

1 **Full title: An Investigation of Bra Concerns and Barriers to Participation in Horse**

2 **Riding**

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8 **Running head: The Breast and Horse Riding**

9

10 **Abstract**

11 Horse riding is a female-dominated sport where participation levels are declining. The
12 influence of the breast on participation levels and current satisfaction with bras for this activity
13 is unknown. This study aimed to investigate bra concerns and breast-related barriers to
14 participation in horse riding. A 6-part, 32 question online survey was completed by 1324
15 females who participated in horse riding. Descriptive and chi-squared analyses were utilised;
16 inductive content analysis was completed to analyse qualitative responses. At least one breast-
17 related barrier was reported by 25% of all participants. Larger-breasted riders were less
18 satisfied ($P < 0.001$) with their bras. Seventy percent of riders stated that improvements needed
19 to be made in bras to help reduce breast health issues, with support, style and fit the most
20 common reasons cited. This study highlights the importance of addressing breast-related
21 barriers and provides rationale for the development of equestrian-specific breast support
22 garments and educational initiatives.

23

24 **Keywords**

25 Barriers; Equestrian; Physical Activity; Self-Efficacy; Clothing design

26

27 **Introduction**

28 The physical health, mental health and social benefits of physical activity have been widely
29 evidenced and as a result existing advice from the Department of Health recommends that
30 adults should participate in 150 minutes of moderate intensity physical activity per week
31 (DofH, 2011). Horse riding and associated activities expend sufficient energy to be classed as
32 moderate intensity exercise (British Horse Society, 2011), and is the 6th most popular activity
33 for UK women (WSFF, 2011). There is a strong gender bias with females representing 74% of
34 the UK riding population (British Horse Society, 2015). Participation in equestrian activities
35 has however decreased by over 11% in the last decade (October 2005 to March 2015; Sport
36 England, 2015), which reflects the general decline seen in physical activity participation by
37 female adolescents (Collings *et al.*, 2014). A relatively high latent demand for horse riding has
38 been identified though, with 90,000 women wanting to do more than they currently do (WSFF,
39 2011). Horse riding is distinctive as a high proportion of those people participating (48%) take
40 part in no other sporting activity (British Horse Society, 2011). This suggests that horse riding
41 is relied upon for moderate intensity physical exercise, and unless participants changed their
42 exercise habits they would be otherwise sedentary. It is therefore important that any potential

43 barriers identified that prevent females from engaging more frequently in horse riding, or to
44 start engaging with the sport, are reduced.

45
46 Recent evidence suggests that breasts may be a barrier to physical activity for female adults
47 and school-aged girls (Burnett *et al.*, 2014; Scurr *et al.*, 2016); yet limited attention has been
48 given to the breasts in physical activity research. Burnett *et al.*, (2014) reported that the breast
49 was a barrier to participation in 17% of females and was the fourth greatest barrier reported
50 behind energy/motivation, time constraints and health. The leading breast-related barriers were
51 “*I can’t find the right sports bra*” and “*I am embarrassed by excessive breast movement*”. In
52 a population of school girls 46% reported that their breasts had some effect on their
53 participation in compulsory sports and exercise, which was more prevalent in larger-breasted
54 girls (63%; Scurr *et al.*, 2016). These studies highlight the need to further explore the influence
55 of breasts on physical activity participation, especially as having large breasts and/or
56 embarrassment due to excessive breast motion may affect a rider’s self-efficacy and
57 confidence.

58
59 Unique to females is the challenge of effectively reducing undesired breast motion to facilitate
60 participation in sport and exercise. Due to limited intrinsic support independent breast
61 movement occurs during physical activity (Page and Steele, 1999), which increases with breast
62 size (Bridgman *et al.*, 2010; Lorentzen and Lawson, 1987). This can lead to breast pain, breast
63 sag and embarrassment (Mason *et al.*, 1999; White *et al.*, 2009). The type of activity undertaken
64 affects the magnitude of breast motion (Risius *et al.*, 2014) and it is proposed that due to the
65 large vigorous vertical movements produced during horse riding (Terada *et al.*, 2006) breast
66 motion will be similarly high to that reported for running and jumping activities. **These vertical
67 movements must be absorbed by the rider, dependent on skills level (Bogisch *et al.*, 2014) and
68 are directly related to gait velocity (Bystrom *et al.*, 2009).** Burbage and Cameron (2017)
69 reported a relatively high prevalence of breast pain in a horse riding population (40%), which
70 increased with breast size, and which affected performance in 21% of riders. **Pain when riding
71 has been suggested as a limiting factor in effective application of cues to the horse, imperative
72 in training and performance, and are directly related to the rider’s ability to maintain postural
73 control (Patterson *et al.*, 2010). The rider’s ability to maintain postural control may be impacted
74 by pain and indeed Lewis and Kennerley (2017) found a highly significant relationship between
75 elite riders competing with pain and their perception of a negative impact on riding
76 performance.**

77
78 Appropriate breast support is effective at reducing the negative health implications associated
79 with breast motion. As the level of breast support increases, breast displacement (Mason *et al.*,
80 1999; White *et al.*, 2009), breast velocity (Scurr *et al.*, 2010) and breast acceleration (McGhee
81 *et al.*, 2013) reportedly decreases. Yet despite the evidence, sports bra usage in a general
82 Australian community was as low as 41% (Bowles *et al.*, 2008). Encouragingly 91% of women
83 running the London Marathon in 2012 wore a sports bra for vigorous activity (Brown *et al.*,
84 2014a), yet the prevalence of sports bra use within a horse riding population has been reported
85 as much lower. Interestingly, Burbage and Cameron (2017) reported that only 14% of smaller-
86 breasted riders and 19% of larger-breasted riders exclusively wore a sports bra for horse riding,
87 suggesting that there is a perception within this population that sports bras are not as important
88 for this activity, despite a high number of riders experiencing breast pain.

89
90 The highest breast-related barrier found by Burnett *et al.* (2014) was “*I can’t find the right
91 sports bra*” highlighting the difficulty women face when seeking appropriate breast support in
92 a large and often confusing marketplace. Dissatisfaction in sports bras has been reported,

93 particularly with shoulder straps digging into the shoulders or slipping off the shoulder (Brown
94 *et al.*, 2014a; Bowles *et al.*, 2012), and rubbing/chafing (Brown *et al.*, 2014a), however bra
95 dissatisfaction within equestrian activities has not been investigated. It would be useful to
96 understand from female horse riders what ergonomic improvements could be made in bras for
97 this activity, especially as current usage is low and excessive exercise induced breast movement
98 and pain may adversely influence rider/horse interactions (Burbage and Cameron, 2017).

99
100 Wearing a well-fitting and supportive bra is important (Chen *et al.*, 2010; White and Scurr,
101 2012). Although it has been reported that women with large breasts may avoid getting
102 professionally fitted due to embarrassment (Wood *et al.*, 2008), Brown *et al.* (2014a) found
103 that marathon runners with larger breasts were twice as likely to get fitted as smaller-breasted
104 women. In addition, nearly three-quarters of marathon runners reported to have average or
105 below-average breast health knowledge (Brown *et al.*, 2014a). The uptake of bra fitting
106 services and current breast health knowledge in horse riders is not known, although it is
107 important to investigate to aid the development of population-specific educational initiatives.

108
109 In summary, horse riding is a popular activity for females yet the influence of the breast on
110 participation levels, and current satisfaction with bras utilised for this activity, is unknown.
111 Therefore, this study aims to explore the influence of the breast as a barrier to participation in
112 horse riding, identify satisfaction with bras utilised for horse riding and to understand the
113 current levels of breast health and bra fitting knowledge in female horse riders.

114 115 **Material and methods**

116
117 Following full institutional ethical approval, a 6-part 32 question on-line survey (Google®
118 Forms) was made available to females who were aged 18 and over and participated in horse
119 riding activity. The on-line survey was accessible for a four-month period; no incentive was
120 offered to participants. An online survey was chosen as they reduce time, cost and potential
121 error arising from the transcription of paper questionnaires, in addition to allowing participants
122 to respond at their convenience (Vehvar and Manfreda, 2008). Volunteer participants were
123 recruited from personal contacts via email and posters were placed within local riding stables.
124 In addition, a number of specialist equestrian social media sites (such as the Horse & Hound
125 forum) were identified and a link to the survey was posted on these sites. A snowball sampling
126 technique was employed where those receiving an email regarding the survey were asked to
127 send on the email to other female horse riders that they knew. Due to the anonymity of the
128 survey, completion of the form was considered as consent to take part in the study (as explained
129 to them in the participant information sheet preceding the survey).

130
131 The survey included Likert scale, multiple-choice and free-text format questions and was
132 designed to take no longer than 15 minutes to complete. Breast health questionnaires used in
133 previous research with a general population (Burnett *et al.*, 2014) and a marathon runner
134 population (Brown *et al.*, 2014a; Brown *et al.*, 2014b) were modified for this study to ensure
135 questions were tailored to horse riders. Section 1 identified bra usage and bra fit issues using
136 Likert scales, which are reported in a concurrent paper (Burbage and Cameron, 2017). Section
137 2 identified any barriers to participation in horse riding experienced, along with the
138 participant's horse riding commitments and level using multiple choice questions. Section 3 of
139 the survey explored breast pain with a mixture of Likert scales, closed and free-text questions,
140 the results of which are also reported by Burbage and Cameron (2017). Section 4 asked
141 participants for their comments and improvements on bras and breast health issues. Sections 5
142 and 6 identified demographic information on breast history and personal characteristics. Prior

143 to distribution the survey was piloted on horse riders (n = 8) to ensure timings and the wording
 144 were appropriate.

145
 146 In total there were 1324 survey responses and data from Google Forms were downloaded into
 147 a Microsoft Excel (2010) spreadsheet. Of the 1324 completed surveys, 59 were removed due
 148 to a missing or invalid self-reported bra size (a key variable of interest), resulting in a final
 149 sample size of 1265 for subsequent analyses. The mode body mass range of participants was
 150 55-64 kg (29%); age was negatively skewed with the mode age range of participants being 18-
 151 24 years (33%). The most popular equestrian activity participated in was dressage (38%),
 152 followed by leisure hacking and trekking (19%), show jumping (17%) and eventing (12%);
 153 64% of participants owned a horse and rode most days. Out of the 1265 valid bra sizes self-
 154 reported there were 81 different bra sizes represented (Table 1); cup size ranged from an AA
 155 cup to a J cup and underband size ranged from 28 to 44 inches. The modal bra size was a 34B
 156 (n = 112).
 157

158 Table 1. Distribution of participants self-reported bra size (UK underband and cup size) (n = 1265)

Underband (inches)	Cup size													159	
	AA	A	B	C	D	DD	E	F	FF	G	GG	H	HH	J	Total
28			1			1	1		1	3					7
30		1	3	8	4	4	6		3	5	4		2		40
32		20	52	71	52	33	29	11	2	7	3	1			161
34	1	40	112	111	77	55	33	11	11	7	4	6	3	1	472
36	3	17	50	73	38	43	27	12	3	9	6	1	2		162
38		3	14	27	33	20	15	9		3	1	4	1		130
40			5	4	8	13	7	2		1	2	1			163
42			1	1	1							1		1	5
44						1	1	1							3
Total	4	81	238	295	213	170	119	46	20	35	20	14	8	2	1643
															1265

165

166 **Data Analysis**

167

168 Descriptive analysis was used to summarise participants’ demographic profiles and barriers to
 169 participation. Pearson’s chi-square χ^2 goodness-of-fit tests were utilised to assess the
 170 association of cup size with the extent to which bras met the needs of the participants, the
 171 frequency of horse riding participation, the uptake of professional bra fit services and breast
 172 health knowledge, in addition to the association of age with breast health knowledge. Cup sizes
 173 AA to C were classed as small-breasted (49% of participants), with cup sizes D and above
 174 classed as large-breasted (51% of participants) (Scurr *et al.*, 2010) for the χ^2 analysis. Age
 175 ranges were condensed into eight categories (18-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54
 176 and ≥ 55 years) to meet Chi-squared assumptions. Cramer’s V effect sizes have been presented,
 177 with 0.10, 0.30 and 0.50 representing a small, medium and large effect, respectively (Cohen,
 178 1992); 95% confidence levels have also been reported to aid data interpretation. All statistical
 179 analysis took place using the IBM SPSS 22 statistics package with an alpha level of 0.05.

180

181 An inductive content analysis was completed to analyse the qualitative responses to the
 182 following question: “What improvements in bras could be made to reduce breast health issues
 183 you experience during horse riding?”. Responses were coded into general dimensions by one
 184 researcher and the results triangulated by another experienced researcher. The frequency of

185 response for each theme is reported as a percentage of the total responses (n = 367) to allow
 186 for the identification of response variations (Gibson and Brown, 2009).

187

188 **Results**

189

190 Participants were presented with a list of common barriers to participation in horse riding,
 191 including five breast-related barriers (Table 2). At least one of the five barriers relating to the
 192 breast was reported in 25% of all participants and the breast accounted for 17% of the total
 193 barriers reported (n = 3858). When split by breast size, 11% of small-breasted riders mentioned
 194 that at least one of the five breast-related barriers applied to them, compared with 38% of large-
 195 breasted riders. The fourth highest barrier to horse riding participation for large-breasted riders
 196 was breast size (25% reported that *'their breasts were too big'*), which comes above cost and
 197 other health reasons. Breast size was not associated with the frequency of horse riding
 198 participation ($\chi^2(3) = 5.199, P = 0.158, V = 0.064, 95\%CI [0.03, 0.13]$).

199

200 Table 2. Percentage barriers to physical activity reported by small-breasted (n = 586) and large-breasted (n = 610) female horse riders

<i>Small-breasted (n = 586)</i>		<i>Large-breasted (n = 610)</i>	
Barriers to exercise participation	%	Barriers to exercise participation	%
I haven't got the time	36	I haven't got the time	42
I don't have time because of my work	33	I don't have time because of my work	35
I haven't got the energy	24	I haven't got the energy	27
I need to rest or relax in my spare time	20	My breasts are too big	25
I can't afford it	20	I need to rest or relax in my spare time	22
There's no one to do it with	19	I have an injury or disability that stops me	21
I have an injury or disability that stops me	14	I can't afford it	20
I'd never keep it up	11	I am embarrassed by excessive breast movement	19
I've got young children to look after	11	There's no one to do it with	18
I'm not the sporty type	10	I'm not the sporty type	17
There are no suitable facilities nearby	8	I can't find the right sports bra	17
I'm too shy or embarrassed	7	I am too fat	17
I might get injured or damage my health	7	I've got young children to look after	15
My health is not good enough	6	I don't like the look of my breasts when I exercise	15
I am too fat	5	I'd never keep it up	14
I can't find the right sports bra	5	I suffer with breast pain	14
I don't enjoy physical activity	4	I'm too shy or embarrassed	11
I don't like the look of my breasts when I exercise	4	There are no suitable facilities nearby	8
I haven't got the right clothes or equipment	3	My health is not good enough	8
I suffer with breast pain	3	I might get injured or damage my health	7
I am embarrassed by excessive breast movement	2	I don't enjoy physical activity	6
I'm too old	1	I'm too old	5
My breasts are too big	1	I haven't got the right clothes or equipment	4

201

202

203

204 Forty-four percent of participants felt that the bra they wore for horse riding sometimes, rarely
 205 or never met their needs for this activity (Figure 1); 'Very Often' was the mode response.
 206 Breast size significantly affected responses ($\chi^2(4) = 52.218, P < 0.001, V = 0.204, 95\%CI$

207 [0.16, 0.26]). Small-breasted riders were more satisfied, with more respondents stating that
 208 their bra ‘Always’ (23%) or ‘Very Often’ (42%) met their needs. Large-breasted riders were
 209 less satisfied, with more riders stating that their bra ‘Rarely’ (17%) met their needs than
 210 ‘Always’ (13%).

211

212 [Figure 1 near here]

213

214 Seventy percent of participants stated that improvements needed to be made in bras to help
 215 reduce breast health issues in horse riding. There were 367 comments made in relation to this
 216 question and an inductive content analysis identified ten general dimensions; support, style, fit,
 217 size, comfort, specialist bras, cost, material, choice and shape (Table 3). The most frequent
 218 topic commented on was support (22%); namely riders commented that bras were not
 219 supportive enough for horse riding. This was followed by Style (16%); there were many
 220 comments relating to how the design of the bra could be improved to help increase support and
 221 to be more aesthetically pleasing. Fit was also an issue (15%), with comments suggesting that
 222 bras needed improved fit (i.e. be functional whilst also fitting well).

223

224 Table 3. Improvements needed in bras to reduce breast health issues experienced (n = 367)

225

General Dimensions	% of Response	Examples
Support	22	Not supportive enough, need more support to reduce pain, need to minimise bounce more
Style	16	Design to be improved (e.g. shoulder straps that do not slip), more aesthetically pleasing, easier to get on and off
Fit	15	Better fitting bras needed, bras that are supportive without needing a tight fit, fitting without rubbing
Size	13	Need better bras for larger riders, bras are not made small or large enough for needs
Comfort	8	More comfort needed, comfort for long rider sessions
Specialist bras	8	Want a bra specifically designed for horse riding, modifications needed to existing products aimed at runners
Cost	6	Sports bras available cost too much, need lower costs for quality products
Material	5	More wicking needed, more breathable fabrics, non-slip shoulder strap material
Choice	5	Not enough choice on the market, wider range of sports bras needed
Shape	3	Would like sports bras which give a nice shape, shape without flattening the breasts

226

227 Nearly one-third of participants (31%) reported that it had been over a year since they were last
 228 professionally fitted for a bra, with 23% of participants reporting that they have never been
 229 fitted (Figure 2). Cup size was significantly related to the uptake of professional fitting services
 230 ($\chi^2(4) = 117.167, P < 0.001, V = 0.336, 95\%CI [0.29, 0.39]$), with a higher proportion of
 231 participants with smaller breasts (42%) reporting never being fitted compared to participants
 232 with larger breasts (15%).

233

234 [Figure 2 near here]

235

236 Less than a quarter (17%) of participants rated their current breast health knowledge or
237 awareness as above average, with only 3% reporting excellent knowledge levels. Breast health
238 knowledge significantly increased with age ($\chi^2(21) = 215.567, P < 0.001, V = 0.233, 95\%CI$
239 $[0.21, 0.27]$; Figure 3), with 15% of 18-24 year olds rating their knowledge as extremely poor,
240 compared to just 1% of over 55's. Breast health knowledge also increased with breast size (χ^2
241 $(4) = 14.367, P = 0.010, V = 0.107, 95\%CI [0.07, 0.17]$), with more larger-breasted participants
242 rating their knowledge as above average or excellent than smaller-breasted participants.
243

244

[Figure 3 near here]

245

246 Discussion

247 One of the key aims for this study was to ascertain the extent to which the breast acts as a
248 barrier for females participating in horse riding. Overall, one quarter of female horse riders
249 reported at least one breast-related barrier (38% larger-breasted riders and 11% smaller-
250 breasted riders) (Table 2); this compares to 17% of women in the general population (Burnett
251 *et al.*, 2014). Moreover, the breast accounted for 17% of the total barriers reported ($n = 3858$),
252 which is more than twice as high as what was reported by Burnett *et al.* (2014; 8%). These
253 results suggest that breast-related barriers are more widespread in the horse riding population
254 and may be contributing to the high latent demand for this activity (WSFF, 2011); they also
255 highlight the importance of considering the breast when investigating the decline in physical
256 activity levels in females.

257

258 The fourth highest barrier for larger-breasted riders was breast size ("*My breasts are too big*"),
259 which was rated higher than common barriers such as cost and other health reasons.
260 Interestingly 51% of the horse riders surveyed were classed as 'larger-breasted' (D cup or
261 above; Scurr *et al.*, 2010), which is considerably higher than the 37% reported in a marathon
262 running population (Brown *et al.*, 2014a), despite the modal bra size being a UK 34B in both
263 populations. This suggests that although a relatively higher number of larger-breasted females
264 may be participating in horse riding than running, breast size is also seen as the greatest barrier
265 for them to participate more often in this activity. Breast size did not however affect the
266 frequency of participation in the sport (i.e. the number of times they ride per month), similar to
267 findings in the general population (Burnett *et al.*, 2014). Whilst this is encouraging, it also
268 suggests that many larger-breasted women may be riding in some discomfort, the impact of
269 which on riding ability and rider/horse interaction is yet to be investigated.

270

271 Appropriate breast support is especially important for larger-breasted women when
272 participating in physical activity as they experience more breast motion and breast pain
273 (Bridgman *et al.*, 2010; Burbage and Cameron, 2017; Lorentzen and Lawson, 1987). Nineteen
274 percent of larger-breasted riders in this study said they were embarrassed by excessive breast
275 movement when they ride (Table 2), indeed the most frequent topic commented on when asked
276 about improvements in bras needed was support (22%; Table 3), namely that bras were not
277 supportive enough for horse riding. With 44% of respondents stating that the bra they wore for
278 horse riding only sometimes, rarely or never met their needs for this activity there appears to
279 be a demand for more appropriate, and perhaps equestrian-specific, bras. **Improvements in**
280 **equestrian specific bra design may also contribute to a reduction in breast pain, reported by**

281 40% of survey respondents (Burbage and Cameron, 2017). This may then lead to an
282 improvement in rider performance (Lewis and Kennerley, 2017) ostensibly enhancing ridden
283 horse welfare. Designing sports bras specifically for the size D (and larger) woman has
284 previously been promoted (Bridgman *et al.*, 2010; McGhee *et al.*, 2012; McGhee and Steele,
285 2010), although it is also important that women with smaller breasts receive optimum support
286 as breast movement can cause breast discomfort across all breast sizes (Lorentzen and Lawson,
287 1987).

288

289 Sports-specific breast support has previously been encouraged due to differences in breast
290 motion reported across varying activity types (Risius *et al.*, 2014), although equestrian sports
291 have not, as yet, been investigated. A horse rider is subject to a range of vigorous movements
292 in response to the movements of the horse, especially in trot, canter and the collected form of
293 these gaits (Bogisch *et al.*, 2014; Byström *et al.*, 2015; Münz *et al.*, 2014) and investigation is
294 needed to quantify the potentially novel effect on breast motion to better inform the ergonomic
295 design of equestrian-specific breast support. This may encourage greater usage of appropriate
296 breast support in female horse riders and help to reduce breast-related barriers, such as
297 excessive breast movement and not being able to find an appropriate bra. In particular,
298 equestrian-specific breast support may need to come in a wider range of bra sizes to cater for
299 the larger-breasted riders who perceive their breast size to be a barrier to them participating in
300 the sport.

301

302 Seventy percent of participants felt that improvements were needed in bras to help reduce
303 breast health issues in horse riding. After support, ‘style’ was the second highest area
304 commented on in relation to improvements needed (Table 3), with frequent remarks relating to
305 bras needing to be more aesthetically pleasing, an improved design and easier to get on and
306 off. The notion of bras being more aesthetically pleasing for equestrian sports is interesting as
307 in dressage, show jumping and the dressage aspect of eventing the “look” of the outfit worn
308 (often light coloured breeches, a white shirt with a black, blue or tweed jacket on top) is
309 important; with the dressage element being subjectively judged, feeling “smart” and “elegant”
310 may be important to rider self-confidence within this particular equestrian discipline. Træen *et*
311 *al.* (2015) indicated that self-efficacy was important in successful horse-rider partnerships,
312 which was negatively impacted by “health issues”. Although breast health issues were not
313 specifically mentioned in this study, having large breasts and an inappropriate bra which leads
314 to embarrassment due to excessive breast motion, are negative issues which may be affecting
315 rider’s self-efficacy and subsequent self-confidence. Dashper and St John (2016) highlighted
316 that the female horse rider was particularly vulnerable to issues of body image and reported
317 that the act of donning “competition” clothing made their sample change their own self-
318 perception, with potential performance consequences. This may be of particular importance in
319 the subjectively judged dressage element of equestrianism where rider position and postural
320 control contribute to the overall performance score (Hawson, 2010), as inadequate breast
321 support could negatively influence this element (Burbage *et al.*, 2016).

322

323 There is no difference between the male and female competition wear which can mean that
324 maintaining a feminine ‘shape’ can be important to some riders (Plymoth, 2013).
325 Consequentially, compression sports bras which reduce the feminine shape by redistributing
326 the mass of the breasts closer to the chest (Page and Steele, 1999) may be seen as inappropriate
327 to some riders. Furthermore, wearing a brightly coloured or black sports bra may not be an
328 attractive option to riders due to the potential visibility of this garment, especially in the
329 summer when many will warm-up for long periods of time at competitions in their white shirt

330 before putting their jacket on to enter the arena (Murray *et al.*, 2006). The style, colour and
331 shape of an equestrian-specific bra would therefore need to be sympathetic to these factors.

332

333 Interestingly, horse riding is often not considered a “sport” by many participants, general public
334 and researchers (Devienne and Guezennec, 2000; Meyers, 2006; Sainas *et al.*, 2016), despite it
335 being a moderate intensity exercise (British Horse Society, 2011) that can increase flexibility
336 and joint torque in young adults (Kang *et al.*, 2013). This perception of horse riding as a
337 “pastime” rather than a “sport”, and the high percentage of participants who are requesting
338 improvements in bras in this study, may be contributing to the low uptake of sports bra use in
339 this population (33%; Burbage and Cameron, 2017), compared to running (91%; Brown *et al.*,
340 2014a). As nearly half of horse riders take part in no other sporting activity (British Horse
341 Society, 2011) it could be reasonable to assume that they do not own a sports bra for other
342 activities and may have a lower awareness of the products available, especially as sports bras
343 are often targeted at runners. They may therefore be more comfortable purchasing and wearing
344 a supportive bra if it were specifically marketed for equestrian sports, consequently increasing
345 the sports bra usage in this population.

346

347 Improvements needed in bra fit were also frequently commented on (Table 3), with participants
348 suggesting that bras need to be able to support without being a very tight fit or rubbing.
349 However, 54% of participants had either never been professionally fitted, or it had been over a
350 year ago (Figure 2). Despite a higher proportion of larger-breasted riders utilising a bra fitting
351 service than smaller-breasted riders, which was also reported by Brown *et al.* (2014a) in a
352 marathon running population, these results demonstrate either a lack of awareness of the
353 importance of bra fitting or reflect the difficulty riders have finding appropriate breast support
354 in the correct size. Improved education specific to horse riding is needed to help this population
355 understand how to achieve an appropriate bra fit. This will help to reduce fit issues that can
356 lead to rubbing, poor posture and upper body pain (Burbage and Cameron, 2017), and may
357 positively impact on sports bra uptake in this population.

358

359 Only 20% of participants rated their current breast health knowledge as above average or
360 excellent (Figure 3), similar to a marathon runner population (Brown *et al.*, 2014a). Older and
361 larger-breasted riders were the most aware of breast health issues but this study highlights that
362 much more needs to be done to help improve these levels, especially for young riders entering
363 the sport. Increased breast health knowledge will aid horse riders to identify appropriate breast
364 support for their activity, to reduce excessive breast motion and embarrassment, and hopefully
365 help to improve their own bra fit. Better awareness of breast health issues and specific
366 information targeted at horse riders may help to reduce the breast-related barriers to
367 participation, which is so important for a female-dominant sport where the numbers
368 participating are declining (WSFF, 2011).

369

370 **Conclusion**

371 Breast-related barriers to participation in horse riding were commonly reported, with breast
372 size being the fourth highest barrier to participation for larger-breasted riders (25%). This
373 highlights the importance of addressing breast-related barriers to encourage more participation
374 in equestrian sports, which has been declining in popularity. Seventy percent of participants
375 called for improvements to be made in bras for horse riding, providing rationale for the
376 development of equestrian-specific breast support garments that are suitable for a wide range
377 of breast sizes and are sensitive to the unique nature of the sport, which requires specific styling,
378 shape and potentially support. It was also evident that greater awareness of bra fit and breast

379 health issues was needed within this population, which could be addressed by specific
380 educational initiatives.

381

382 **Acknowledgements**

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384 Portsmouth and the staff and students of University Centre Sparsholt for their assistance in
385 promoting this survey

386

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391 **References**

392 Bogisch, S., Peinen, K. G., Wiestner, T., Roepstorff, L. and Weishaupt, M. A. 2014. Influence

393 of velocity on horse and rider movement and resulting saddle forces at walk and trot 10(1):

394 23–32.

395 Bowles, K. A., Steele, J. R. and Munro, B. J. 2012. Features of sports bras that deter their use

396 by Australian women. *Journal of Science and Medicine in Sport* 15(3): 195–200.

397 Bowles, K., Steele, J., Munro, B. and Bowles, K. 2008. What are the breast support choices of

398 Australian women during physical activity? *British Journal of Sports Medicine* 42(8):

399 670–673.

400 Bridgman, C., Scurr, J., White, J., Hedger, W. and Galbraith, H. 2010. Three-dimensional

401 kinematics of the breast during a two-step star jump. *Journal of Applied Biomechanics*

402 26(4): 465–472.

403 Brown, N., White, J., Brasher, and Scurr, J. 2014. An investigation into breast support and

404 sports bra use in female runners of the 2012 London Marathon. *Journal of Sports Sciences*

405 32(9): 801–809.

406 Brown, N., White, J., Brasher, A. and Scurr, J. 2014. The experience of breast pain (mastalgia)

407 in female runners of the 2012 London Marathon and its effect on exercise behaviour.

408 *British Journal of Sports Medicine* 48(4): 320–325.

409 Burbage, J. and Cameron, L. 2017. An investigation into the prevalence and impact of breast
410 pain, bra issues and breast size on female horse riders. *Journal of Sports Sciences* 35(11):
411 1091-1097.

412 Burnett, E., White, J. and Scurr, J. 2015. The influence of the breast on physical activity
413 participation in females. *Journal of Physical Activity & Health* 12(4): 588-594.

414 Bystrom, A., Rhodin, M., Peinen, K., Weishaupt, M.A. and Roepstorff, L. 2009. Basic
415 kinematics of the saddle and rider in high-level dressage horses trotting on a treadmill.
416 *Equine Veterinary Journal* 41: 280-284.

417 Byström, A., Roepstorff, L., Geser-von Peinen, K., Weishaupt, M. and Rhodin, M. 2015.
418 Differences in rider movement pattern between different degrees of collection at the trot
419 in high-level dressage horses ridden on a treadmill. *Human Movement Science* 41: 1–8.

420 Chen, C. M., LaBat, K. and Bye, E. 2010. Physical characteristics related to bra fit. *Ergonomics*
421 53(4): 514–524.

422 Cohen, J. 1992. A power primer. *Psychological Bulletin* 112(1): 155–159.

423 Collings, P. J., Wijndaele, K., Corder, K., Westgate, K., Ridgway, C. L., Dunn, V., ... Preece,
424 M. 2014. Levels and patterns of objectively-measured physical activity volume and
425 intensity distribution in UK adolescents: the ROOTS study. *International Journal of*
426 *Behavioral Nutrition and Physical Activity* 11(1): 23.

427 Dashper, K. and St John, M. 2016. Clothes make the rider? Equestrian competition dress and
428 sporting identity. *Annals of Leisure Research* 19(2): 235-250.

429 Devienne, M. F. and Guezennec, C. Y. 2000. Energy expenditure of horse riding. *European*
430 *Journal of Applied Physiology* 82: 499–503.

431 Department of Health. 2011. Physical Activity Guidelines for Adults (19-64 years). Available
432 at <https://www.gov.uk/government/organisations/department-of-health>

433 Gibson, W. and Brown, A. 2009. Working with qualitative data. London, UK: Sage
434 Publications.

435 Hawson, L.A. 2010. Variability of scores in the 2008 Olympic dressage competition and
436 implications for horse training and welfare. *Journal of Veterinary Behaviour: Clinical
437 Applications and Research* 5: 170-176.

438 Kang, S. R., Yu, C. H., Jung, G. Y., Moon, D. A., Park, S. Y., Kim, J. J., and Kwon, T. K.
439 2013. Analysis of the indoor horse riding exercise equipment on the young people.
440 *International Journal of Precision Engineering and Manufacturing* 14(8): 1471–1478.

441 Lewis, V. and Kennerley, R. 2017. A preliminary study to investigate the prevalence of pain
442 in elite dressage riders during competition in the United Kingdom. *Comparative Exercise
443 Physiology* 13(4): 259-263.

444 Lorentzen, D. and Lawson, L. 1987. Selected sports bras: a biomechanical analysis of breast
445 motion while jogging. *Physician and Sportsmedicine* 15(5): 128-139.

446 Mason, B. R., Page, K. A. and Fallon, K. 1999. An analysis of movement and discomfort of
447 the female breast during exercise and the effects of breast support in three cases. *Journal
448 of Science and Medicine in Sport* 2(2): 134–144.

449 McGhee, D. E. and Steele, J. R. 2010. Breast elevation and compression decrease exercise-
450 induced breast discomfort. *Medicine and Science in Sports and Exercise* 42(7): 1333-
451 1338.

452 McGhee, D. E., Steele, J. R., Zealey, W. J. and Takacs, G. J. 2013. Bra-breast forces generated
453 in women with large breasts while standing and during treadmill running: Implications for
454 sports bra design. *Applied Ergonomics* 44(1): 112–118.

455 Meyers, M. C. 2006. Effect of equitation training on health and physical fitness of college
456 females. *European Journal of Applied Physiology* 98(2): 177–184.

457 Münz, A., Eckardt, F. and Witte, K. 2014. Horse-rider interaction in dressage riding. Human
458 Movement Science 33: 227–237.

459 Murray, R. C., Mann, S. and Parkin, T. D. 2006. Warm-up in dressage competitions:
460 association with level, competition type and final score. Equine and Comparative Exercise
461 Physiology 3(April 2007), 185.

462 Page, K. and Steele, J. 1999. Breast Motion and Sports Implications for Future Research. Sports
463 Medicine 27(4): 205–211.

464 Paterson, M., Doyle, J., Cahill, E., Caulfield, B. and McCarthy Persson, U. 2010. Quantifying
465 Show Jumping Horse Rider Expertise using IMUs. Conference proceedings of the Annual
466 International Conference of the IEEE Engineering in Medicine and Biology Society.
467 <http://dx.doi.org/10.1109/IEMBS.2010.5626214>

468 Plymoth, B. 2012. Gender in equestrian sports: An issue of difference and equality. Sport in
469 Society (September 2013), 37–41. Available at:
470 <http://www.tandfonline.com/doi/abs/10.1080/17430437.2012.653204>

471 Risius, D., Milligan, A., Mills, C. and Scurr, J. 2014. Multiplanar breast kinematics during
472 different exercise modalities. European Journal of Sport Science, (June), 1–7.

473 Sainas, G., Melis, S., Corona, F., Loi, A., Ghiani, G., Milia, R., ... Crisafulli, A. 2016. Cardio-
474 metabolic responses during horse riding at three different speeds. European Journal of
475 Applied Physiology. doi:10.1007/s00421-016-3450-7

476 Scurr, J., Brown, N., Smith, J., Brasher, A., Risius, D. and Marczyk, A. 2016. The Influence of
477 the Breast on Sport and Exercise Participation in School Girls in the United Kingdom. The
478 Journal of Adolescent Health : Official Publication of the Society for Adolescent Medicine
479 58(2): 167–73.

480 Scurr, J., White, J. and Hedger, W. 2010. The effect of breast support on the kinematics of the
481 breast during the running gait cycle. Journal of Sports Sciences 28(10): 1103–1109.

482 Terada, K., Clayton, H. and Kato, K. 2006. Stabilization of wrist position during horseback
483 riding at trot. *Equine and Comparative Exercise Physiology* , 3(April 2007), 179.

484 The British Horse Society. 2011. The health benefits of horse riding in the UK. Available at:
485 <http://www.bhs.org.uk/enjoy-riding/health-benefits>

486 The British Horse Society. 2015. BETA National Equestrian Survey. Available at:
487 <http://www.bhs.org.uk/~media/bhs/files/pdf-documents/equestrian-statistics.ashx>.

488 Træen, B., Westerberg, A. C., Njøten, M. O. and Røysamb, E. 2015. Predictors of self-efficacy
489 in Norwegian competition riders. *Journal of Equine Veterinary Science*.
490 doi:10.1016/j.jevs.2015.07.021

491 Vehovar, V. and Manfreda, K. L. 2008. Overview: online surveys. In *The SAGE Handbook of*
492 *Online Research Methods*, edited by Fielding, N. G., Lee, R. M., & Blank, G. 177-194.
493 London, UK: Sage Publications.

494 White, J. and Scurr, J. 2012. Evaluation of professional bra fitting criteria for bra selection and
495 fitting in the UK. *Ergonomics* 55(6): 704–711.

496 White, J., Scurr, J. and Smith, N. a. 2009. The effect of breast support on kinetics during
497 overground running performance. *Ergonomics* 52(4): 492–498.

498 Women’s Sport and Fitness Foundation. (2011). *Equestrian Factsheet*. Available
499 at: [http://www.bhs.org.uk/~media/bhs/files/pdf-documents/women-and-equestrianism--](http://www.bhs.org.uk/~media/bhs/files/pdf-documents/women-and-equestrianism--2011.ashx)
500 [2011.ashx](http://www.bhs.org.uk/~media/bhs/files/pdf-documents/women-and-equestrianism--2011.ashx).

501 Wood, K., Cameron, M. and Fitzgerald, K. 2008. Breast size, bra fit and thoracic pain in young
502 women: a correlational study. *Chiropractic & Osteopathy* 16(1): 1.

503

504

505 Figure 1. The extent to which participant's bras met their needs for horse riding (n = 1258)

506

507 Figure 2. Frequency distribution of when small-breasted and large-breasted participants
508 were last professionally measured for bra size (n = 1264)

509

510 Figure 3. Age distribution of participants' rating of their knowledge or awareness of
511 breast health issues (n = 1264)

Figure 1

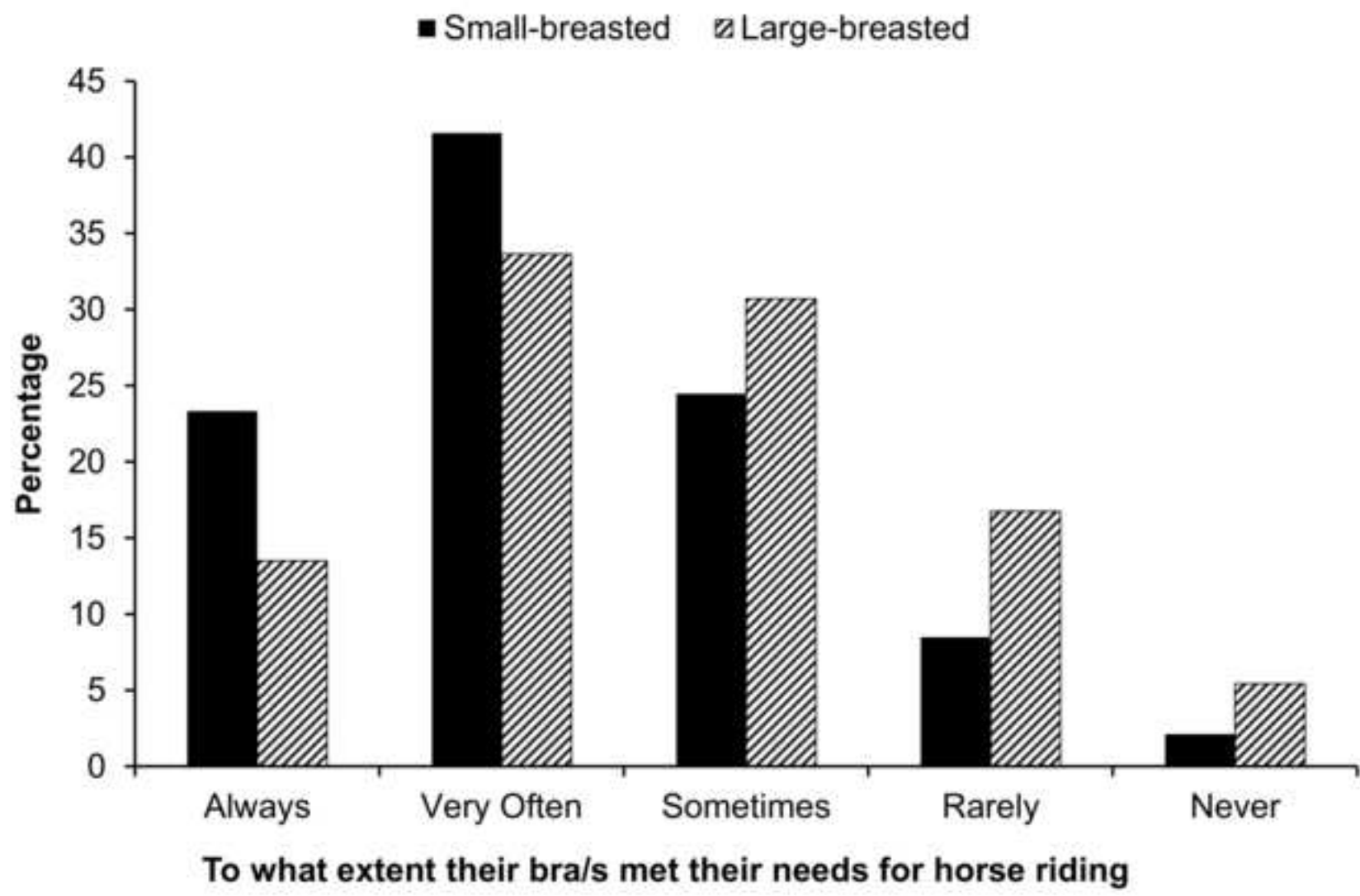


Figure 2

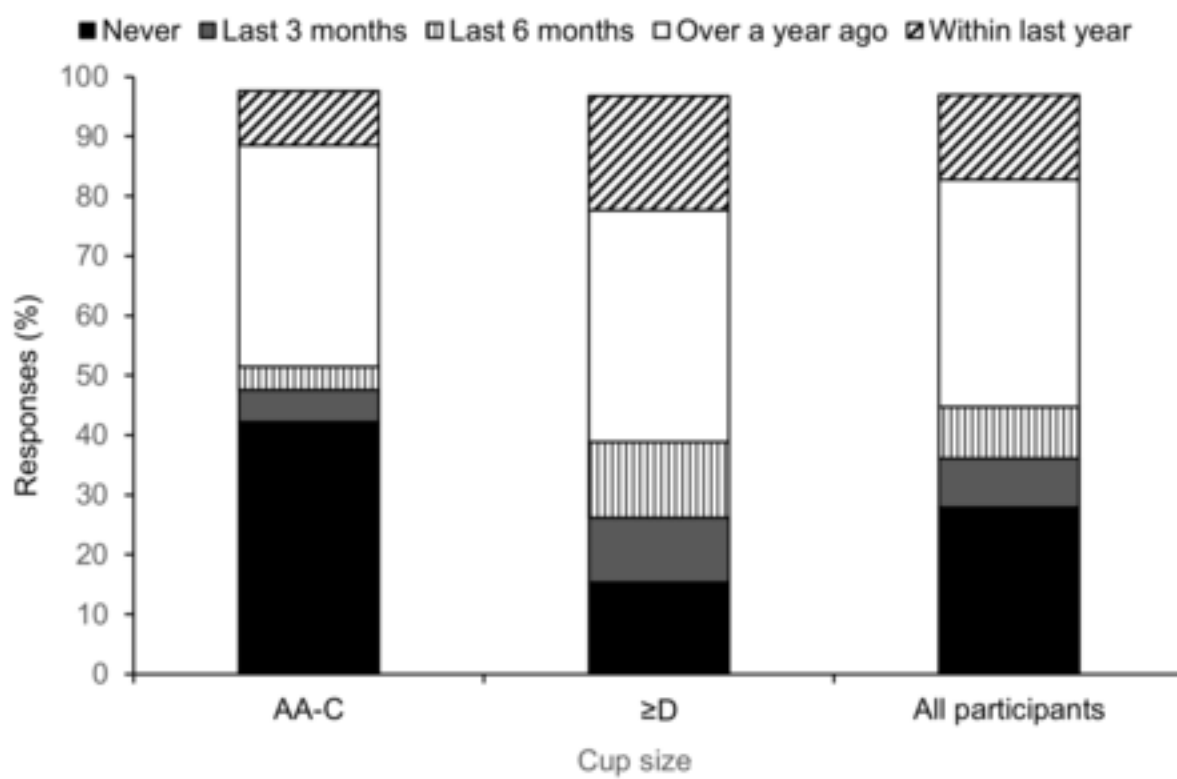


Figure 3

