RIDER REPORTED FACTORS INFLUENCING CHOICE OF STIRRUP LENGTH IN DRESSAGE, SHOWJUMPING AND EVENTING, AND PARA EQUESTRIANISM

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Abstract

The main functions of a saddle are to improve rider stability and comfort, with the stirrups providing support for the rider's legs. The criteria upon which riders base their choice of stirrup length for different equestrian disciplines does not appear to have been reported. Therefore, this study was designed to investigate the factors that play a role in a rider's choice of stirrup length for different equestrian and para-equestrian disciplines. An online questionnaire consisting of open and closed demographic questions and 28 Likert scale questions related to factors which are anecdotally associated with stirrup length was distributed via social media horse pages. Respondents were asked to identify factors that influenced their decision making when setting their stirrup length in dressage, showjumping and eventing (dressage, showjumping and cross-country phases). Two thousand, one hundred and eighty-three participants took part in this study, the majority were female (97%; n=2131). Eight percent of the sample (n=184) categorised themselves as para-equestrians. Most respondents (n=1200) identified themselves as dressage riders (amateur: 89%, n=1068; professional: 11%, n=132), 665 riders engaged in showjumping (amateur: 87%, n=579; professional: 13%, n=86) and a further 393 riders selected eventing as their primary discipline (amateur: 89%, n= 350; professional: 11%, n=43). All riders consistently ranked feel of stirrups once mounted, how stable stirrups feel once moving and type of saddle being used as the three most important factors when deciding stirrup length across the disciplines. Dressage riders were more greatly influenced by the factors investigated when setting stirrup length then either showjumping or event riders (Kruskal Wallis: $P<0.04$). For eventing participants, exercise type, safety, saddle type and rider stability were key factors influencing stirrup length selection between different phases of the competition. These factors were generally ranked as more important for the dressage / flatwork phase compared to showjumping or cross country schooling (Kruskal Wallis: $P<0.01$). Stirrup length is likely to affect rider comfort, performance and safety while having relatively less effect on the horse's well-being, therefore it is not surprising that riders from all disciplines placed high emphasis on factors related to the rider and saddle.

Introduction

The saddle forms the interface between the horse's back and the rider's seat. It improves rider stability and comfort by providing a surface that conforms to the shape of the rider's seat and thighs with the stirrups supporting the weight of the rider's legs (Kang *et al*., 2010). Across equestrian disciplines, stirrup length varies when riding in different positions for different purposes. Equestrian practice teaches riders to use a longer stirrup length for dressage, an intermediate stirrup length for general-purpose riding, and a shorter stirrup length for galloping and jumping. Preferential weighting of one stirrup, known as stirrup-stepping (Ritter, 2011; Todd, 1991), is used as an aid for bending the horse's body. One anecdotal recommendation for estimating stirrup length for different purposes is that for flat work the length should be adjusted so that if the rider's fingertips are placed on the bar of the saddle, the stirrup will reach into the armpit. For jumping, the stirrups are shortened to the extent that the stirrup reaches into the armpit when the closed fist is placed on the stirrup bar (Zettl, 1998). The difference between these two approximations is of the order of 6-8 cm.

When riding in a light seat, as used for cross country during eventing, also known as a two-point position, the seat of the saddle is unweighted and most of the rider's weight is borne by the stirrups. The vertical oscillations of the horse's back are absorbed by flexions of the riders' hip, knee and ankle joints rather than by movements of the lumbo-pelvic-hip complex. By using the light seat, rider antero-posterior stability is improved (Peham *et al*., 2010) and oscillations in the forces on the horse's back are reduced resulting in lower peak force values (Peham *et al*., 2010). For jumping, the stirrups provide a platform that supports the kinematic adjustments in the rider's position during the approach, take off, jump suspension, landing and move off.

When riding for dressage or on the flat riders typically sit deeper into the saddle to facilitate increased contact between their legs and the horse. This would not be possible with short stirrups, particularly when using a dressage saddle with straight cut panels (Quinn & Bird, 1996). A further point is that during higher level dressage, sitting trot is expected, with the rider selecting an upright posture in order to remain in balance and move in phase with the horse (Byström et al., 2009). Münz et al. (2014) explains that dressage also requires the rider's seat to be well adjusted and stable in order to communicate with the horse through the pelvis as well as the rein and leg aids; without correctly chosen and adjusted stirrups this could prove difficult to achieve.

The criteria upon which riders base their choice of stirrup length for different sports does not appear to have been reported. Therefore, this study was designed to investigate the factors that influence a rider's choice of stirrup length for different equestrian disciplines: dressage, showjumping, eventing and para-equestrian.

Materials & Methods

Participants

Participants were recruited online via sharing a link to the survey onto social media (Facebook®) on selected UK equine-related or discipline-specific groups including but not limited to: British Dressage, Eventing UK, #Twittereventing, Horsepoo (Cambridge, Suffolk, East Anglia, Bedfordshire, Peterborough, Lincolnshire, Northamptonshire, Hertfordshire and Essex pages). The survey invitation was targeted to riders competing in either affiliated and unaffiliated competitions for one of more disciplines: dressage, showjumping and eventing, or within para-equestrian sport in the UK. Inclusion criteria required participants to be actively engaged in horse-riding and to be over 18 years of age. The survey was anonymous. Ethical approval was granted by the Ethics Committee of the University of East Anglia.

Survey Design

The study was designed as an online questionnaire (Survey Monkey®) with a combination of open, closed and Likert style questions. The questionnaire was split into four major sections: demographic questions examining participant signalment and three discipline-specific sections containing questions linked to riders' selection of stirrup length for dressage, showjumping and eventing, and para-equestrian sport. Questions were designed as Likert scales allowing riders to select the response which most closely fitted their practice in the context of the question (e.g. choosing how likely it would be for them to adapt their stirrup length when riding a new horse). The survey was designed using routing logic to allow respondents to proceed through the survey responding to their specific discipline to encourage compliance. The draft survey was tested by 15 experienced users then edited to correct any errors before being fully deployed. The survey was live for 12 days and 97% (n=2117) of responses were obtained within the first 8 days.

Demographic factors

Respondents were asked questions relating to their amateur/professional equestrian status, gender, age, disabilities and injuries or illnesses relating to musculoskeletal system.

Individual disciplines

Riders were asked "Which factors influence your choice of stirrup length when riding?" and could then select relevant factors for each equestrian discipline they participated in: Dressage (in pure dressage); Showjumping (in pure showjumping); Flatwork or Dressage (in eventing); Showjumping (in eventing); Jumping Cross-Country (in eventing) or para-equestrian sport. Respondents were then asked 28 questions related to factors which anecdotally have been linked to rider selection of stirrup length (Table 1). The response was structured as a 5-point Likert scale ranging from 1: no influence, 2: slight influence, 3: moderate influence, 4: strong influence, 5: very strong influence / always with an additional option of "No opinion/Don't know" provided, these responses were not included in

subsequent analyses. For showjumping as a discipline and for showjumping and cross-country jumping in eventing, additional questions were included specifically related to jumping (Supplementary File 1, Table S1). A final open question asked respondents if there were any other factors influencing their choice of stirrup length.

Data Analysis

Data were exported from Survey Monkey™ to Microsoft Excel™ Version 2010 (Redmond, WA, USA). Data were analysed using descriptive statistics; frequency analysis identified the demographic profile of respondents. For the Likert scale questions examining which factors related to stirrup length selection, frequency analysis was conducted and in addition a numerical rating was assigned to the available responses (from 1: no influence to 5: very strong influence / always) to enable an arithmetic median and interquartile range for each factor to be calculated across the disciplines investigated. Responses to the additional option of "no opinion / don't know" were excluded prior to analysis.

Data were non-parametric, therefore a series of Kruskal-Wallis analyses (alpha: $P<0.05$) identified if differences in participant rating of factors considered anecdotally to influence stirrup length occurred between the disciplines and between competition phases for event riders. For factors where significant differences were found, Mann Whitney U post-hoc tests identified how ratings differed between the disciplines. Median rankings for individual factors were examined to identify the direction of differences between disciplines; where median values were the same, mean rank differences obtained from post hoc tests differentiated between disciplines.

Results

Respondent profile

Two thousand, one hundred and eighty-three respondents took part in this study. Of the respondents, 97% (n=2131) were female, 3% (n=66) were male. The majority classified themselves as amateur riders (91%; n=1983) and the remaining 9% (n=200) self-categorised themselves as professional riders. Every age category was represented but not equally. Twenty-eight percent (n=607) of respondents were 18-25 years, 26% (n=578) were 26-35 years, 19% (n=426) were 36-45 years, 17% (n=383) were 46-55 years, 7.5% (n=165) were 56-64 years and 2% (n=39) of respondents were older than 65 years. The majority of respondents did not present with lower body disability (92%; n= 1960)

or acquired degenerative disorders in the joints of the lower body (82%; n=1747), however 31% (n=660) had suffered some form of serious injury e.g. fracture or ligament damage to their lower limb.

Dressage

A total of 1200 dressage riders participated in the survey; 89% (n=1068) defined themselves as amateur riders whilst 11% (n=132) ranked themselves as professional equestrians. Eighty five percent of respondents (n=1026) were currently competing at elementary level of dressage or lower, with 23% (n=260) participating in unaffiliated dressage. Dressage riders ranked how stirrups feel when mounted, how stable stirrups feel when moving, type of saddle used, personal comfort and personal safety as the five most influential factors in determining their choice of stirrup length (Table 1). An overview of dressage respondent responses is provided in Supplementary File 2, Table S2.1.

Table 1: Discipline specific median responses for factors influential to rider stirrup length. Ranking scores: 1: no influence, 2: slight influence, 3: moderate influence, 4: strong influence, 5: very strong influence / always Values are median± IQR (inter-quartile range). Shaded boxes indicate the five most influential factors in each sport

Question	**Dressage (n=1200)**	**Show-jumping (n=655)**	**Eventing (n=635)**			**Para-riders (n=184)**
			DR	**SJ**	**XC**	
Feel when mounted	5±1	4±1	4±1	4±1	4±1	4±1
Measurement of arm length to stirrup	2±2	2±1	2±1	1±1	1±1	2±2
Stirrup bar to ankle distance	2±2	2±1	1±1	1±1	1±1	2±2
Front view from the ground	1±1	1±1	1±1	1±1	1±1	1±1
How warmed up the rider was	3±2	3±2	2±2	2±2	2±2	2±2
Rider stability	3±1	4±1	4±1	4±1	4±1	4±1
View in mirror when mounted	2±2	2±1	1±1	2±2	1±1	1±1
Reviewing photos or videos	2±2	2±2	2±2	2±2	2±2	2±2
Rider fitness level	3±2	3±2	2±2	2±2	2±2	3±2
Rider safety	3±2	3±2	3±2	4±1	3±2	4±1
Rider health	3±3	3±2	2±2	2±3	2±2	3±2
Rider back pain	2±2	2±2	2±2	2±2	2±2	3±2

Rider comfort	4±1	4±1	3±2 n=391	3±2	3±2	4±1
Rider boot type	2±2	2±2	2±2	2±2	2±2	2±2
Horse temperament	4±2	2±2	3±2	3±2	3±2	3±2
Riding new or unfamiliar horse	4±2	3±2	3±2	3±2	3±2	3±2
Horse back problem	3±2	2±3	2±3	2±2	2±2	3±2
Horse experience	3±2	2±1	3±2	3±2	3±2	3±2
Horse height	2±2	2±2	2±2	2±2	2±2	2±2
Horse conformation	2±2	2±2	2±2	2±2	2±2	3±2
Saddle type used	4±1	3±1	4±1	3±2	3±2	4±1
Stirrup type used	2±2	1±2	2±2	2±2	2±2	3±2
Coach input	3±2	3±2	3±2	3±2	3±2	2±1
Friend's input	1±1	2±1	1±1	1±1	1±1	1±1
External factors e.g. weather	2±1	1±1	1±1	1±1	1±1	1±1
Exercising inside vs outside	1±0	1±0	1±0	1±0	1±0	1±1
Exercise type e.g. schooling, jumping	3±2	2±2	3±2	3±2	3±1	3±1
Riding at home vs competition	2±1	2±1	1±1	1±1	1±1	1±1
SJ fence height		2±1			3±2	
XC speed				3±2		
XC Fence type				3±2		

Showjumping

Fewer respondents participated in showjumping (n=665). Of these, 87% (n=579) defined themselves as amateurs whilst 13% (n=86) categorised themselves as professional riders. Eighty-four percent of showjumpers (n=550) were currently competing in British Showjumping Foxhunter (1.20m) classes or lower, with 54% (n=357) participating in unaffiliated competitions. Analogous to dressage riders, showjumpers also ranked how stirrups feel once mounted, how stable stirrups feel once moving, type of saddle used, personal comfort and personal safety as the five most influential factors in determining their choice of stirrup length (Table 1). Interestingly, the weather and whether riding inside or outside were ranked the least influential factors in determining stirrup length for both dressage and

showjumping riders. An overview of showjumping respondent responses is provided in Supplementary File 2, Table S2.2.

Eventing

Three hundred and ninety three event riders responded to the survey (n=393). Similar to the demographics of dressage and showjumping, the majority of respondents rated themselves as amateurs (89%; n= 350) with only 11% (n=43) defining themselves as professional riders. Ninety five percent of respondents were currently competing at British Eventing Novice (1.00m) level or below, with 44% (n=172) competing in unaffiliated classes. Event riders consistently rated how stirrups feel once mounted, how stable stirrups feel once moving and type of saddle being used as the three most important factors when deciding stirrup length across flatwork, showjumping and cross-country riding. However when dressage schooling, riders then ranked riding a new or unfamiliar horse and horse temperament and behaviour as more influential to stirrup length, compared to personal safety and personal comfort, which were the fourth and fifth most influential factors when showjumping or riding cross-country (Table 1). An overview of event rider responses is provided in Supplementary File 2, Table S2.3.

Para-Equestrian

Eight percent of the sample (n=184) categorised themselves as para-equestrians. Twenty-six percent (n=47) of these riders competed in Para-dressage. Para-equestrians, similar to the other groups surveyed, ranked feel when mounted, rider stability, rider safety, rider comfort and saddle type as the five most influential factors in determining their choice of stirrup length.

Comparisons between disciplines

Despite all riders ranking feel of stirrups once mounted as one of the top five important factors that influenced stirrup length, analysis identified that this factor as statistically significant and was rated more influential by dressage riders compared to eventers and showjumpers (Table 2). Dressage riders were also more likely to consider the length of the stirrup relative to their arm length and stirrup bar alignment to the ankle angle when determining stirrup length or to use a mirror to check stirrup length compared to showjumpers and eventers (Table 2). Rider's experience with their mount and the general experience level and health of the horse strongly influenced riders' decisions when setting stirrup length; dressage riders rated this factor as more influential than eventers and showjumpers

(Table 2). Rider health and fitness, tack and exercise also determined rider choice of stirrup length, with dressage riders once again being more influenced by these factors than riders engaged in showjumping or eventing (Table 2).

Within the eventing respondents, exercise type, safety, saddle selection and rider stability were key factors which influenced stirrup length selection between the phases of competition (Table 3). Interestingly, these factors were generally ranked as more important for the dressage/flatwork phase compared to showjumping or cross country schooling.

Table 2: Comparison of importance of factors in determining stirrup length between disciplines. P: probability; DR: dressage; SJ: showjumping; EV: eventing; Ranking scores: 1: no influence, 2: slight influence, 3: moderate influence, 4: strong influence, 5: very strong influence / always. Don't know / no comment responses were removed prior to analysis. Bold denotes significant results (P<0.05).

Factor	**Kruskal Wallis analysis**	**Post-hoc Mann Whitney U analysis (median score)**	**MRD: mean rank difference: lower score denotes less influential.**
Feel mounted	**P=0.04**	**EV (4) to DR (5) P=0.005** **SJ (4) to DR (5) P= 0.015**	
Measure arm	**P=0.001**	**EV (2) to DR (2); P=0.004** **SJ (2) to DR (2); P=0.009**	**EV MRD reduced by 106.43** **SJ MRD reduced by 85.45**
Stirrup bar ankle	**P= 0.0001**	**EV (1) to DR (2); P = 0.0001** **SJ (2) to DR (2); P=0.0001**	**SJ MRD reduced by 112.18**
Look front floor	**P = 0.007**	**EV (1) to DR (1); P = 0.011**	**EV MRD reduced by 89.42**
Rider warmed up	P = 0.183	Non-significant; P>0.05	
Rider stability	P = 0.054	Non-significant; P>0.05	
Mirror when mounted	**P = 0.0001**	**SJ (2) to EV (1) P=0.042** **SJ (2) to DR (2) P = 0.0001**	**SJ MRD reduced by 155.66**
Photo or video	P = 0.106	Non-significant; P>0.05	
Rider fitness	**P = 0.0001**	**SJ (3) to DR (3) P = 0.0001** **EV (2) to DR (3) P = 0.007**	**SJ MRD reduced by 177.47**
Safety	**P = 0.044**	**EV (3) to DR (3) P = 0.044**	**EV MRD reduced by 82.44**
Rider health	**P = 0.004**	**EV (2) to DR (3) P =0.012** **SJ (3) to DR (3) P = 0.049**	**SJ MRD reduced by 72.03**
Rider back pain	P = 0.678	Non-significant; P>0.05	
Rider comfort	**P = 0.01**	**EV (3) to DR (4) P = 0.0001**	
Boot type	**P = 0.008**	**EV (2) to DR (2) P = 0.009**	**EV MRD reduced by 97.67**
Horse temperament	P = 0.063	Non-significant	
New of unfamiliar horse	**P = 0.0001**	**SJ (3) to DR (4) P= 0.0001** **EV (3) to DR (4) P = 0.017**	
Horse back problem	**P = 0.001**	**EV (2) to DR (3) P = 0.005** **SJ (2) to DR (3) P = 0.008**	
Horse experience	**P = 0.008**	**SJ (2) to DR (3) P = 0.006**	**SJ MRD reduced by 92.21**
Horse height	P = 0.523	Non-significant; P>0.05	
Horse conformation	**P = 0.011**	**EV (2) to DR (2) P = 0.036**	**EV MRD reduced by 84.37**
Saddle	**P = 0.0001**	**SJ (3) to DR (4) P =0.0001**	
Stirrup	**P = 0.003**	**EV (2) to DR (2) P = 0.006**	**EV MRD reduced by 77.65**
Coach	**P = 0.013**	**SJ (3) to DR (3) P = 0.012**	**SJ MRD reduced by 85.42**

Friends	P = 0.562	Non-significant; P>0.05	
External factors	P = 0.172	Non-significant; P>0.05	
Exercising in vs out	P =0.150	Non-significant; P>0.05	
Exercise type	**P =0.0001**	**DR (3) to SJ (2) P= 0.0001**	
Home vs competition	P=0.582	Non-significant; P>0.05	

Table 3: Comparison of importance of factors in determining stirrup length between competition phases in eventing. P: probability; DR: dressage / flatwork; SJ: showjumping; XC: cross country; Ranking scores: 1: no influence, 2: slight influence, 3: moderate influence, 4: strong influence, 5: very strong influence / always. Bold denotes significant results (P<0.05).

Factor	**Kruskal Wallis analysis**	**Post-hoc Mann Whitney U analysis (median score)**	**MRD: mean rank difference: lower score denotes less influential.**
Feel mounted	P = 0.048	Non- significant; P>0.05	
Measure arm	**P = 0.0001**	**XC (1) to DR (2) P = 0.0001** **SJ (1) to DR (2) P = 0.01**	
Stirrup bar ankle	**P = 0.002**	**XC (1) to DR (1) P = 0.004** **SJ (1) to DR (1) P = 0.011**	**XC MRD reduced by 66.0** **SJ MRD reduced by 60.36**
Look front floor	P = 0.291	Non-significant; P>0.05	
Rider warmed up	P = 0.876	Non-significant; P>0.05	
Rider stability	**P = 0.007**	**DR (1) to XC (2) P = 0.012** **SJ (1) to XC (2) P = 0.028**	
Mirror when mounted	**P = 0.0001**	**DR (1) to XC (1) P = 0.012** **SJ (1) to XC (1) P = 0.028**	**DR MRD reduced by 140.77** **SJ MRD reduced by 90.13**
Photo or video	P = 0.603	Non-significant; P>0.05	
Rider fitness	P = 0.079	Non-significant; P>0.05	
Safety	**P = 0.0001**	**DR (2) to XC (2) P = 0.0001** **SJ (2) to XC (2) P = 0.0001**	**DR MRD reduced by 144.77** **SJ MRD reduced by 90.13**
Rider health	P = 0.306	Non-significant; P>0.05	
Rider back pain	P = 0.833	Non-significant; P>0.05	
Rider comfort	P = 0.973	Non-significant; P>0.05	
Boot type	P = 0.751	Non-significant; P>0.05	
Horse temperament	P = 0.337	Non-significant; P>0.05	
New of unfamiliar horse	P = 0.118	Non-significant; P>0.05	
Horse back problem	P = 0.286	Non-significant; P>0.05	
Horse experience	P = 0.212	Non-significant; P>0.05	
Horse height	P = 0.289	Non-significant; P>0.05	
Horse conformation	P = 0.099	Non-significant; P>0.05	
Saddle	**P = 0.013**	**SJ (2) to DR (1) P = 0.010**	
Stirrup	P = 0.619	Non-significant; P>0.05	
Coach	P = 0.943	Non-significant; P>0.05	
Friends	P = 0.826	Non-significant; P>0.05	
External factors	**P = 0.014**	**DR (1) to XC (1) P = 0.012**	**DR MRD reduced by 60.14**
Exercising in vs out	P = 0.116	Non-significant; P>0.05	
Exercise type	**P = 0.0001**	**SJ (1) to DR (3) P = 0.0001** **SJ (1) to XC (1) P = 0.0001**	**SJ MRD reduced by 262.01**

Home vs competition	P = 0.521	Non-significant; P>0.05	

Discussion

This study evaluated factors influencing the rider's choice of stirrup length in the dressage, showjumping, and eventing, and within para-equestrian sport. The top five factors were highly consistent across disciplines, with riders in all sports selecting stability, safety, comfort and saddle type. The only exception was observed in eventers, who when riding dressage/flatwork, rated riding a new or unfamiliar horse and the horse's temperament as more influential than their personal safety and comfort.

Riders were more reliant on their feel and stability when mounted to determine stirrup length than on visual input provided before mounting (observing stirrup length from the ground), when mounted (looking in a mirror) or retrospectively (reviewing photos or videos). Estimates of stirrup length based on the rider's arm or leg length are familiar to most riders but were not very influential among riders participating in this survey with the possible exception of dressage riders. The fact that riders are heavily dependent on their sense of proprioception agrees with a previous study that showed riders consistently adjusted their stirrups to the same length relative to leg length even when mounted on different horses (Andrews-Rudd et al., unpublished data). Since equestrianism is a sport based on the rider's feel for the horse's movement, it is not surprising that the rider's feel when mounted was highly ranked as a determinant of stirrup length.

Most of the factors listed in the survey fall within the broad categories of rider, saddle, horse, exercise type and external influences. Given that stirrup length is likely to affect rider comfort, performance and safety while having relatively less effect on the horse's well-being, it is not surprising that riders from all disciplines placed high emphasis on factors related to the rider and saddle. Effective communication with the horse requires that the rider maintains a functional position in the saddle (Peham et al., 2010). Ideally, the rider's ear, shoulder, hip and heel are vertically aligned when viewed from the side (Blokhuis et al., 2008), which allows the rider to sit with a neutral alignment of the spine and pelvis. Each gait moves the rider in a characteristic three-dimensional pattern (Fruehwirth et al., 2004), which is accomplished by a feed forward mechanism that anticipates the horse's cyclic movements (Terada et al., 2006). In order to ride effectively, riders should not have to struggle to keep their feet securely in the stirrups in spite of the positional perturbations, which could explain the high percentage of responses suggesting that feel of stability is highly influential on their choice of stirrup lengths. During jumping, stirrup pressure is needed for leverage and to facilitate the action of

the limbs as springs which cannot happen if the stirrup length is too long. Riders will be able to feel if stirrups are too long by linking their experience to proprioception: they may have experienced lack of stability previously from choosing an incorrect length, so it is perhaps unsurprising that riders chose both feel and stability as highly influential factors.

In choosing a suitable stirrup length, the rider draws on past experience to anticipate the appropriate length for the workout that will follow. For example, in eventing it is expected that stirrup length would be longest in the dressage phase and shortest in the cross country phase. Eventers factored in the type of exercise and, if jumping, the size and type of fence, all of which were rated as moderately important in determining stirrup length in this survey. In general, eventers ranked the factors a little differently for the three phases of the sport with exercise type being one of the key considerations in selecting stirrup length. Safety, saddle selection and rider stability were also key factors for eventers, particularly so when riding dressage or flatwork.

Stability of the rider, and ultimately the horse-rider system, is a sensitive measure of the quality of a rider (Peham et al., 2004). Clearly the rider needs to be stable, especially during jumping and the associated sharp turns, and this may explain why dressage riders rated stability a little lower than showjumpers and eventers. The fact that stability was highly influential with regard to selection of stirrup length is to be expected, though it was rated slightly lower by dressage riders than riders in other disciplines. The rider tends to be destabilized by gravitational, inertial and ground reaction forces generated by the horse during locomotion (Peham et al., 2010). The rider's ability to activate the core musculature to stabilize the lumbo-pelvic-hip complex is key (Wilson et al., 2005). In general, rider stability, defined in terms of the longitudinal range of motion of the centre of pressure beneath the saddle, is greater in the two-point position than when sitting in the saddle (Peham et al., 2010); however, the two-point seat is seldom used in dressage riding.

The rider's core musculature is relatively less effective in controlling movements of the trunk from side to side compared with from front to back, which results in a weaker coupling between rider and horse in the transverse direction (Münz et al., 2014). Stirrups are particularly beneficial in stabilizing the rider from side to side through the application of differential pressures on the two stirrups. Equality of stirrup lengths will clearly be beneficial in this regard and it has been reported previously that riders are able to select equal left and right stirrup lengths without external input (Andrews-Rudd et al., unpublished data). The problem of maintaining mediolateral stability may be even more challenging in some para-equestrian riders depending on the nature of their disability (Clayton et al., 2011). Whilst the results highlight the importance of stability to the rider when selecting stirrup length, we did not consider how riders achieved this in reality and if they would select equal lengths for both of their stirrups. Further work exploring how stability is achieved in practice, and if rider perception of stability translates to enhanced stability during riding is warranted.

The saddle couples the rider to the horse to provide stability and influences the movements of the horse (Peham et al., 2004), the rider (Peham et al., 2001), and the entire horse-rider system (Winkelmeyr et al., 2006). Therefore, saddle selection is key to performance. Saddles differ in the shape of the flaps and in the presence/position of thigh and knee rolls that are designed to assist in correct placement of the riders' legs and to provide stability, especially during jumping (Belton, 1997; Edwards, 2007). It is not unexpected that saddle type would be a determinant of stirrup length, as respondents have indicated. The fact that the saddle was less influential for jumping than for flat or dressage riding may be related to the fact that it would be unusual to jump in a saddle that was not forward cut, whereas any type of saddle may be used for flat work. This could explain why the saddle was more highly rated as a determinant of stirrup length for flat riding than for jumping.

Limitations

The majority of respondents were female and therefore may be biased and not reflective male riders' perspectives. It should also be noted that most respondents classified themselves as amateur riders, therefore the results cannot be considered to fully represent the views of professional riders. Further research testing how riders, across disciplines and status, select their stirrup length in practice to support the views presented here is warranted.

Conclusion

Regardless of discipline, riders consistently ranked feel of stirrups once mounted, how stable stirrups feel once moving and type of saddle being used as the three most important factors when deciding which stirrup length to use when riding. Dressage riders were influenced more by extrinsic factors when selecting stirrup length than showjumping or event riders. Stirrup length is likely to affect rider comfort, performance and safety, while having relatively less effect on the horse's well-being, therefore it is not surprising that riders from all disciplines placed high emphasis on factors related to the rider and saddle.

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