 0.006$). A straight approach to a jumping-effort reduced the chance of faults by 48 % ($P < 0.0001$) compared to a non-straight approach. These preliminary results suggest faults are not randomly distributed in elite showjumping and that patterns exist within fault accumulation demonstrating that the application of PA techniques in equestrian sport could lead to a performance advantage.

Keywords: Jumping; Horses; Equestrian; FEI; Competition; fault

INTRODUCTION

Performance analysis is an essential tool that systematically evaluates factors identified to enhance performance to provide accurate, effective and objective feedback, which can then inform athlete decision-making with the aim of increasing future competitive success (Nicholls et al., 2018; Nelson and Groom, 2012). To be successful, performance analysis usually occurs within a defined context and is used synergistically with the athlete, their coach and performance analyst using the information gained to inform skill development, design training regimes and competition strategies aligned to periodization and performance targets (McGarry, 2009). Once a defined goal is set, the performance analyst will aim to describe, explain and predict the athlete's performance by identifying associations between sport-specific behaviours (actions) and outcomes (key performance indicators or goals), whilst considering the influence of extrinsic variables, such as other competitors and the environment, to develop performance improvement strategies (McGarry, 2009; Williams, 2013).

Performance analysis can be used within training to assess athlete progress or within competition environments to reflect on the success of competition strategies and to analyse specific aspects of athlete performance (Williams, 2013). Traditionally, human sports feedback involved subjective observations based predominately on an athlete's coaches' perceptions and experiences (Maslovat and Franks, 2015). Unfortunately, the success of using subjective observations to inform training and competition strategy development is reliant on the ability of the athlete's or coach's memory recall, which is reported at best to be ~50 % (Nicholls and Warsfold, 2016; Laird and Waters, 2008). How athletes can access feedback is changing through the advent of technology and the increased implementation of performance analysis techniques enabling coaches and the athletes themselves to review and analyse multiple facets of an individual or team. The effectiveness of applied performance analysis has been documented in football and rugby. Within these area, studies have demonstrated the use of a performance analyst and coach combination, using video analysis techniques aided athlete recall, encouraged self-critique, expedited unemotional reflection on their performance and improved player confidence as well as changing athlete behaviour (Groom and Cushion, 2004; Francis and Jones, 2014). Performance analysis should therefore be considered a fundamental tool to facilitate athlete learning and development, and competitive success.

Despite the widespread uptake of performance analysis across human sports, its application within equestrianism is still in its infancy (Williams, 2013; Randle and Loy, 2019). The welfare of the horse is becoming an ever more important focus across all horse sports (Waran and Casey, 2005) leading to increased calls for the application of evidence-based practice. Performance analysis techniques can provide an approach that encourages professionals to use the best evidence possible when making decisions about the methods, treatments and actions employed to achieve their performance goals whist concurrently safe guarding the welfare of the equine athlete (Waran and Randle, 2013). However equine performance analysis traditionally focuses on subjective assessment of performance through observation or 'feel' (Williams, 2013; Ely et al., 2010), concepts that are subject to individual perception, bias and rely on memory recall rather than being evidence based. Analysing performance in equestrianism is also complex, requiring focus on the individual performance characteristics in the horse (influenced by the rider), the rider (which can be influenced by the horse), the horse and rider as a partnership, and the 'performance' as a holistic entity (Williams, 2015). This is complicated further by the reliance on self-analysis required as many equestrian partnerships train in relative isolation compared to equivalent partnerships in human sport. Parallels could be drawn with this complexity to the dynamics which exists in team sports in the human field, where performance analysis techniques have proved successful (Groom and

Cushion, 2004; Francis and Jones, 2014). Scope therefore exists to apply performance analysis techniques across equestrian sport to gather objective data that will add to the developing evidence base to enable riders, trainers and coaches to make informed decisions when implementing training regimes and competition tactics to enhance equine performance and welfare.

Showjumping is the most popular equestrian sport amongst the Fédération Equestre Internationale (FEI) disciplines (FEI, 2017; Gorecka-Bruzda et al. 2013). Yet despite this, little research contextualised to performance analysis for the sport exists (Williams, 2013; Murphy et al. 2009). The key aim of the equestrian discipline is for horse and rider combinations to complete a course of jumping obstacles within a defined time or in the fastest time without scoring any penalties (faults). A successful elite showjumping horse needs to have superior physical abilities to be able to jump and clear successfully various fence types of heights up to 1.60 m and widths of 2.00 m for oxers (a fence with 2 - 3 rails or poles that may be set at the same or different heights), 2.20 m for triple bars and up to 4.50 m for water jumps (FEI, 2017). Elite horses also need to possess a suitable temperament to facilitate 'rideability' (Visser et al., 2003) and sufficient fitness to meet the physiological demands to successfully complete the competition itself (Williams, 2015). Tactics are a central component of success in sport (Rein and Memmert, 2016) including showjumping with riders determining the speed and approach their horse takes to fences. Therefore, implementing an effective competition strategy in the ring is essential to enable optimal performance (Williams, 2013; Sampaio and Macas 2012).

Accruing faults is a key negative performance indicator in showjumping. It is commonly believed by showjumping riders and trainers that faults do not occur by chance, but are associated with particular types or location of fences. This study aimed to use notational analysis, a performance analysis technique designed to assess competition strategies (Duthie et al., 2003), to characterise faults as defined by the FEI (knocking down a fence pole/rail/plank, displacing an obstacle, a foot landing in a water jump, refusal or "run-out"). The hypothesis was that faults at elite level showjumping are not random.

MATERIALS & METHODS

All rounds of horse and rider combinations competing in the Second Round of the FEI Nations Cup[1] 2017 competition in European Division 1 at ten different outdoor events were reviewed (see Table 1). The competitions were publicly available on Sky Sports HD and each competition was recorded using a Sky Box. The competitions took place between May and August. Five competitions took place on grass and three on artificial surfaces. All competitions were held outdoors. All competitions consisted of 15 fences with the exception of St Gallen (n = 14 fences) and La Baule and Lummen (n = 16 fences), and also comprised a double and a treble (n = 8 competitions), two doubles (n = 1) or three doubles (n = 1).

Table 1. Competitions in the 2017 FEI Nations Cup European Division 1 and competitions from which data was obtained.

Venue	Country	Date	Division	Level
Lummen	Belgium	26-30 Apr 2017	Europe 1	5*
La Baule	France	11-14 May 2017	Europe 1	5*

[1] Further information regarding the FEI Nations cup series is available at: https://inside.fei.org/fei/events/fei-nations-cup-series/jumping

Rome	Italy	24-29 May 2017	Europe 1	5*
St Gallen	Switzerland	1-4 Jun 2017	Europe 1	5*
Rotterdam	Holland	22-25 Jun 2017	Europe 1	5*
Falsterbo	Sweden	13-16 Jul 2017	Europe 1	5*
Hickstead	Great Britain	27-30 Jul 2017	Europe 1	5*
Dublin	Ireland	9-13 Aug 2017	Europe 1	5*
Sopot	Poland	8-11 Jun 2017	Europe 1	5*
Gijon	Spain	30-04 Sep 2017	Europe 1	5*

Notational analysis is an inexpensive and accessible method of providing insight into the technical demands of sport activities, by recording and quantifying athlete movement patterns that characterize skilled performance in relation to performance goals (Duthie et al., 2003). This technique was applied to assess if relationships existed between fence type, approach and direction with faults. Fences were classified from video recordings by jumping effort (jump number, incremental including the individual elements of combination fences), jump type (upright, oxer, Liverpool [oxer with water underneath], water, triple bar, gate, upright-planks, upright-wall; single, double, triple), approach line (straight approach [4 or more strides after a turn or following on from a previous fence], left-rein [more than 45° from previous fence], slight-left [less than 45°], right-rein [more than 45° from, [previous fence], slight-right [less than 45° from previous fence]) and direction (in relation to the collecting-ring: away; towards; across). Faults/penalties were recorded as: pole knocked down; refusal; error of course; foot in water. Total faults and the distribution of faults for every quarter of the course were calculated. The completion time and any time penalties incurred over the optimum course time were also recorded for each horse and rider combination.

Data analysis

Frequency analysis identified patterns in fault accumulation and fence number, type, horse and rider approach to the fence and the location of the fence on the course. Chi squared goodness of fit analyses identified if there was a difference between the expected and observed frequency of faults across the Nation Cup competitions. Pearson's correlation examined if relationships existed between fault accrual and fence number sequentially within a jumping round. A series of T-tests and ANOVA analyses with post-hoc LSD tests, determined if differences occurred between the percentage of faults accrued and the direction of approach to a fence and the distribution of faults throughout the course: first vs. second half and between each quarter of the course. Significance was set at $P < 0.05$.

Logistic regression

Fence level and course level variables were analysed through univariate analysis to inform multivariable model building using the dichotomous variable: faults vs. no faults. Three fence level variables were included in the final model: jumping effort (incremental), fence type (e.g. upright, oxer), approach line (redefined as a binary variable: straight vs. not-straight). Two course level variables were also included: faults in the first vs. second half of the course and time (s) if the combination finished over the optimum time allocated, if a horse and rider completed the course within the allocated time they scored 0 s. Factors were considered eligible for inclusion in the final multivariate model if the level of significance found during univariate regression was $P < 0.1$ or if the removal of the factor had a significant impact on the model ($P < 0.05$) (Williams et al., 2013a). All models were refined through a backward stepwise process with variables retained if Likelihood ratio P-values were < 0.05 (Williams et al., 2013a). At each step of model building Omnibus tests identified if factors had a significant effect on the model fit and should be retained($P < 0.05$) (Pallant, 2010). Model fit was assessed using the Hosmer-Lemeshow goodness of fit test ($P > 0.05$) (George and Mallery, 2010). The predictive ability of the model was examined through receiver operating characteristic (ROC) curve analysis (Reardon et al., 2012). All statistical analyses were conducted using Statistic Packages for Social Sciences (SPSS) version 21 (Chicago, IL, USA).

RESULTS

A total of 250 horse and rider combinations attempting 3052 jumping efforts were analysed. Courses contained on average 15 jumping efforts (JE) and field size ranged between 18 and 23 combinations. The most common fence types were: Upright (65 efforts, 42.5 %); Oxer (58 efforts, 37.9 %); Water (10 efforts, 6.5 %); Liverpool (9 efforts, 5.9 %); Triple-bar (6 efforts, 3.9 %); Planks (3 efforts, 2.0 %); Gate (2 efforts, 1.3 %). None of the competitions analysed included a wall jump. Combinations were clear at the majority of JE (93.6%; n=2857) with faults only occurring at 6.4% (n=195) of the JE reviewed.

Nineteen countries were represented, with Holland having the highest number of horse and rider combinations (n=30), followed by Ireland (n = 28) and France (n = 26). Team selection resulted in some horse and rider combinations jumping at multiple venues, but across all competitions only 1 horse and rider combination retired and 4 combinations were eliminated. The average time allowed was 78.9±3.5s (range 75-84s). Of the 250 horse and rider combinations that completed the course, 81 % (n = 202) were inside the time limit, whilst 19 % (n = 48) were outside the time limit for the course.

Fault type

The most common faults were: knock-downs (5.5 %); time penalties (0.8 %); fault at a water jump (0.3 %); refusal/run out (0.2 %). Faults were distributed across fence types, however interestingly faults occurred more commonly at upright fences (49 %) and at jumping efforts that were part of a combination fence (41%).

Fault location on the course

A linear relationship was found between jumping-effort number and number of fences knocked-down ($r = 0.7$; $P = 0.001$) (Figure 1). There were 2.8 times more knock-downs for the second half of the course (efforts 9-15) compared with jumping efforts 1-7 ($P < 0.05$). Distribution of faults also varied significantly between the four quarters of the course ($P = 0.0001$). Post hoc analyses identified the number of faults increased sequentially between the 1st (n = 13, mean faults = 4) and 3rd (n = 53, mean faults = 6, $P = 0.03$) and 1st and 4th quarters (n = 83, mean faults = 7, $P = 0.0001$), as well as between the 2nd (n = 43, mean faults = 5) and 4th quarters ($P = 0.0001$), and the 3rd and 4th quarters ($P = 0.03$).

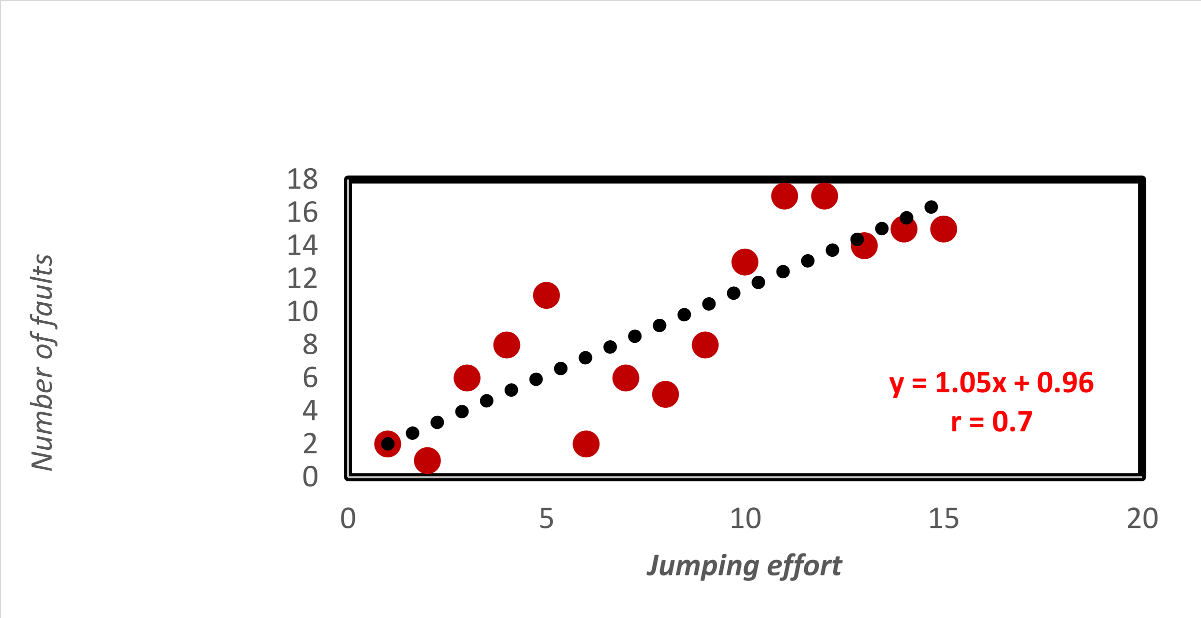

Figure 1: Linear increase in risk with increasing number of efforts - 70% of variance observed is due to jumping effort number

Fence approach

Faults were more common (percentage of attempts) when fences were jumped straight-on (7.9%) on a left or right rein (>45° from previous fence; 3.8%; P<0.001) but were similar to either at a slight right or slight left approach (<45° from previous fence; 6.2%).

Logistic regression

Combinations which completed their round above the optimum time were 1.1 times more likely to have faults for every 0.1 seconds they were over the time (P < 0.0001). Faults were also on average 4 times more likely to occur at jumping efforts 3, 4, 5 and 8 in the first half of the course (P < 0.03). The probability of scoring faults then increased to being 9 times more likely in the second half of courses at jumping efforts 9, 10, 11, 12, 13 and 14 (P < 0.006). A straight approach (defined as straight vs. not straight) to a jumping effort reduced the chance of faults by (P=0.0001) by 48 % compared to a non-straight approach. Interestingly, although fence type was not significant in the model (P>0.05), its inclusion did improve model fit. Receiver operating characteristic determined the model had moderate predictability (ROC: 68%).

DISCUSSION

This preliminary performance analysis of elite showjumping suggests that for these competitions, faults were not randomly distributed. The results also demonstrate that simple notational analysis techniques have been effective and identified factors which could inform competitive tactics to reduce the probability of horse and rider combinations gaining faults in Nations Cup competitions.

Influence of the course

Faults increased sequentially though the course with horse and rider combinations more likely to incur faults in the second half of the courses evaluated. This is in contrast to the anecdotal opinions of show jumping riders who often reflect that horses are more likely to score faults at the first and last fences. Interestingly, Harris et al. (2018) reported similar performance patterns across a British Equestrian Federation (BEF) World Class Performance three-day training session when evaluating horse's showjumping performance. They found horses' recorded higher mean heart rates, increased faults and scored lower in coach graded assessment of their jumping technique in the third quarter of the course. Generally, horses which scored lower for jumping technique recorded a closer take off position to the fence, which would then require an increased physical effort to create the required trajectory to clear the fence without incurring faults, contributing to the higher heart rates observed (Harris et al., 2018). The approach and the position of the horse's centre of gravity and hind limb placement at take-off determines if the resultant jump is successful or not (Powers and Harrison, 1999, 2002; Walker et al., 2018). However, rider positioning is also influential on a successful jump, this is proposed to be due to the rider's instruction and resultant effect on the horse's behaviour during the approach to the fence rather than inertial effect of the rider's position on the horse (Powers and Harrison, 2002). The positive relationship found between a straight approach and reduced propensity to incur faults in the multivariable model, supports the importance of good rider positioning and control during showjumping. The increased faults recorded across the second half of competitions here, could therefore represent differences in horses' approach and take off stride or the influence of the rider for fences 9 to 14. To further enhance the application of performance analysis within showjumping, more detailed notational analysis evaluating horse and rider positioning and the linear projectile kinematics of individual combinations would be worthwhile.

Influence of rider tactics

It is the role of the rider within showjumping competitions to dictate the horse's speed, approach to fences and stride pattern to guide their equine partner to success. Therefore, the sequential increase in faults observed in Nation Cup competitions could reflect changing tactics in the rider as the course progresses. Increased falls in jump racing have been associated with increasing speed (Williams et al., 2013a, b; Pinchbeck et al., 2001). However here, horses which recorded slower times, that were over the optimum time allowed, were more likely to incur faults, suggesting average speed is not a contributing factor to scoring more faults. The slower times recorded could reflect control issues on the course and a lack of 'rideability'. For example, if the horse refused a fence, had a run out or the rider found it difficult to control the horse on the course, or if it had a pole which upsets the horse's rhythm, the time taken to complete would likely increase. Hall and Barlow (2016) investigated if behavioural events influenced jump success in elite showjumpers, finding that horses which scored faults recorded increased lateral head shake and ears twitched back behaviours compared to horses that cleared the fence. Whilst these behaviours may be indicative of pain, they could also be a visual representation of a temporary breakdown in communication between horse and rider. Therefore, the relationship identified between time and faults could provide a proxy measure for rideability and suggests this concept may be key to success in elite showjumping.

Fence type

We expected fence type to be influential on horse performance, as traditionally riders and coach have considered that upright or vertical fences can be more difficult to jump successfully. Interestingly, whilst faults were more common at upright fences and at JE within combinations, and although the inclusion of fence type improved model predictability, fence type was not significantly associated with an increased risk of incurring faults. Walker et al. (2018) reported elite horses, such as those jumping in Nations Cup competitions, adopt consistent jumping kinematics regardless of fence type, which could explain the lack of influence found. The increased percentage of faults that occurred at jumping efforts cited within combination fences, could also reflect rider tactics, where the stride patterning and rhythm of horse and rider combinations is key to successful jumping. However, it should also be noted that performance is multifactorial and the definition of fence types applied here may not have been detailed enough to expose relationships. Fence location and colour have also been associated with jumping performance (Stachurska et al., 2002). Therefore, for future work it would be beneficial to integrate fence location: topography, alone or in combination, situation to course entrance, fence design: ascending, descending or parallel oxer, style: fillers and decoration, and colour into performance analysis.

Implications for horse welfare

Further research to evaluate the influence of performance analysis techniques on horse welfare across competition seasons is warranted. However these preliminary results demonstrate that the use of performance analysis techniques such as notational analysis can identify patterns within horse and rider performance that could be influential to combinations competitive success. For riders, increasing the understanding of what factors and tactics reduce fault accumulation within individual combinations, can support the development of training and competition strategies to enhance performance and by association potentially reduce the risk of horse falls, injuries associated with poor jumping technique and negative welfare from a breakdown in horse and rider communication, enhancing the welfare of the competition horse.

Limitations

This study only evaluated one season of the second round of European Nations Cup competition. Further analysis to identify if differences occurred in horse and rider performance and tactics between the first and second rounds, and longitudinal analysis of combinations across multiple elite level competitions would enable more accurate performance analysis that could identify patterns related to courses, riders, horses or specific horse and rider combinations. However, the success of the simple notational analysis used here, provides preliminary evidence that the use of performance analysis techniques could inform training and competition strategies in showjumping.

CONCLUSION

Understanding the impact of factors which influence horse and rider performance can inform training and competition strategies. These preliminary results suggest patterns exist within fault accumulation in elite showjumping and that faults are not randomly distributed and that the application of performance analysis techniques in equestrian sport could lead to a performance advantage.

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