Performance analysis of show jumping rounds at a national pony competition

Abstract

Performance analysis is utilised by coaches and athletes to identify areas to work on in training and to identify strengths in athlete performance in various sports. However, performance analysis is not commonly used within equestrian sports. The purpose of this study was to evaluate minors and their ponies competing in show jumping at a national pony competition to see if course variables affected performance. All jumping rounds were watched online. Type of faults (e.g. rails, refusals, time faults, fall of horse and or rider), type of fence (e.g. vertical, oxer), approach angle, section of the course where fault(s) occurred and round time were recorded. Spearman's Correlation assessed if round time was correlated to total faults and a series of Kruskal-Wallis analyses determined if significant differences in faults occurred between sections of the course, where these existed, post hoc tests established where differences occurred between rounds. There was no significant difference in total faults across the 4 rounds of competition and no meaningful correlation between round time and total faults ($r = 0.34$; $P=0.008$). There were no differences between fence type and faults although more faults occurred at verticals (51.7%, n = 46 faults at verticals versus 48.3%, n = 43 at oxers; $P=0.610$). Faults were more likely to occur during the final quarter of the course (32.6%, n = 29) when compared to the first quarter (23.6%, n = 21; $P=0.028$). These results showed that faults were more likely to occur in the final quarter of a round. The information gained from this performance analysis could be beneficial to inform training or riding strategies, especially when preparing for a competition.

1 Introduction

Performance analysis is a technique that evaluates identified factors in order to provide objective feedback and enhance performance within a sport. With this feedback, athletes can improve decision-making in order to increase success in future competitions (Marlin and Williams, 2020; Nicholls *et al*., 2019). This technique needs to occur within a specific context and is used concurrently with an athlete, their coach(s) and a performance analyst to use information gained from this analysis to help with informing skill development, designing training plans and competition strategies aligned to key performance indicators (McGarry, 2009). Once a particular goal is defined and set, the analyst will describe, explain and predict an athlete's performance by identifying associations between actions (sport-specific behaviours) and outcomes (goals or key performance indicators) while considering external factors such as other competitors and the environment. Through this process, performance improvement strategies can be developed (Marlin and Williams, 2020; McGarry, 2009; Williams, 2013).

Even though performance analysis has been implemented within sports, such as football and rugby, it hasn't been commonly used within the equestrian sport of show jumping. The objective of show jumping is for a horse and rider combination to complete a course consisting of jumping obstacles within a specific time or in the fastest time without accruing any penalties, also known as faults. Jumping obstacles can vary based on the competition level but fence heights typically range from 0.70 to 1.60 meters. Fence width must exceed the height by 5 to 15 cm for oxers (a fence with 2-3 rails or poles that can be set at the same or different heights) (USEF, 2022b).

Due to the welfare of both horse and rider being an increasingly important priority (Campbell, 2021), there has been an increased need to use evidence-based practices across different equestrian sports (Mills *et al*., 2005). Performance analysis techniques could provide approaches and strategies for riders to utilise evidence-based practices when making decisions about training and preparing for competitions while keeping the welfare of the horse in mind (Marlin and Williams, 2020; Waran and Randle, 2017). Equine performance analysis has mainly focused on subjective assessments through 'feel' or observation of a performance (Ely *et al*., 2010; Williams, 2013). However, using these subjective assessments relies on memory recall and are dependent on individual perception of a performance, thus being prone to bias. Analysing equestrian performance is complex as it requires focus on the performance of the horse (which can be influenced by the rider), performance of the rider (influenced by the horse), the partnership between the horse and the rider and the 'performance' as a whole entity (Williams, 2015). This complex partnership between horse and rider is exacerbated further since most equestrian athletes train individually (often in isolation) so self-analysis is common compared to human sports. However, the complexity of the horse and rider partnership parallels dynamics seen within human team sports, where performance analysis has been successful (Francis and Jones, 2014; Groom and Cushion, 2004). Despite the complexities seen within equestrian sports, performance analysis techniques can be successfully applied to collect objective data to enable riders, trainers and coaches to make informed decisions when implementing training and competition strategies in order to enhance performance (Marlin and Williams, 2020).

While there have been some studies done within the equestrian sport of show jumping using performance analysis (Marlin and Williams, 2020; Williams *et al*., 2022) to analyse horse and rider performance, these studies have focused on professional athletes competing in Fédération Equestre International (FEI) competitions. To the authors' knowledge, there are no studies currently published looking at performance analysis within minor riders competing in show jumping. In human sports, utilising video analysis in amateur ice hockey has been shown to be useful to both coaches and youth athletes to help with athletic development and progression to the next level within the sport (Lee, 2011). This could also be applied to minors competing in equestrian sports to help with short-term performance improvement of a horse and rider combination as well as long-term development for the rider to progress to elite levels of show jumping. Therefore, implementing performance analysis to provide evidence-based strategies to improve training and preparing for competitions should be beneficial to minor riders competing in show jumping.

The objective of this study was to evaluate minors and their ponies (under the height of 147 cm) competing in show jumping to see if the course variables studied affected performance using notational analysis, a technique designed to evaluate competition strategies (Duthie *et al*., 2003). This technique was used during this study to characterise faults, defined as the knocking down of any obstacle or standard with any portion of the rider or horse when jumping the obstacle, a disobedience (refusal) at a fence or fall of horse and or rider (USEF, 2022b). It was hypothesised that faults were more likely to occur at verticals versus oxers and during the final section (divided into quarters) of the course versus the others.

2 Materials and methods

Riders and ponies evaluated for this study competed at the 2021 United States Equestrian Federation Pony Finals (USEF) in Lexington, Kentucky, USA in the Pony Jumper Championship. All riders that competed were considered amateur riders and under the age of 18. Consent of riders to be evaluated for this study according to the North Carolina State University Institutional Review Board was not needed due to rider age and other information being available publicly online. Ponies

were all required to be under the height of 147 cm according to competition rules established by USEF (2022a). Riders and their ponies qualified for this competition by accumulating points throughout the year in order to be eligible to compete.

The competition occurred from August 12-14, 2021 at the Kentucky Horse Park in Lexington, Kentucky. All rounds of the competition were held outdoors in a German Geo Textile (GGT) footing arena. The competition consisted of 4 rounds across 3 days of competition. Each round of competition had a different course; however, the number of jumping efforts varied between 12 to 14. Fence heights throughout the rounds of competition were between 1.05 to 1.15 m. All rounds of the competition were recorded by videographers at the competition and then streamed live on the USEF Network.[1] The live recordings were also available to be streamed after the competition, so recordings of the rounds were watched online following the conclusion of the competition.

Notational analysis is a methodology that provides insight into the technical demands of various sport activities such as the equestrian sport of show jumping. This is accomplished by using video recording and quantifying movement patterns that indicate skilled performance in relation to an athlete's performance goals (Duthie *et al*., 2003). This method was applied to evaluate performance at this particular competition to see if there was a relationship between identified course variables studied and faults. Fences were classified by jumping effort, jump type (oxer or vertical), approach angle (left approach [more than 45° from previous fence], right approach [more than 45° from previous fence] or straight approach [4 or more strides following from a previous fence or a turn]) and correct canter lead on approach to the fence (yes or no). These classifications were adapted from a previous study (Marlin and Williams, 2020). Fault type (refusal, rail or fall of horse and or rider), section of the course (divided into quarters based on the number of jumping efforts), round time, time faults and total number of faults were recorded. If a rider and pony combination produced a fault-free round or were excused (eliminated) was also assessed.

Data analysis

Frequency analysis identified patterns in fault accumulation and jumping effort number, jump type, approach angle to the fence and the location of the fence on the course. Spearman's Correlation examined if relationships existed between fault accrual and jumping effort number sequentially across the jumping rounds reviewed. Kruskal Wallis analysis determined if differences occurred between faults accrued and the distribution of faults across the quarters of the course; subsequent post-hoc Mann Whitney U analyses identified where differences in fault accrual existed between each quarter of the course. Significance was set at $P<0.05$.

3 Results

A total of 23 rider and pony combinations were seen during the first round of competitions. Once the first round of competition was complete, the number of combinations did change slightly as some did not qualify to compete in subsequent rounds. However, the number of combinations competing ranged from 14 to 23 throughout the competition. The ages of riders ranged from 11 to 17 years of age and ponies were all under the height of 147 cm.

Courses had an average of 13.25 jumping efforts, 6.5 verticals, 6.75 oxers and 2 combinations (denoted as *a* and *b*, however for analysis these were deemed individual fences counted incrementally) (Table 1). Oxers made up the majority of fence types (50.94%) versus verticals (49.06%). The time allowed to complete the round(s) ranged from 74 to 80 s, the average time allowed was 77 s. Throughout 78 total rounds of competition, the majority of combinations were within the time allowed with only 3 rounds accruing time faults.

	Round 1	Round 2	Round 3	Round 4
Jumping efforts	13	14	14	12
Verticals	7	7	6	6
Oxers	6	7	8	6
Combinations	2	2	2	2
Fence height	1.05 m	1.10 m	1.10 m	1.05 m
Time allowed	74 s	80 s	76 s	78 s

1 Breakdown of the number of jumping efforts, verticals, oxers, combinations, fence height and time allowed across the four rounds of competition observed for analysis.

Table 1

Jumping variables and time allowed across the 4 rounds of competition[1]

78 total rounds occurred with 20 (25.5%) being a fault-free round (no accrual of faults and completed within the time allowed) and the remaining 58 (74.4%) had faults produced (knocking a rail, refusal, fall of horse and or rider or over the time allowed). Spearman's correlation found no meaningful correlation between round time and the total number of faults (r = 0.34; P=0.008).

Fence type

When comparing the type of fence and faults throughout the competition, 46 faults occurred at verticals (51.7%) and 43 occurred at oxers (48.3%), however there was no significant difference found between type of fence and fault accrual (P=0.610). The majority of faults (70.6%; n = 12) occurred at verticals within combinations while 29.4% (n = 5) occurred at oxers but no significant difference in fault accrual was found between fence types (P=0.411).

Fence approach angle

Fence approach angle was defined as left, straight or right when evaluating performance at this particular competition. Throughout the competition, 18% of faults occurred on left approaches, 13.5% on right approaches and 68.5% on straight approaches. However, no significant differences were found between these different fence approach angles (P=0.576).

Sections of the course

Different sections (divided into quarters) of the course were assessed during this analysis. Kruskal-Wallis analyses found that there was a significant difference (P=0.014) for fault occurrence between the four different quarters of the course. Post-hoc analysis with a Bonferroni adjustment identified that faults were more likely to occur during the final quarter of the course (32.6%, n = 29) when compared to the first quarter (23.6%, n = 21; P=0.028) (Figure 1).

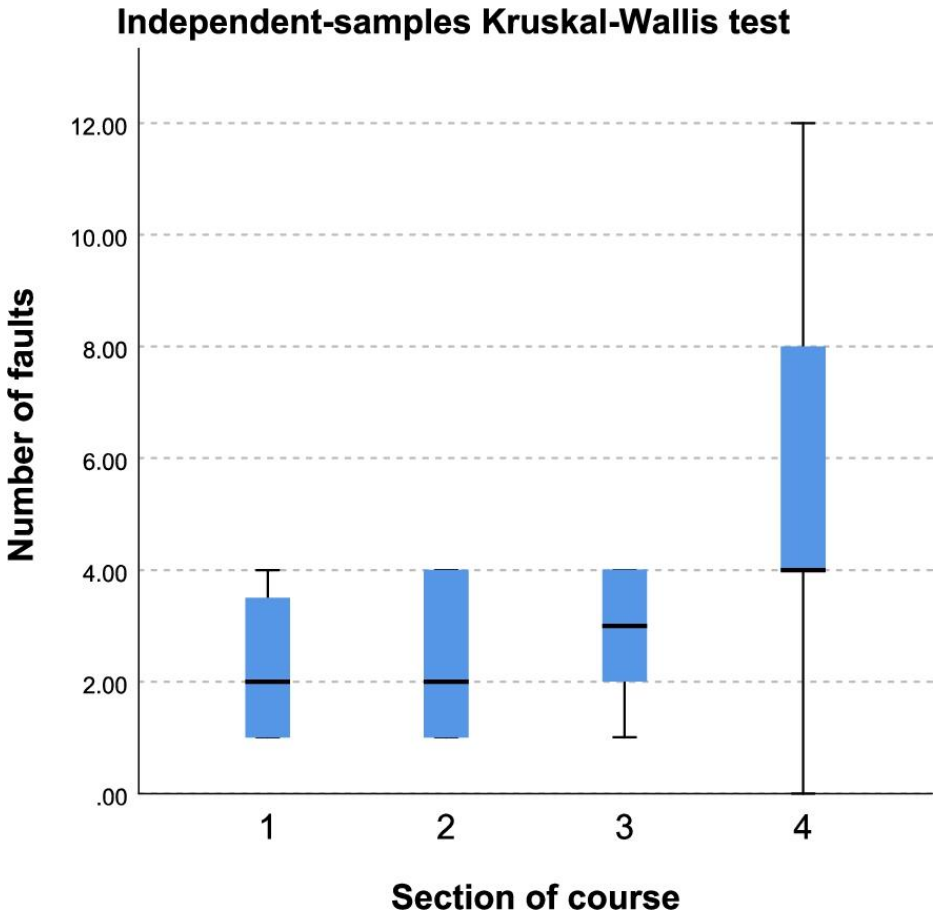

Figure 1

Fault accrual amongst different sections of the course. Representation of fault accrual throughout the different sections of the course, divided into quarters. Results indicated that faults were more likely to occur during the final quarter (denoted as 4) of the course when compared to the first quarter (denoted as 1).

4 Discussion

Performance analysis of minors and their ponies competing in show jumping at the 2021 USEF Pony Finals was conducted in order to see if the course variables studied affected performance. To the authors' knowledge, this was the first study conducted using performance analysis to evaluate minor and/or amateur riders competing at this particular competition. Although the results indicated that not all course variables studied were statistically significant, there were evident patterns of how faults accrued. The results also demonstrated that notational analysis is an inexpensive and effective way to help inform training and riding strategies, especially when preparing for competitions.

Faults and section of the course

It was expected that faults were more likely to occur during the final quarter of the course versus the others. Based on the results, faults were found to be statistically significant during the final quarter of the course versus the first. This is in agreement with a study by Marlin and Williams (2020), who found that the number of faults increased between the 1st and 4th quarters and knock-downs (rails) were 2.8 times more likely to occur within the second half of the course versus the first.

One possible reason for the increase in fault accrual during the final quarter of the course versus the others could be from pony and rider fatigue, influenced by a number of factors. As this competition

was held outdoors and during the summer, environmental factors such as the weather could have played a role in fatigue. The classes for this particular competition were typically held in the hottest part of the day. Based on this, riders and ponies may be more likely to physically fatigue easier. Increased fault accrual could also be due to the rider experiencing mental fatigue towards the end of the course. Since the sport of show jumping involves a partnership amongst horse and rider where the rider is primarily making the decisions, this could be considered both a physically and cognitively-demanding sport. Mental fatigue is defined as a psychobiological state that is caused by extended periods of demanding cognitive activity (Marcora *et al*., 2009). A systematic review revealed that mental fatigue has a negative impact on skilled performance, including decision-making and technical skills in human sports such as basketball and soccer (Sun *et al*., 2021). Therefore, mental fatigue could be influencing a rider's concentration and decision-making skills as the amount of time spent in this cognitively-demanding activity continues, resulting in increased fault accrual seen within later sections of the course.

Fence type

Faults at vertical fences were expected to occur more frequently versus at oxers. Traditionally, riders and coaches have considered vertical fences more difficult to successfully jump (Marlin and Williams, 2020). However, there was no significant difference between the type of fence (verticals or oxers) and occurrence of faults, although more faults occurred at verticals (51.6%, n = 46) versus at oxers (48.3%, n = 43). This is in agreement with Marlin and William's (2020) findings, in which faults were found to be more common at verticals but this was not significantly associated with increased faults. Another study found that the highest probability of faults occurred at vertical obstacles with water (Ničová and Bartošová, 2022), and although the present study did not have water obstacles, faults did occur more at verticals. The lack of influence of fence type found in the present study and Marlin and William's (2020) study could be due to a horse's jumping kinematics. Walker *et al*. (2018) found that elite show jumping horses use similar techniques to successfully jump over a fence, regardless if the fence is a vertical or oxer. However, since the present study was looking at non-elite ponies and amateur riders, the ponies may not have a consistent jumping technique across the different fence types. Another study found that lower-level horses free jumping a 1 m vertical fence had a significant difference in their back motion versus a group of higher level horses (Cassiat *et al*., 2004). It is important to note that Cassiat *et al*. (2004) did not assess ponies who would likely free jump at a lower height, thus results could be skewed on jumping technique if ponies were included. Therefore, depending on the level of experience a horse or pony has, jumping technique may play a role on the occurrence of faults at different fence types. Fence design and colour could also be associated with jumping performance. In a recent study, fence design and colour combinations were assessed and it was found that fence design had more of an influence on fault accrual rather than colour in elite show jumping (Williams *et al*., 2022). Future work from the present study could be undertaken to assess if fence design as well as colour does have an influence on fault occurrence at amateur level competitions.

Limitations

One major limitation was the low number of jumping efforts seen throughout the competition. Due to this factor, this could have been the reason why the study failed to see many statistically significant differences even though there were trends seen of how faults accrued. This study also only evaluated these rider and pony combinations at this particular competition. If these combinations were evaluated longitudinally, this could help identify patterns within particular courses and these specific combinations, thus allowing for a more accurate analysis of performance. Finally, all rounds were evaluated through competition recordings posted on the USEF Network so

the performance analyst was reliant on the videographer and could not manipulate the angles at which particular fences were seen so some course variables (such as approach angle) could have been recorded inaccurately based on the angle seen within the video. Despite these limitations, notational analysis used within the present study provides evidence that performance analysis could be beneficial to inform training and riding strategies within the sport of show jumping.

5 Conclusions

Information gained from performance analysis techniques could be beneficial to inform training or riding strategies, especially when preparing for competitions. As the welfare of horses and riders becomes increasingly important, utilising these techniques could provide evidence-based approaches for riders to use when training and competing while keeping the welfare of the horse in mind. Therefore, research within performance analysis should continue to be done and this technique should be advocated to be used regularly within the equestrian sport of show jumping.

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