Understanding rider: horse bodyweight ratio trends, weight management practices and rider weight perceptions within leisure and amateur riders in the UK

Running title: RHBW Ratio Trends, Weight Management and Perceptions in Riders

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Abstract

Horse riders in the UK have a legal responsibility for the welfare of the horses in their care, outlined by the Animal Welfare Act (2006). Understanding weight management factors that influence rider: horse bodyweight (RHBW) ratio is key to safeguarding horse welfare as human obesity rates increase. Recent high-profile incidents have seen riders being asked to dismount for being too heavy, demonstrating an awareness of the possible impact of excessive rider weight, threatening the equestrian industry's social licence to operate. This study investigated RHBW trends within the UK leisure and amateur rider population to understand rider perception of 'ideal' RHBW and factors influencing rider and horse weight management. An online survey (SurveyMonkey®) was distributed via UK equine-related Facebook™ groups and collected information on horse and rider demographics, rider weight management strategies and respondents' views on the importance of rider weight on horse welfare. Kruskal-Wallis analyses with Mann Whitney U post-hoc tests identified whether differences in respondent views differed between RHBW groups. A total of 971 riders completed the survey; respondents were aged between 18-65+ years old and 88% (*n*=953) were experienced riders. RHBWs were calculated for 764 (79%) of respondents as 21.2% (n=206) did not know either their own and/or their horses' weight. Weight tapes (44.5%; *n*=432) and weigh bridges (29.5%; *n*=286) were common horse weight estimation methods. RHBWs ranged from 4.9% to 21.88%, mean: 12.5%±2.7%. Riders with lower RHBW thought about their own weight less and measured their horses' weight less often than those with higher ratios ($P<0.005$, $P< 0.0004$, respectively). The majority of riders who participated were weight conscious and recognised potential detrimental impacts associated with increased rider weight. Development of RHBW guidelines supported by equestrian governing bodies would highlight the need for riders to consider the impact of weight and support them in choosing suitable horses.

Keywords: rider, equine, welfare, obesity, weight, social license to operate, equestrian

Introduction

Over the past 40 years there has been a substantial increase in the use of horses for recreational, competitive and performance purposes in the developed world (BETA, 2019; Jones and McGreevy, 2010; Robinson, 1999). In the United Kingdom (UK) the horse is classified as a companion animal and therefore not afforded protection of classification as a livestock species (The Welfare of Farmed Animals (England) Regulations 2007). However, UK horse owners and riders do have a legal responsibility and a duty of care, outlined within the Animal Welfare Act (2006) and the DEFRA Code of Practice (2017), to ensure the optimal welfare of the domesticated horse (Williams and Tabor, 2017). Despite this, some ridden horses are subject to practices involved in traditional training, riding and competing that can potentially have negative consequences for their welfare. The carrying of weights (riders) beyond their individual capabilities may be one such example (Halliday and Randle, 2013).

Riding a horse could be considered detrimental to the horse's welfare (McGreevy, 2007) particularly if rider weight starts to increase disproportionately to the horse's weight, body condition, skill, fitness levels and ability. If the welfare of the horse is seen by the public eye to be compromised, it could threaten the equine industry's social licence to operate. However, the full extent of the effect of rider weight on the horse is still largely unknown as a variety of other human related factors such as saddle fit, fitness levels and rider ability are also proposed to have a potential influence on how much weight the horse can carry without compromising their welfare (de Cocq et al., 2004; Greve and Dyson, 2013; Powers and Kavanagh, 2005). It is commonly argued that other horse attributes such as cannon bone circumference and breed have an influence on how much the horse can carry, however these claims have yet to be objectively substantiated.

Horses can carry heavier riders without displaying signs of pain, as horses are highly adaptable and tolerant to human interventions potentially exposing them to insult or injury (McGreevy, 2004; McGreevy et al., 2011). Adding dead weight (e.g. lead weights carried in a saddle cloth) onto the horse's back produces extension of the thoracolumbar spine to counteract the weight added, increasing retraction of the forelimbs and protraction of the hindlimbs as the horse avoids over-extension of the thoracolumbar spine (Benton, 2006; deCocq et al., 2004). However, dead weight does not truly represent riders' abilities in the saddle as riders' postural stability, balance and synchronicity will influence distribution of bodyweight (Randle et al., 2017), as the rider can shift part of their weight load onto the horse's hindlimbs in the trot (Schamhardt et al., 1991). Increasing rider weight on the horse's back has been found to influence relative stance duration (Clayton, 1997; Sloet Van Oldruitenborgh-Oosterbaan et al., 1995), decrease stride lengths and increase stride frequencies (Gunnarsson et al., 2017). Increased rider weight can also contribute to an increase in thoracolumbar stiffness in the horse (Martin et al., 2016; Peham et al., 2004).

A small change in stride kinematics can lead to visible kinematic changes such as temporary lameness and associated behavioural changes such as tail swishing, consistent changes in head movements and spontaneous gait changes, over the length of a typical riding session (Dyson et al., 2019). Injury acquired from repetitive overload training from carrying excessive rider weights (Marlin, 2014) can contribute to soft tissue injuries, back pain and the pathogenesis of physical structures such as overriding dorsal spinous processes (ODSP) in the horse (Clayton and Stubbs, 2016; deCocq et al., 2004). Dyson et al. (2019) demonstrated riders over 15% of the horse's bodyweight may have a detrimental effect on the horse. Despite this, few studies have evaluated rider weight which may be due to it being a sensitive subject. This is problematic for the equestrian industry as little guidance is available for use within organisations where horses are ridden (such as riding schools) on appropriate/suitable rider: horse weight ratios, and for the individual horse owner / rider who wants to ensure they are an appropriate weight for their horse.

The impact of increasing weight in riders was highlighted as a research priority at the 2nd International Saddle Research Trust Conference, and in a meeting held by World Horse Welfare, in 2015 (Clayton et al., 2015). It was concluded that ways to help the rider assess whether they are suitable for their horse in terms of rider weight, height and ability, should explored along with pre-riding initiatives (Clayton et al., 2015), such as rider focused off-horse fitness or additional forms of exercise. Recent examples of riders being asked to dismount for being too heavy during high profile competitions such as Horse of the Year Show in 2017 and Great Yorkshire Show in 2019, have been reported in equestrian and mainstream media. This indirect recognition of negative impacts on the horse that threaten equine welfare has the potential to call into question equestrian sport's social license to operate (Fiedler, 2020; Heleski et al., 2020; Williams and Marlin, 2020).

The percentage of obese people within the UK population is increasing (NHS Digital, 2019), therefore by association, the average weight of the UK rider population is also likely to be increasing at a similar rate. Data outlining the average RHBW ratio of UK riders do not exist. In 2013, a preliminary study, by Halliday and Randle (2013) reported collegiate rider RHBW ratios ranging between 14.2% and 16.6%, which was substantially heavier than the 'proposed ideal' ratio of 10% commonly reported in the lay equine press and media. College riders are aged between 16-18 years and represent a relatively active age group (Sport England, 2020), therefore the increased ratios reported in this study could be greater in more sedentary age groups. The BETA 2019 survey identified 50% of UK riders are over 25 years of age and therefore additional work is needed to understand whether heavier rider weights are a prevailing issue across all of the UK riding population. However, despite the increase in media attention and disqualification of riders at competitions, no general consensus on, or evidence-based, definitive RHBW ratio guidelines currently exist to help riders assess whether they are a suitable weight for their horse. The aim of this study, therefore, was to explore RHBW ratio trends within UK leisure and amateur horse riders in order to understand rider perception of 'ideal' RHBW ratio and to identify factors that could influence rider and horse weight management.

Methods

Participants
A total of 971 leisure and amateur horse owners/loaners/carers took part in an online survey. Leisure riders were defined as individuals who engaged in hacking/trekking/leisure riding and unaffiliated equestrian activities (activities not associated with a governing body), regardless of their riding experience. Amateur riders were defined as experienced riders (over 3000 hours of riding experience) who regularly compete in affiliated equestrian activities (activities associated with a governing body) but for whom equestrianism was not their main source of income (Williams and Tabor, 2017). Participants were recruited via a survey shared across UK wide equestrian-related Facebook™ groups such as Chit Chat and Tack, Happy Hackers and Family Horses, BSJA, British Dressage and The Nutty Nags. Participants in the study were over 18 years old and consisted of female (n=954), male (n=16) and other (n=1) riders. Ethical approval was granted by Hartpury University Ethics Committee.

Survey Design
The survey was designed as a 30-question online questionnaire using Survey Monkey© (San Mateo, CA, USA), split into four sections that consisted of 2 open, 22 closed and 6 Likert (Supplementary File 1):

Section 1: Horse demographics asked respondents to record their horse's weight, height, age, breed and sex.
Section 2: Rider demographics asked respondents their age, gender, weight, height, location, riding level, preferred disciplines and weight tracking habits. This enabled RHBW ratio and

Body Mass Index (BMI) to be calculated. Demographic data were used to categorise respondents and allow comparisons between different groups of riders and horses to identify trends.
Section 3: Riders' views on rider weight and their fitness habits were collected using closed questions.
Section 4: Rider agreement on statements related to rider weight and equine welfare. A series of five-point unipolar rating scales (1 = strongly disagree to 5 = strongly agree) were used to determine rider agreement with a series of statements about rider weight. The draft survey was piloted prior to distribution by four experienced horse riders and led to three minor wording changes to help the user better understand the questions. The survey was live for 17 days, between 19th March 2020 and 4th April 2020, with 74% (*n*=718) of responses obtained within the first four days.

Data Analysis
Data were exported from SurveyMonkey© to Microsoft Excel Version 16.35 (Redmond, WA, USA) and coded for analysis. RHBW ratios (%) and Body Mass Index (BMI) were calculated for each respondent using the following formulae:

$$\text{RHBW ratio} = (\textit{Rider bodyweight/horse bodyweight}) \times 100\ (\%)$$ (Halliday and Randle, 2013)

$$\text{BMI} = \textit{weight (kg)} / [\textit{height (m)}]^2\ (\text{kg/m}^2)$$ (Keys, et al. 2014)

Data were then imported into IBM Statistical Package for the Social Sciences (SPSS) (IBM Corp. Released 2019. IBM SPSS Statistics for MAC OS, Version 26.0. Armonk, NY: IBM Corp to enable mean±standard deviation (sd) and median±interquartile range (IQR) to be calculated for each of the variables collected. Frequency analysis identified group frequencies between demographic variables across horse and rider combinations, for age, gender, breed, riding level and preferred disciplines, and frequency of responses for Likert scale and ranking questions, which was a successful approach used by Farmer-Day et al. (2018).

Data met non-parametric assumptions, therefore a series of Kruskal-Wallis analyses tested if differences existed between RHBW ratios and categorical variables. Where significant differences existed, Mann Whitney U post-hoc tests were used to determine where differences occurred between groups within categorical variables. Chi-squared tests established if relationships existed between categorical variables such as BMI, rider age, and the frequency of additional physical activity. A series of Spearman's correlation coefficient tests identified if associations occurred between continuous variables such as horse and rider weight, and horse and rider height. Significance was set at $P<0.05$; correlation results were considered meaningful if alpha values were <0.05 and correlation coefficients (r) were between ±0.50 – 0.69 were considered moderate, ±0.70-0.89 as high / strong and 0.90-0.99 as very high / strong and ±1 as perfect correlations (Hinkle et al., 2003; Mukaka, 2012).

Results

Respondent Profile
The study recruited 971 voluntary respondents, consisting of female (98.1%; *n*=954), male (1.6%, *n*=16) and other (0.1%, *n*=1) riders. The 2020 British Equestrian Trade Association (BETA) 2019 survey identified approximately 1 million people regularly ride in the UK; based on this figure, sample size recruited accurately represents the views of UK riders to ±3% margin of error at the 95% confidence interval (Survey Monkey Margin of Error Calculator, 2020). The majority of riders considered themselves experienced (88%; *n*=854),

whilst the remaining considered themselves as novices (12%; *n*=117). Rider age was not represented equally; 42.4% (*n*=412) of riders were 18-24 years, 22.1% (*n*=215) were 25-34 years, 13.9% (*n*=135) were aged 35-44 years, 12% (*n*=117) were 45-54 years, 7.5% (*n*=73) were 55-64 years, and the remaining 2% (*n*=19) were over 65 years old. Riders from across the UK were represented in the study (Figure 1). Leisure riding/hacking (28%; *n*=272), showjumping (21.6%; *n*=210), dressage (20.7%; *n*=201) and eventing (18%; *n*=175) were the most popular preferred disciplines across the sample. The remaining disciplines included showing, hunting and endurance; a full listing is provided in Supplementary File 2, Table S1. Based upon UK qualification levels, a total of 34.7% (*n*=337) riders held a level 3 qualification, whilst 34.5% (*n*=335) held a level 2 qualification, 19.6% (*n*=190) held a level 4 qualification, 9.2% (*n*=89) held a level 1 qualification, and the remaining 2.1% (*n*=20) held no qualifications.

Figure 1. The distribution of leisure and amateur riders across the United Kingdom that reported their RHBW ratio data.

Horse Profile

The majority of horses included were geldings (59.6%; *n*=579) and mares (40%; *n*=388), with only a small percentage of stallions (0.4%; *n*=4). The mean age of horses was 11.76±4.96 years, range: 3 to 30 years old. There were 40 horse breeds/types represented in the study. The most common breeds were Warmbloods (18.6%; *n*=181), Irish Sports Horses (12.9%; *n*=125), Thoroughbreds (11.4%; *n*=111), Cob Types (8.7%; *n*=84) and Welsh Types (6.5%; *n*=63). The remaining breeds, including cross breeds, are reported in Supplementary File 3.

Rider Measurements, Weight Assessment and Physical Fitness Habits

Each BMI category was represented in the study (Figure 2), however since 4.8% (*n*=47) of riders did not know their weight, their BMI could not be calculated. Mean rider weight was 67±13 (range: 38kg to 120kg; *n*=924), the remaining 47 riders did not know their weight, and 13 of these 47 riders did also not know their horse's weight. Mean rider height (metres) was 1.67±0.07m (range: 1.50m to 2.14m). No meaningful correlation was found between rider height (metres) and rider weight (kg) (*r* = .365, *p*=.0004) (*n*=924 riders, Supplementary File 4, Figure S1). Riders reported a relatively active lifestyle, with 43.9% (n=426) taking part in additional physical activity outside of their normal equestrian activities every day. Thirty six percent (*n*=350) of riders took part in additional physical activity once weekly, 6.3% (*n*=61) took part monthly, 4.3% (*n*=42) took part every few months, and the remaining 9.5% (*n*=92) never took part in additional physical activity outside of riding. An overview of the types of additional physical activities that rider's participant in can be found in Supplementary File 4, Table S3.

The frequency of riders assessing their own weight varied, however just under a third (32%, *n*=311) assessed their weight weekly (Figure 3a). Riders' preferred method of assessing their weight was by using a set of scales (95.8%, *n*=930) (Figure 3b), the remaining riders used other assessment methods such as how well their clothes fit (0.6%, *n*=6), and their body condition (0.3%, *n*=3) to assess their weight (Figure 3b).

Chi Squared analysis identified significant associations between rider BMI and age, and how often respondents took part in physical activity (χ^2 (23, *n*=924):23.441, *p*=0.024; χ^2 (25, *n*=971):50.93, *p*=0.002, respectively) (Supplementary File 4, Table S1; Table S2). Types of additional physical activity undertaken included running (27.1%; *n*=263), walking (29.7%; *n*=288), gym (21.4%; *n*=208); cycling (7.2%; *n*=70), yoga (5.7%; *n*=55), Pilates (5.7%; *n*=55) and swimming (6.1%; *n*=59).

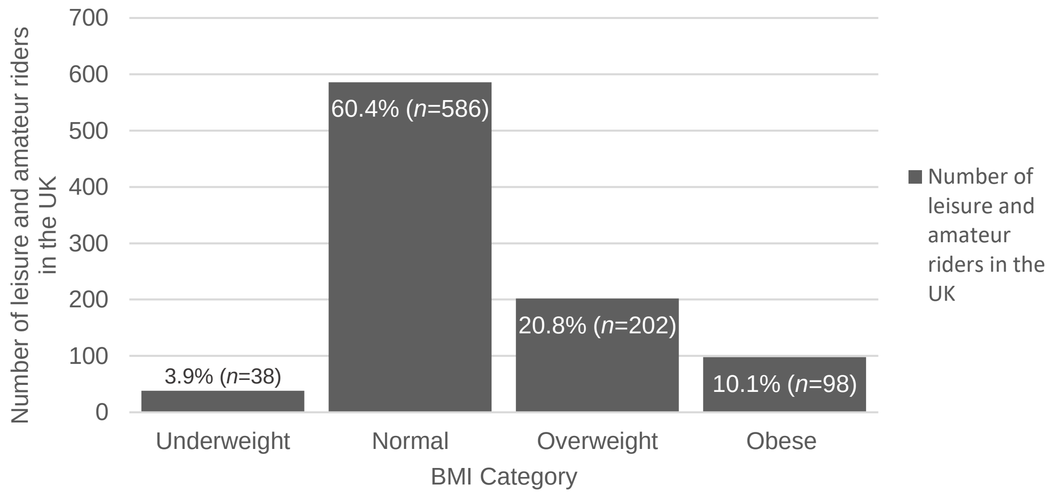

Figure 2. Reported Body Mass Index Categories of Leisure and Amateur Riders in the United Kingdom

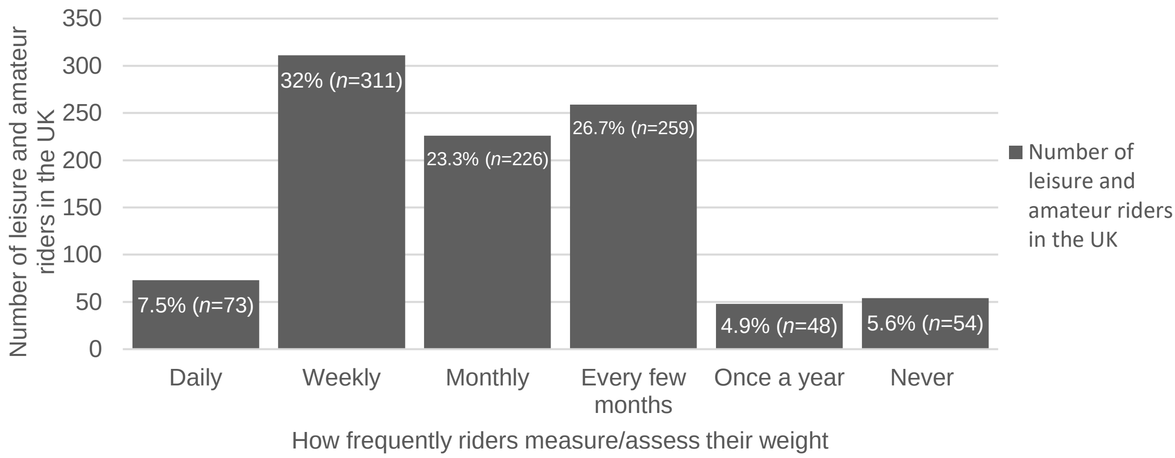

Figure 3a. Reported Rider Weight Habits of leisure and amateur riders in the UK: frequency that riders measure/assess their own weight

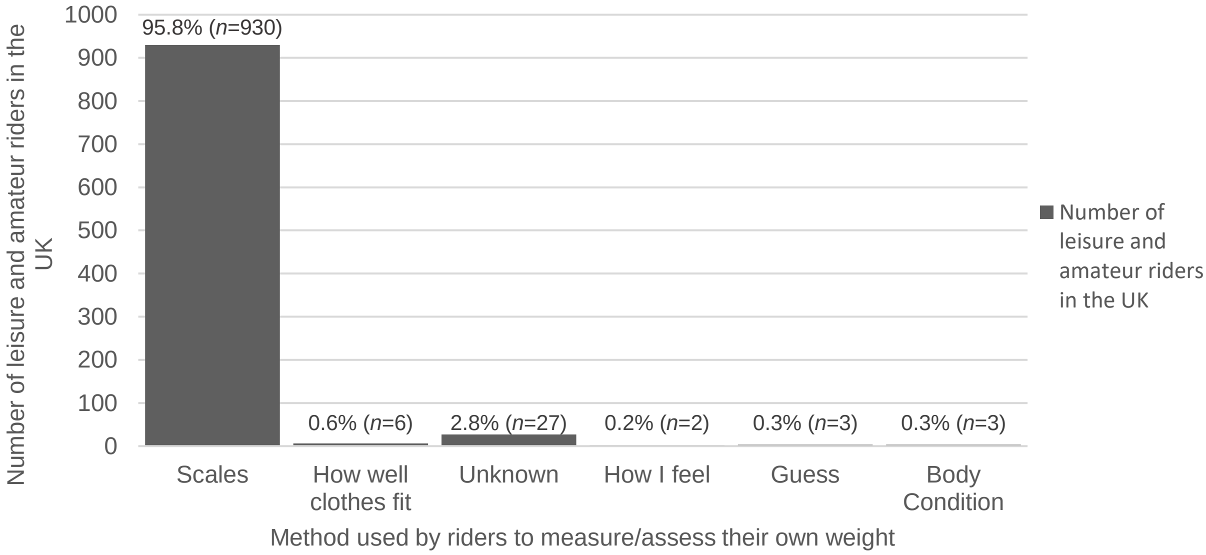

Figure 3b. Reported Rider Weight Habits of leisure and amateur riders in the UK: methods used by riders to measure/assess their own weight

Horse Measurements and The Rider's Horse Weight Assessment Habits

The mean weight of the horses in the study was 549±103kg (*n*=811), range: 250kg to 1000kg; 175 riders did not know their horse's weight, and 15 of these riders did also not know their own weight. Median horse height was 15.3±1.2hh, range: 11.2hh to 18.3hh. A strong positive correlation was found between horse height (hh) and horse weight (kg) (r = .714, p=.0004) (Figure 4). Over a third (34.4%, *n*=334) of riders assessed their horse's bodyweight every few months (Figure 5a), and riders' preferred methods of assessing their horse's weight is by a weight tape (44.5%, *n*=432) or a weigh bridge (29.5%, *n*=286) (Figure 5b).

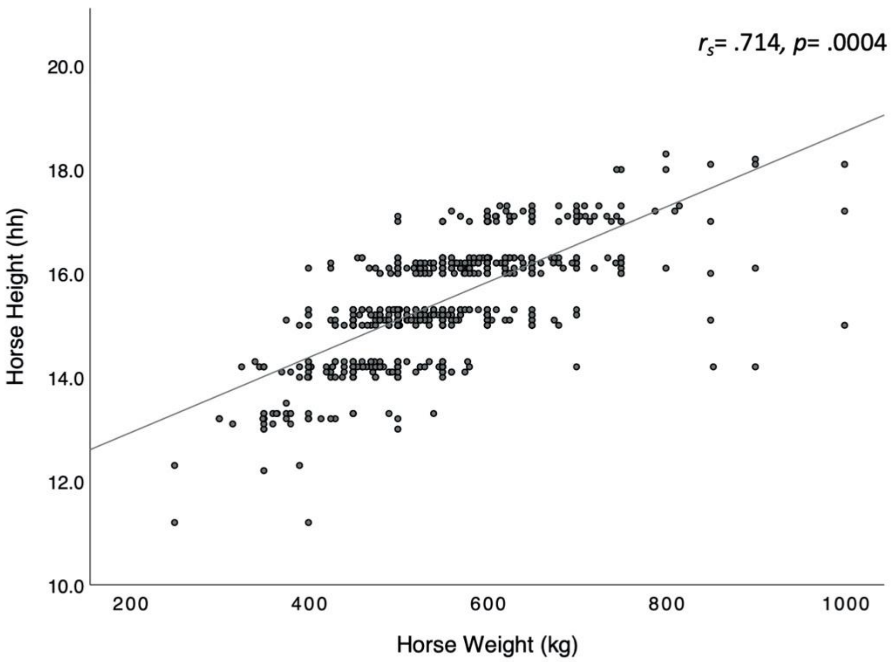

Figure 4. The Relationship between horse height and horse weight of horses owned by leisure and amateur riders in the UK

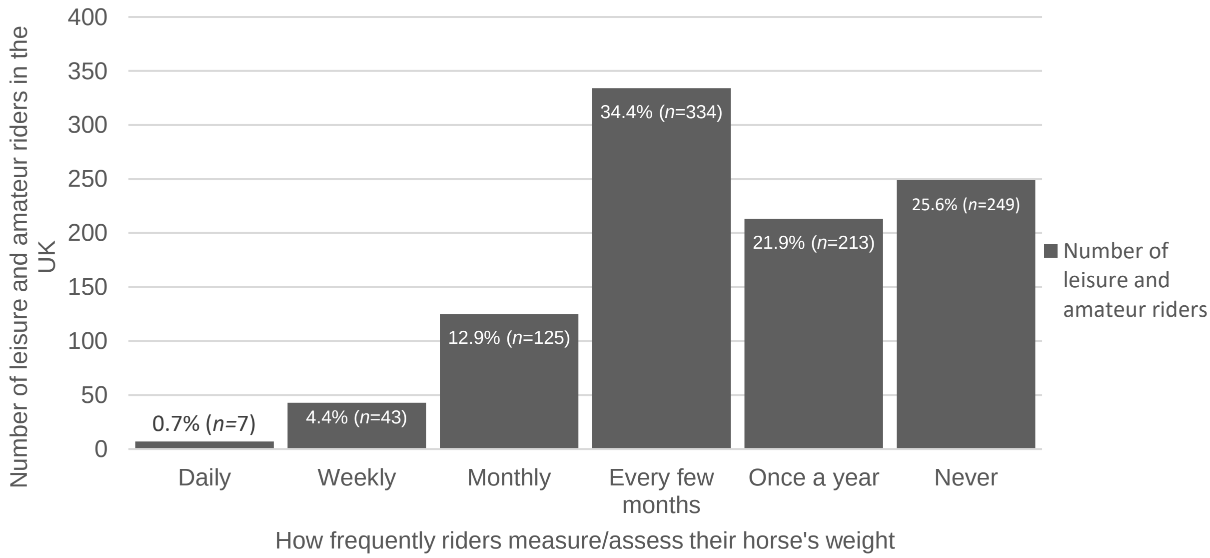

Figure 5a. Reported Horse Weight Habits of leisure and amateur riders in the UK: frequency that riders measure/assess their horse's weight

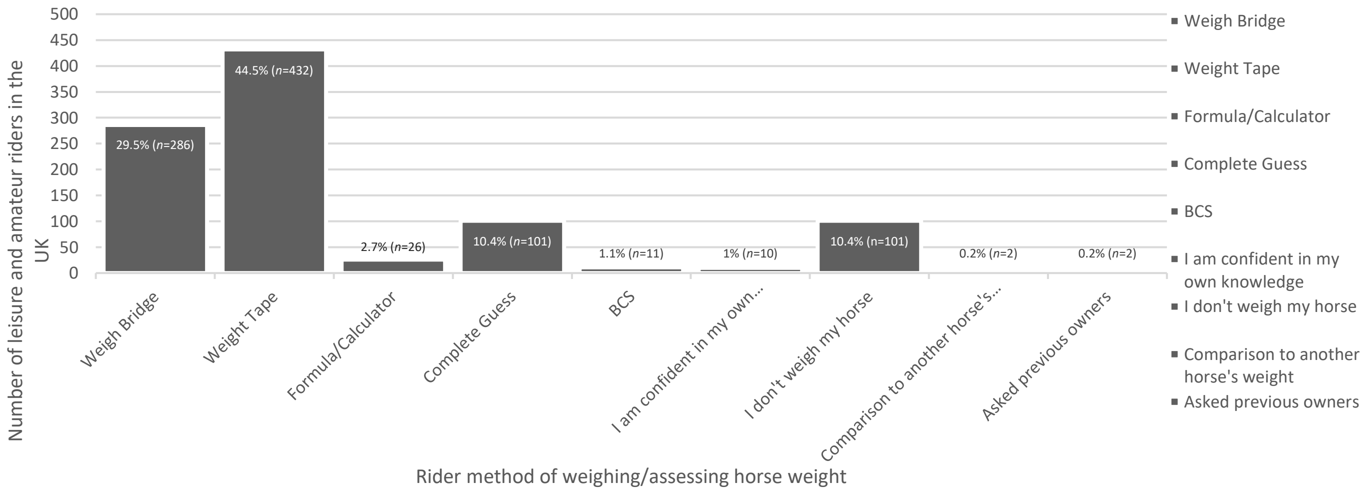

Figure 5b. Reported Horse Weight Habits of leisure and amateur riders in the UK: methods used by riders to measure/assess their horse's weight

Rider: Horse Bodyweight Ratio

RHBW ratio was calculated for 764 (78.8%) horse and rider combinations, as 21.2% (*n*=207) did not know either their weight, or their horses' weight, or both. The mean RHBW ratio was 12.5±2.7%, the median was 12.14±3.33%, range: 4.9% to 21.88% throughout the sample. RHBW ratio data were split according to weight groups in order to gain a more detailed understanding of the data. Only 1 person (0.1%) was under 4.99% of their horse's bodyweight, 11.3% (*n*=110) were between 5% and 9.99%, over half of the riders (53.9%; *n*=523) were between 10% and 14.99%, 12.6% (*n*=122) were between 15% and 19.99%, and the remaining 0.8% (*n*=8) were over 20%. No relationships were found between horse and rider weight (kg) (r_s=.265, *p*=.0004) and rider height (m) and horse height (hh) (r_s=.314, *p*=.0004) (Supplementary File 5, Figure S1; Figure S2).

Kruskal Wallis analyses identified significant differences between RHBW and horse age (*p*=0.001), horse breed (*p*=0.002), preferred discipline (*p*=0.0004), BMI category (*p*=0.0004), rider age (*p*=0.0004), UK region (*p*=0.005), qualification level (*p*=0.0004), how often riders think about their weight (*p*=0.0004), how often riders weigh their horse (*p*=0.0004), method used to weigh their horse (*p*=0.0004), how often riders weigh themselves (*p*=0.0004) and the method used to weigh themselves (*p*=0.0004) (Table 1). Respondents who owned warmbloods (median±IQR=10.52±3.55%) had significantly lower RHBW compared to those who owned welsh types (median±IQR=13.49±6.49%; *p*=0.007). Showjumping combinations had significantly lower RHBW ratios (median±IQR=10.25±12%) than dressage riders (median±IQR=11.35±4.01%; *p*=0.026) and leisure riders/hackers (median±IQR=11.82±5.57%; *p*=0.0004). Significant differences were found between all BMI categories (*p*=0.0004); as BMI increased so did RHBW ratio (Table 1). Significantly lower RHBW ratios were found for 18-24-year olds (median±IQR=10.79±12.79%) compared to 35-44 year olds (median±IQR=12.09±12.79%; *p*=0.0004) and 45-54 year olds (median±IQR =11.95±5.41%; *p*=0.0004). Riders within the East Midlands had significantly lower RHBW ratios (median±IQR=10.26±12.15%) than riders in Yorkshire and The Humber (median±IQR=12.73±3.71; *p*=0.044). Those riders with level 1 (median±IQR=10.77±12.84%) and 2 (median±IQR=10.85±13.15%) qualifications had lower RHBW ratios than those with level 4 qualifications (median±IQR=11.71±4.21%; *p*=0.024; *p*=0.004). Riders who never thought about their weight had lower RHBW ratios (median±IQR=10.51±5.36%) than those that always thought about (median±IQR=11.82±4.59%, *p*=0.005). Those who never weighed their horse had lower RHBW ratios (median±IQR=9.41±12.18%) than those who weighed their horse weekly (median±IQR=12.71±4.6%, *p*=0.0004), monthly (median±IQR=11.96±3.99, *p*=0.0004), every few months (median±IQR=11.8±3.85%, *p*=0.0004) and once a year (median±IQR=11.23±4.61%, *p*=0.0004). Riders who weighed themselves every few months had significantly lower RHBW ratios (median±IQR=10.91±4.75%) compared to those who weighed themselves weekly (median±IQR=12±4.39%; *p*=0.011).

Table 1. Significance between RHBW Ratio[1] and horse and rider variables
[1] RHBW Ratio = rider: horse bodyweight ratio

RHBW Ratio	**Variable**	**Kruskal Wallis Analysis**	**Post-hoc Mann Whitney U tests**	**Median±IQR**
	Horse Sex	*P*=0.395		
	Horse Age	*P*=0.001	No significance between groups	
	Horse Breed	*P*=0.002	Warmblood-Welsh Type (*p*=0.007)	Warmblood = 10.52±3.55% Welsh type = 13.49±6.49%
	Preferred Discipline	*P*=0.0004	Showjumping-Dressage (*p*=0.026) Showjumping-Leisure Riding/Hacking (*p*=0.0004)	Showjumping = 10.25±12% Dressage = 11.35±4.01% Leisure Riding/Hacking = 11.82±5.57%
	BMI Category	*P*=0.0004	Underweight-Normal (*p*=0.16) Underweight-Overweight (*p*=0.0004) Underweight-Obese (*p*=0.0004) Normal-Overweight (*p*=0.0004) Normal-Obese (*p*=0.0004) Overweight-Obese (*p*=0.0004)	Underweight = 8.61±5.83% Normal = 10.96±3.49% Overweight = 12.58±5.14% Obese = 15.46±5.27%
	Rider Age	*P*=0.0004	18-24 years – 45-54 years (*p*=0.004) 18-24 years– 35-44 years (*p*=0.0004)	18-24 years = 10.79±12.79% 35-44 years = 12.09±12.79% 45-54 years = 11.95±5.41%
	Postcode	*P*=0.136		
	UK Region	*P*=0.005	East Midlands-Yorkshire and The Humber (*p*=0.044)	East Midlands = 10.26±12.15% Yorkshire and The Humber = 12.73±3.71%
	Riding Level	*P*=0.741		
	Qualification Level	*P*=0.0004	Level 1-Level 4 (*p*=0.024) Level 2-Level 4 (*p*=0.004)	Level 1 = 10.77±12.84% Level 2 = 10.85±13.15% Level 4 = 11.71±4.21%
	Image Perception Test Score	*P*=0.608		
	Ideal Maximum R:H BW Ratio	*P*=0.121		
	How often riders think about their weight	*P*=0.0004	Never-Always (*p*=0.005) Never-Very Often (*p*=0.0004) Every few months-Always (*p*=0.0004) Every few months-Very often (*p*=0.0004) Sometimes-Always (*p*=0.015) Sometimes-Very Often (*p*=0.0004)	Never = 10.51±5.36% Always = 11.82±4.59% Very Often = 12±4.12% Sometimes = 10.86±12.86% Every few months = 10.18±6.73%
	Frequency of Extra Physical Activity	*P*=0.585		
	How often riders weigh their horse	*P*=0.0004	Never-Once a year (*p*=0.0004) Never-Every few months (*p*=0.0004) Never-Monthly (*p*=0.0004) Never-Weekly (*p*=0.0004)	Never = 9.41±12.18% Weekly = 12.71±4.6% Monthly = 11.96±3.99% Every Few Months = 11.8±3.85% Once a year = 11.23±4.61%
	Method used to weigh/assess horse bodyweight	*P*=0.0004	I don't weigh my horse-Formula/Online Calculator (*p*=0.001) I don't weigh my horse-I am confident in my own knowledge (*p*=0.007) I don't weigh my horse-Weight Tape (*p*=0.0004) I don't weigh my horse-Weigh Bridge (*p*=0.0004) I don't weigh my horse-Complete Guess (*p*=0.0004)	

	How often a rider weighs/assesses their own bodyweight	*P*=0.0004	Never-Daily (*p*=0.034) Never-Every few months (*p*=0.004) Never-Monthly (*p*=0.001) Never-Weekly (*p*=0.0004) Every few months-Weekly (*p*=0.011)	Daily = 10.86±4.40% Weekly = 12±4.39% Monthly = 11.2±4.31% Every Few Months = 10.91±4.75% Never = .000±11.08%
	Method used to weigh/assess rider weight	*P*=0.0004	Unknown-Scales (*p*=0.001)	Unknown = 10.56±2.97% Scales = 11.55±4.24%
	Whether large R:H BW ratios are an issue in the UK	*P*=0.611		
	Source used to seek advice	*P*=0.226		
	Rider gender	*P*=0.684		

Rider Weight Awareness

Under half of the rider population (47%, *n*=456) agreed that 16-20% was the maximum RHBW ratio a horse could carry, 5.7% (*n*=55) agreed upon 21-25%, and 2.4% (*n*=23) agreed that over 25% was the maximum RHBW ratio a horse could carry (Figure 6a). A large proportion of riders always thought about their weight (23.8%; *n*=231), whilst 31.8% (*n*=309) often thought about their weight (Figure 6b). There was a strong agreement between riders that higher RHBW ratios are an issue in the UK (Figure 7a). If riders were to seek advice about their suitability for a horse or horse weight, one third of them would seek advice from their trainer/coach (31.6%; *n*=307) and another third would seek advice from their vet (34.4%; *n*=334) (Figure 7b).

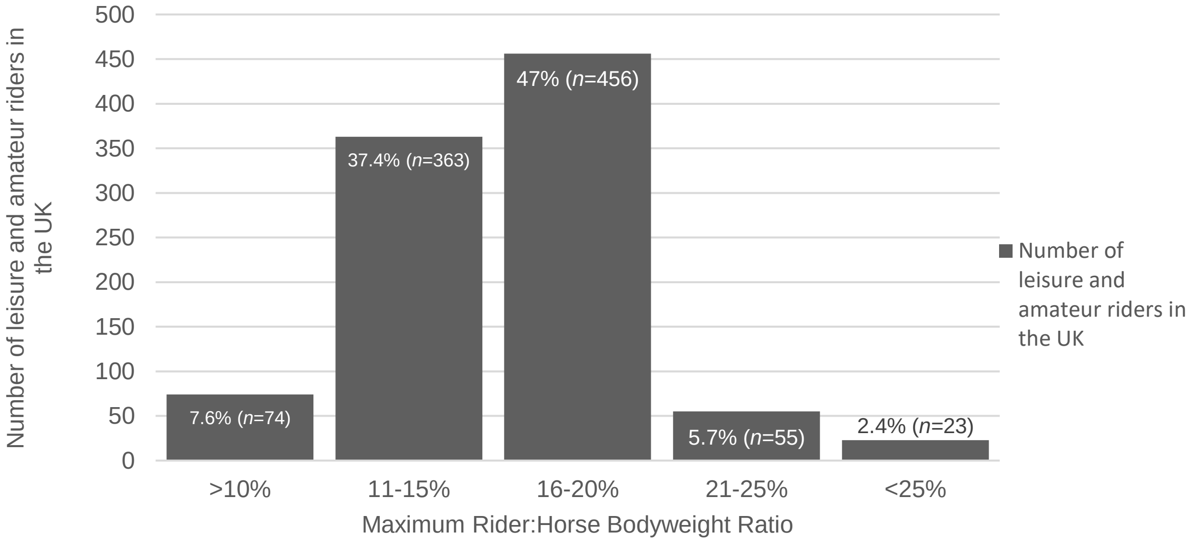

Figure 6a. Reported Rider Weight Awareness – The RHBW ratios that leisure and amateur riders in the UK believe is the maximum a horse should carry.

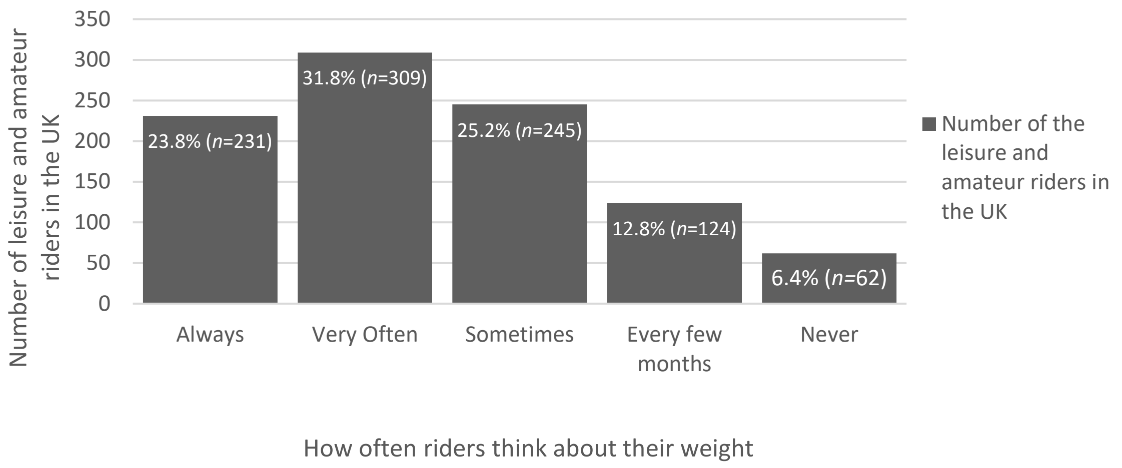

Figure 6b. Reported Rider Weight Awareness – How often leisure and amateur riders in the United Kingdom think about their 'rider' weight

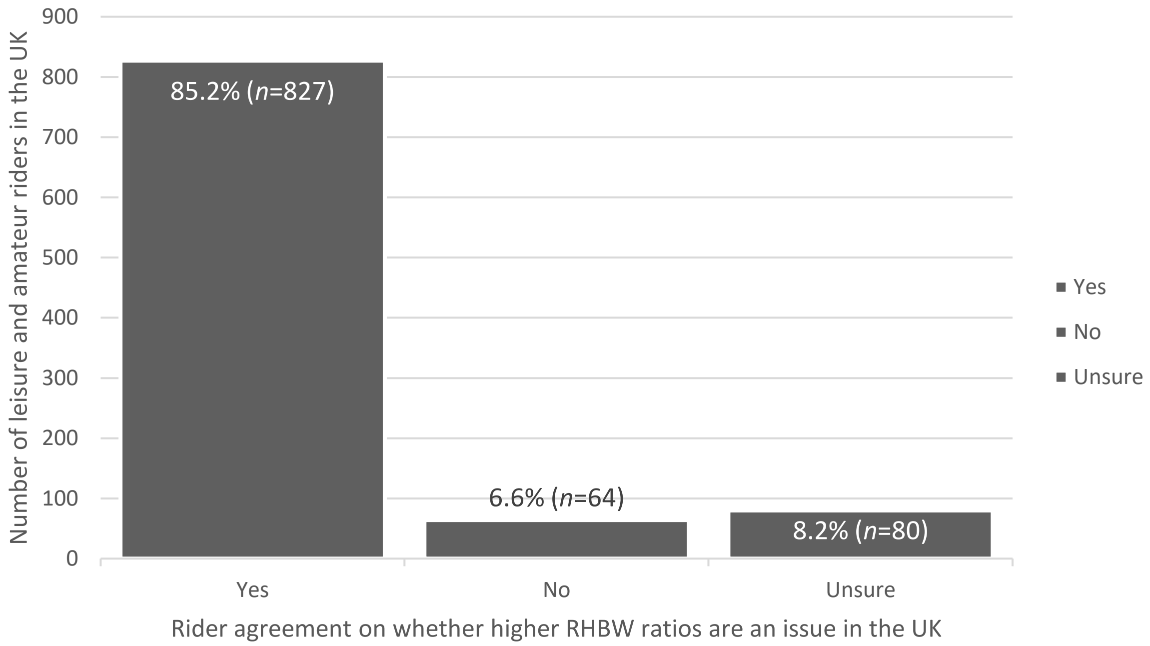

Figure 7a. Reported Rider Weight Awareness – Are higher RHBW ratios an issue in the United Kingdom?

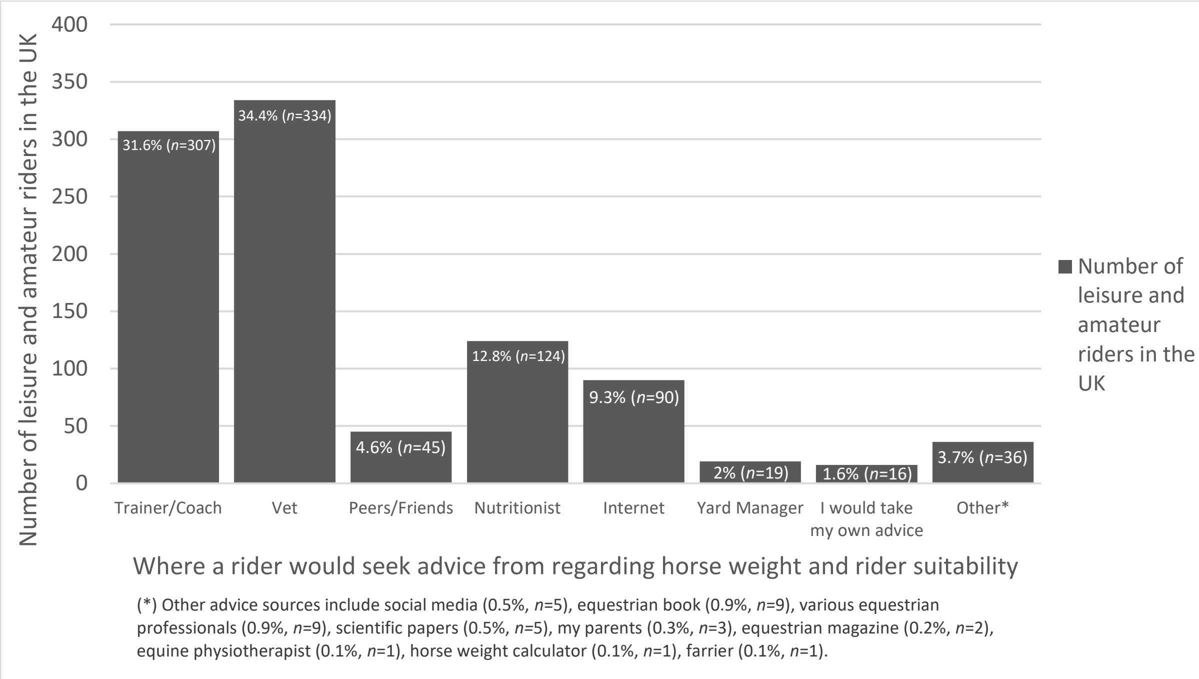

Figure 7b. Reported Rider Weight Awareness – Where a leisure or amateur rider in the UK would seek advice from regarding horse weight and rider suitability

Rider agreement with statements associated with rider weights varied, but nearly three quarters (74.6%; *n*=724) of respondents agreed that the effect of rider weight can be exacerbated by the rider being unbalanced and inexperienced compared to a balanced, experienced one (Figure 8).

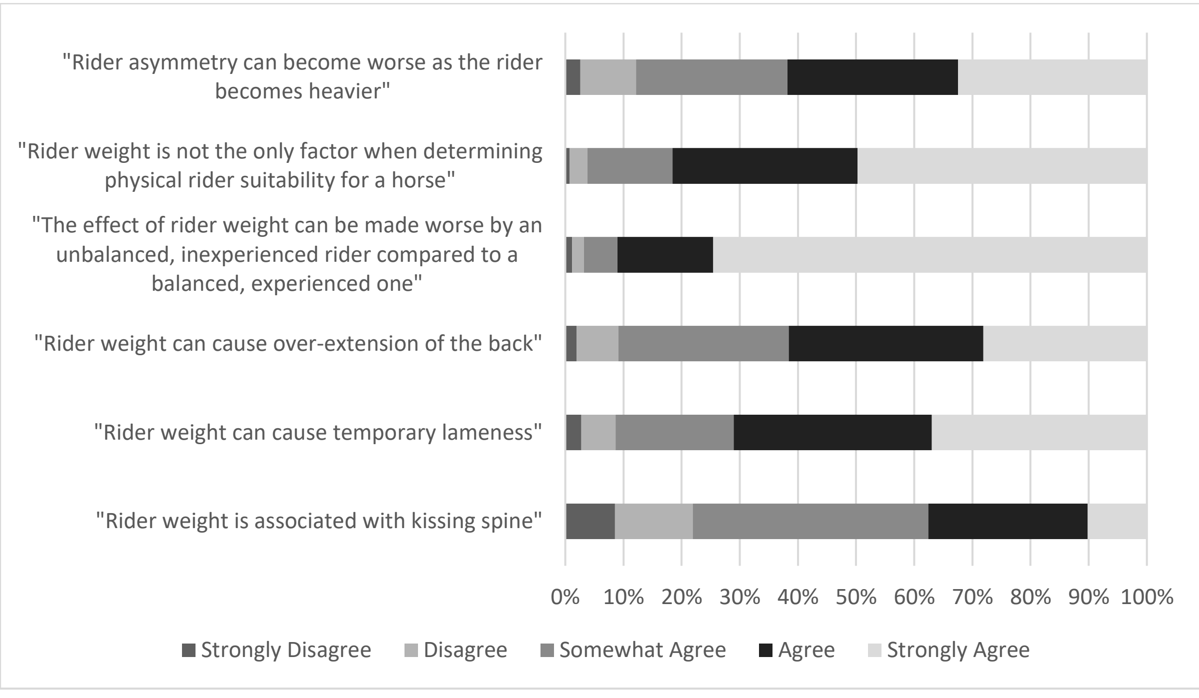

Figure 8. Reported Likert-style responses from leisure and amateur riders in the UK to statements associated with rider weight

Discussion

Mean RHBW ratios in this study were 1.7% lower (mean±sd: 12.5±2.7%, range: 4.9-21.88%) than those previously reported by Halliday and Randle (2013), but this could be due to a wide distribution of rider ages reported in the current study. The equivalent age grouping (18-24 years old) to that used by Halliday and Randle (2013), in this study, reported a mean±sd RHBW of 12.08±2.56% (range: 4.9-20%), which is 2.12% lower than that reported by Halliday and Randle (2013). Riders aged between 25-44 years old reported higher RHBW ratios (mean±sd: 12.67±2.71%, range 6.35-21.10%). While the higher RHBW ratios reported in the 25-44 years old age group could reflect the fact that there was a smaller sample size of riders in this age group rather than the age related differences; they are conversant with trends observed in medicine which associate higher BMIs with adults aged 25 years and over (GBD, 2015). For this reason, both age groups cannot be compared in this study. However, it should be noted that the 25-44 year old age group represents the largest rider population (*n*=558,000) in the UK in 2018, compared to 18-24-year olds who represent 468,000 of riders in the UK (BETA, 2019). This study also found a larger range of RHBW ratios across all respondents (mean±sd: 4.9±21.88%) than previously reported in 2013. These changes could be due to a number of reasons including weight estimation methods, human underestimation of human and horse weights, increasing human and horse obesity rates and riders being more RHBW ratio conscious.

Given industry practice to assess rider and horse suitability, it is interesting to note regional differences occurred; riders in the Yorkshire and The Humber had significantly higher RHBW ratios of 12.73% compared to the East Midlands, who had RHBW ratios of 10.26%. Differences in the RHBW ratio reported between regions in this study could relate to regional press or local initiatives highlighting rider weight, which have influenced rider body awareness. Socioeconomic differences could also explain the differences reported however, these were not associated with bodyweight or BMI in humans by Ball and Crawford (2005). It should be noted that the significance of RHBW ratio between the two counties were unexpected (Figure 1), and may reflect respondent or sampling bias in the survey.

In the current study, 47% of riders reported that 16-20% is the maximum weight a horse can carry, but only 12.6% of riders belonged to this category of RHBW ratio. This may suggest that riders believe that their horses can carry more weight than they are already carrying and may not see any risk to their horse's welfare if their weight did increase, putting their RHBW ratio into the 16-20% category. There has only been one piece of evidence to suggest that the horse's welfare may be compromised if they are carrying riders who are in the RHBW ratio category of 16-20% and above (Dyson et al., 2019). Numerous other studies have identified biomechanical and physiological performance changes, or no changes, within horses at higher RHBW over 20% (for example: Matsuura et al., 2013; Gunnarsson et al., 2017; Christensen et al., 2020), suggesting rider weight could be a factor that can influence equine performance. However, Dyson et al. (2019) suggested that the RHBW ratio alone could not determine rider suitability and other factors such as saddle fit for the rider should also be considered. Therefore, riders who may fall into the 16-20% category in the future, or the 13.4% of the population in this study who were already over 15% of the horse's bodyweight, should not immediately be alarmed about compromising horse welfare solely based on their RHBW ratio, unless there are obvious signs of implications on welfare such as lameness and behavioural indications of pain. Further research into the reliability of RHBW ratios on rider and horse suitability, and the other factors that are involved in assessing rider suitability are warranted to create an evidence-informed consensus that can be applied across the equestrian industry to educate riders and protect equine welfare.

Weight Estimation Methods

Riders in the study used a variety of methods to estimate their horses' weight, the most common method being a weight tape. A small proportion of riders used a weigh bridge to measure horse weight, which is the most accurate method (Wagner and Tyler, 2011). While the weight tape is an easy and cheap method of estimating horse weight, where a weigh bridge is not available due to a lack of accessibility, Wagner and Tyler (2011) found equine bodyweight estimates decreased by 65.81kg (13.38% decrease based on the mean weight: 491.94±78.59kg) when using a weigh tape compared to the weigh bridge. For some riders, alongside the body weight formula, the weight tape is the only option available to them and a significantly better method than having no way to measure horse weight. Consequently, riders surveyed in the current study could be underestimating, or overestimating, their horses' weight, or their own weight, as a way of decreasing their true RHBW ratio. Human body weight has been reported to be underestimated in previous studies (Nikolaou et al., 2017), particularly in women (Clarke et al., 2014) and those populations who are overweight (Maukonen et al., 2018). Further work measuring rider and horse combination weights using gold standard methods, such as weighing scales and a weigh bridge, will allow comparison to the results reported in the current study, and eliminate the potential bias ~~recognised~~ acknowledged in this study. It will also hopefully encourage further development of an inexpensive, easy to use tool for riders to use to determine appropriate maximum rider weights for horses.

Equine Obesity

Equine obesity has been reported to range between 20.6% and 45% in horses (Giles et al., 2014; Robin et al., 2015; Stephenson et al., 2011; Wyse et al., 2008) and 72% in ponies (Menzies-Gow et al., 2017). Obesity is more prevalent in horses used for leisure or pleasure riding (Morrison et al., 2017), which may reflect why RHBW ratios reported in this study are 1.7% lower than reported in 2013. A recent study reported that owners struggle to differentiate equine obesity from the shape the horse was "meant to be", particularly if a horse was a heavier breed (Furtado et al., 2020). Whilst BCS wasn't reported in the current study, heavier horses with excessive adipose tissue, perceived as their "shape" by their owner due to their breed, could have influenced individual interpretation of weight and may partially underpin the percentage of lower RHBW ratios reported in this study. These horses could be carrying heavier riders that are above their optimum abilities than that reported in this study. In humans, obese young adults exhibit poor postural stability that is associated with increased spinal lordosis due to excessive abdominal fat (Son, 2016). Overweight horses also accumulate excess abdominal adipose tissue which could place increased strain on the spine and loading on limb joints resulting in excessive joint strain (Morrison et al., 2017) and potentially lead to degenerative joint disease (Wallin et al., 2000) and poor performance (Gunnarsson et al., 2017). Whilst there is no evidence to suggest that regular ridden exercise by heavier riders results in long term damage to horses, recent work suggests increased rider weight can be associated with lameness (Dyson et al., 2019), the pathogenesis of overriding dorsal spinous processes (ODSP) (Clayton and Stubbs, 2016; deCocq et al., 2004) and a temporary change in spine curvature (Benton, 2006). The amount of excess adipose tissue that a horse carries should be considered when determining how much weight the horse can actually carry safely. This could be by deciding on a single RHBW ratio maximum for overweight horses, or an ideal range for RHBW ratio which takes into account additional risk factors, or to only consider RHBW ratio when the horse is at its ideal weight.

Body Condition Score

It was concerning that 18% of the sample did not know their horse's weight. This could be a result of riders judging their horse's weight based on Body Condition Score (BCS), inaccessibility of weight measurement tools, or lack of understanding of the importance of knowing and monitoring a horse's bodyweight. BCS is a subjective, visual assessment that determines whether a horse is of a healthy weight. However, BCS is not strongly associated with how heavy the horse is (Carroll and Huntington, 1988) and scores have been reported to vary between riders (Morrison et al., 2017). The use of BCS can be inaccurate when assessing the maximum rider weight, a horse can carry. Horse owners are more likely to score a lower BCS than professionals would (Morrison et al., 2017; Potter et al., 2016) and therefore, in the current study, BCS was not considered. Further work could explore BCS and RHBW ratios to better understand obese horses' weight carrying ability, so that riders can make better informed decisions when deciding rider: horse suitability.

Additional Physical Activity Amongst Riders

Leisure and amateur riders in this study reported frequent additional activity levels, with 79.9% of the population with varying BMI categories, taking part in additional physical activity outside of riding every day or weekly, which is 4.4% more than the reported fairly active and active adults in the UK (Sport England, 2020). The frequency of activity reported by riders in the UK may be a reflection of the lower RHBW ratios reported here compared to those reported in 2013 by Halliday and Randle; 55.6% of respondents also reported that they always, or often, think about their weight. This may imply that riders are becoming more conscious about their weight and fitness levels. The frequency of exercise and thoughts about weight amongst riders may be a result of increasing societal pressure globally towards dieting and undertaking exercise (Yiannakis and Melnick, 2001) and an increased use of fitness technology (Glynn et al., 2014; Laranjo et al., 2020) combined with increased mainstream equine media coverage of rider focused workouts. The growing prevalence of social media influence, both positive and negative, amongst the online equestrian community, could also be changing rider behaviour and perception of their own weight and fitness, a concept that has already been reported to influence horse owners' decisions and practice in the equine industry during the COVID-19 pandemic (Williams et al., 2020). Alongside this, recent studies have shown that different forms of additional exercise such as muscular endurance training, core fitness programmes, Pilates and rider specific training, can all improve the rider in different ways (Aegerter et al., 2020; Hampson and Randle, 2015; Lee et al., 2015), and could have encouraged riders to increase the amount, and type, of additional physical activity that they currently partake in. Response bias can also influence the accuracy of self-reporting in surveys; pressure to be lighter from rider weight studies reported on mainstream equestrian publications and media sources, may have resulted in participant bias and riders underestimating their weight, a trait which is already common amongst women (Wen and Kowlaski-Jones, 2012) who made up the majority of this sample. Further work could explore the effect of social media and industry influence to conform to rider weight stereotypes and to undertake additional exercise, on riders of all ages, levels and genders.

Rider Body Mass Index (BMI)

In the current study, a lower rider BMI indicated a lower RHBW ratio, and vice versa. BMI can be a good reflection of RHBW ratio of riders and is a useful proxy measure for adiposity (Ellis, 2000; Zemel et al., 1997). Some riders who were considered overweight and obese had lower RHBW ratios than riders who were considered normal however without the BCS of the horse, it is difficult to determine if these riders have chosen suitable horses for their weight, or whether they are riding overweight and obese horses. BCS is therefore an important factor to consider when using RHBW ratios to assess horse and rider suitability. BMI should only be used as a proxy measure and care should be taken by riders who are athletically fit with larger muscle mass when interpreting BMI results, as BMI cannot distinguish between body fat mass and muscle mass (Rothman, 2008). Nearly three quarters of riders in the study strongly agreed that riders with poor riding ability and a lighter weight have more of an effect on the horse's back than those of a larger weight who have a better riding ability. Riders with larger muscle mass may be physically fitter, and consequently have a higher BMI, than those with less muscle mass. High muscle mass riders may have better posture, more accurate aids and stability in the saddle (Lee et al., 2015), compared to riders with a larger body fat mass, who have less postural stability (Son, 2016) which could affect their riding. Whilst there is no research to show the relationship between rider weight and rider abilities, and their effect on the horse, it is known that riders with less postural stability and increased asymmetry can show diminished ability to follow the movement of the horse (Lagarde et al., 2005). Riders who are stiff and tense in their adjustments are more likely to be less skilled riders (Lagarde et al., 2005), and therefore by association, the added pressure of increased weight of less skilled riders could have detrimental effects on overall performance and the efficiency of horse learning and welfare (McGreevy, 2007). However, the asymmetries in more experienced riders, that have been found to increase with competition level and years of riding (Hobbs et al. 2014) equally cannot be ignored, and future research opportunities exist to evaluate how rider ability and rider weight in combination influence riding practice, and impact equine health and welfare.

Riders must also consider the fit of the saddle for their body type, as well as for their horse. Heavier riders who find themselves sitting on the cantle of the saddle may distribute weight unevenly, creating smaller areas of localised pressure (de Cocq et al., 2006; Meschan et al., 2007; Von Peinen et al., 2010) and cause saddle slip (Greve and Dyson, 2013). This can result in poor performance (Greve et al., 2015) and further injury, as poorly fitting saddles are a leading cause of back pain in horses (deCocq et al., 2004). Therefore, it is recommended that whilst riders should consider their BMI when determining approximate RHBW ratios, they should also consider the weight of their horse, their own muscle mass, riding ability and saddle fit when selecting an appropriate equine partner.

Horse Breed

Differences in RHBW ratio were found across horse breeds. Riders of Welsh type horses recorded larger RHBW ratios than those of warmbloods, and this could reflect the traditional belief that horse breeds with 'heavier' limbs, or more bone, such as Welsh types, have the ability to carry heavier weights (Dyson et al., 2019). There is no evidence to suggest that metacarpal region circumference is associated with a horse's ability to carry more weight. Powell et al. (2008) reported negative associations with horse muscle soreness and tightness, within horses with larger metacarpal region circumference (size). The differences reported may be associated with a breed prevalence for specific equestrian disciplines. Warmbloods were the most common breed ridden by showjumpers in this study, who also reported lower RHBW ratios compared to leisure riders/hackers and dressage riders, which could reflect the increased physiological demand of horses and riders required during showjumping compared to leisure riding and dressage rather than a breed specific difference (Douglas et al., 2012; Williams, 2013). These results suggest it is important that governing bodies promote the demystification of beliefs that are not supported by scientific research, in order to safeguard the welfare of 'heavier' limbed horses. Further research into the association between breeds, disciplines and RHBW ratios may facilitate a better understanding of the reasons behind varying RHBW ratios.

Rider Knowledge

Rider knowledge surrounding the effects of heavier rider weights, and the other factors involved, varied widely across the population. There was mixed agreement towards potentially harmful effects to the horses' welfare such as ODSP, and temporary lameness, and demonstrates a lack of education about these effects, which could have stemmed from various results within research, and inaccurate information reported by the media, especially information that comes from unreliable sources on social media. Those riders that actively engage in equestrian content posted on social media, could be contributing to a confused population of horse riders. Nevertheless, the proliferation of false information on social media has previously affected stock markets, and slowed emergency response during disasters and terrorist attacks, and often gains high engagement from social media users compared to true information (Kumar and Shah, 2018). There is no reason why false information posted by leisure and amateur riders on social media could lead to significant compromises within the equine industry, including to the horse's welfare. However, only 10.3% of the riding population in this study would turn to the internet (9.3%) or social media (1%), when they need to seek advice on their horse suitability, but this still leaves 10% of horses in potentially vulnerable welfare positions. Based on the data reported, it would be inappropriate for riders to deem false or misinterpreted information correct, potentially placing some horses at risk of welfare implications.

Limitations

There were some limitations in the current study. The use of a survey to collect data can risk respondent bias, whereby only those who are interested in the topic are more likely to participate. By using social media to promote the survey, this can risk selection bias can result in only those who use Facebook^{TM} answering the survey. This may have caused unequal representation of age of riders, and their location in the UK depending on the type of respondents in the selected Facebook^{TM} groups. Rider experience level and gender were also not equally represented in the study, and the results could apply more towards female riders. Riders estimated their own and their horse's weight using a variety of methods; this approach does however provide a good indication of what riders think they weigh, yet it does not give validated horse or rider weights, highlighting the importance of weighing horses using accurate methods in relation to RHBW ratio.

Conclusion

Average RHBW ratio in this study was 12.5±2.7% which is lower than those reported seven years ago. This decrease could be due to a number of reasons including participant profile, an increase in equine obesity leading to smaller ratios, differing weight estimation methods, an increase in rider fitness popularity and social media pressure to be 'fit'. Leisure and amateur riders appear to be rider weight conscious and take steps to manage their own weight appropriately. However, a small proportion of owners do not know their horse's weight, despite the increase in high profile campaigns to reduce the prevalence of equine obesity and its associated conditions. A small percentage (13.4%) of RHBW ratios exceeded 15%, which has been reported to cause temporary lameness in a recent study. However, until further research exploring the reliability of the RHBW ratio considering other factors has been conducted, riders and riding establishments should use the current research available (relating to horse and rider weight) to enable them to make an evidence-informed decision whether they are suitable to ride individual horse. Further research measuring the actual weight of riders and their horses to assess absolute RHBW ratio, whilst considering BCS and rider body fat mass, could benefit governing bodies in assisting riders to become more aware of the impact of rider weight and choosing suitable horses to match their needs and abilities.

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Conflict of Interests
There were no conflicts of interest.

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