



Open Research
Archive

<https://research.stmarys.ac.uk/>

TITLE

Sports bra use, preferences and fit issues among exercising females in the US, UK and China

AUTHOR

Brown, Nicola; Jenny, Burbage and Joanna, Wakefield-Scurr

JOURNAL

Journal of Fashion Marketing and Management

DATE DEPOSITED

17 November 2020

This version available at

<http://research.stmarys.ac.uk/id/eprint/4444/>

COPYRIGHT AND REUSE

Open Research Archive makes this work available, in accordance with publisher policies, for research purposes.

VERSIONS

The version presented here may differ from the published version. For citation purposes, please consult the published version for pagination, volume/issue and date of publication.

TITLE

Sports bra use, preferences and fit issues among exercising females in the US, UK and China

AUTHOR

Brown, Nicola; Jenny, Burbage and Joanna, Wakefield-Scurr

JOURNAL

Journal of Fashion Marketing and Management

DATE DEPOSITED

UNSPECIFIED

This version available at

<http://research.stmarys.ac.uk/id/eprint/4444/>

COPYRIGHT AND REUSE

Open Research Archive makes this work available, in accordance with publisher policies, for research purposes.

VERSIONS

The version presented here may differ from the published version. For citation purposes, please consult the published version for pagination, volume/issue and date of publication.

1 **Accepted:** Journal of Fashion Marketing and Management

2

3 **Authors:** Nicola Brown, Jenny Burbage, Joanna Wakefield-Scurr

4

5 **Title:** Sports bra use, preferences and fit issues among exercising females in the US, UK and
6 China.

7

8 **Abstract**

9 **Purpose:** Previous research suggests that many active females are not engaging in sports bra
10 use, despite the positive health benefits. The aim of this study was to establish and compare
11 sports bra use, preferences, and bra fit issues for exercising females in some of the largest and
12 most diverse global underwear markets (US, UK and China). **Design/methodology/approach:**
13 A survey covering activity levels, sports bra use and preferences, bra issues, and demographics
14 was administered via Qualtrics and completed by 3147 physically active females (aged ≥ 18
15 years) from the US (n=1060), UK (n=1050) and China (n=1037). **Findings:** In general,
16 participants were 25 to 29 years, 121 to 140 pounds, 34B bra size, and pre-menopausal. *'I can't*
17 *find the right sports bra'* was the most frequent breast barrier to exercise (25.4%). Three-
18 quarters of women wore a sports bra during exercise, with significantly higher use in China
19 (83.9%), compared to the UK (67.2%). A third of all participants reported sports bra shoulder
20 straps 'digging into the skin'. Sports bra preferences were; compression sports bras, with a
21 racer back, wide straps, thick straps (in US and UK), thin straps in (China), adjustable straps
22 and underband, no wire, maximum breast coverage (in US and UK), including nipple
23 concealment, and with padded/moulded cups. **Originality/value:** Information provided on
24 differences in sports bra use, preferences and bra issues across three major global markets could

25 be utilised by brands and manufacturers to optimise bra marketing and fit education initiatives,
26 and inform future sports bra design and distribution strategies.

27

28 **Keywords:** consumer behaviour, consumer preferences, brands, sports bra, bra fit, bra design,
29 breasts, international markets, female apparel

30

Accepted version

31 **Introduction**

32

33 The global women's activewear market is growing year on year, recording a total revenue of
34 approximately \$119 billion in 2017 and forecast to reach almost \$217 billion by 2025
35 (O'Connell, 2019). The sports bra market record a revenue of \$9 billion in 2019 and is expected
36 to reach \$38.4 billion by 2026, representing significant growth (WinterGreen Research, 2020).
37 The US dominates the global sports bra market, with 45% of female consumers shopping for
38 or purchasing a sports bra in 2018, compared to 38% in 2015 (NPD, 2019). However, statistics
39 also indicate increased demand for sports bras in other regions, with the UK increasing its
40 sports bra stock by 17% since 2018 (Marci, 2020), and the Asia-Pacific region expected to
41 show the fastest growth rate (9.6%) in the women's activewear market, during the forecast
42 period 2018-2025 (Bhandalkar & Das, 2018). Understanding bra consumer needs in these
43 dominant regions and the value consumers attach to certain bra attributes when making a
44 purchase decision is important to optimise consumer offering, and develop effective marketing
45 and promotion activities. The growth of the global sports bra market is driven by increased
46 female participation in sports and exercise and increased awareness the need to support the
47 breast (O'Connell, 2019). The breast has limited intrinsic support and as a consequence
48 excessive breast movement can occur during physical activity (Page & Steele, 1999; Scurr,
49 White, & Hedger, 2009, 2011). This movement has been reported to range from 4 cm during
50 walking to 15 cm when running (Bowles, Steele, & Munro, 2008; Scurr, White, & Hedger,
51 2011). Repeated loading on the delicate breast supporting structures, due to excessive breast
52 motion, may result in breast discomfort, breast sag and embarrassment (Bowles *et al.*, 2008;
53 Mason *et al.*, 1999; Page and Steele, 1999; Starr *et al.*, 2005). Up to 72% of exercising females
54 (Gehlsen & Albohm, 1980) are reported to experience breast pain and, despite the success of

55 the global sports bra market, one in five adult women (Burnett et al.,2015) and over half of
56 adolescent girls (Scurr et al., 2016) report the breast as a barrier to exercise.

57

58 Well-designed sports bras are more effective in limiting breast motion than standard fashion
59 bras or crop tops (Boschma, Smith & Lawson, 1996; Bowles et al., 2008; Bowles, Steele, &
60 Munroe, 2012; Mason et al., 1999; Page & Steele, 1999) and are advocated to reduce breast
61 motion and discomfort during physical activity (Mason *et al.*, 1999; Scurr *et al.*, 2010; Scurr
62 *et al.*, 2011; White *et al.*, 2009; White *et al.*, 2011). Currently, there are three distinct sports
63 bra designs on the market: compression, encapsulation, and combination. Compression sports
64 bras typically pull over the head, do not have cups and restrict breast motion by compressing
65 the breast to distribute their mass across the chest wall (Page & Steele, 1999; Starr et al., 2005).
66 Encapsulation sports bras support each breast individually in separate, structured cups to limit
67 breast movement (Page & Steele, 1999; Starr et al., 2005). Compression bras both encapsulate
68 and compress the breasts, although in varying degrees dependent on the sports bra design. In
69 addition to these bra types, there is also a wide variation in sports bras features such as closure
70 methods, strap configurations, cup styling, and adjustability options (Page & Steele, 1999;
71 Zhou, Yu & Ng, 2012). Understanding how consumers perceive these particular bra attributes
72 is important for the bra industry to optimise consumer satisfaction. However, to date there is
73 limited information surrounding sports bra preferences.

74

75 Despite the growth in the sports bra market, and increased understanding of breast support
76 requirements, research has identified that sports bra use among female populations is low. In
77 the UK Scurr *et al.* (2016) identified that over half of 2089 adolescent girls surveyed reported
78 never wearing a sports bra during sport and exercise. In China, only 40% of 404 women
79 surveyed had ever worn a sports bra; sports bra usage was affected by age, breast size and

80 monthly income (Chen *et al.*, 2019). Bowles *et al.* (2008) reported that among adult populations
81 in Australia sports bra use was as low as 41%. Many Australian females were more likely to
82 wear an everyday bra during physical activity regardless of their age or bra size, highlighting
83 a lack of engagement in sports bra use. Bowles *et al.* (2008) proposed that this finding
84 suggested consumers may be dissatisfied with current sport bra designs and recommended that
85 more attention should be placed upon aspects of sports bra design that are important to
86 consumers. This finding was echoed by Burnett *et al.*, (2015), who reported that breasts were
87 a barrier to physical activity participation for 17% of women in the UK, with the most
88 influential breast related barrier to being 'I can't find the right sports bra'. This suggests that
89 the current bra market may not provide appropriate breast support options. Engagement in
90 sports bra use by women in the US is currently unknown, despite the US dominating the global
91 sports bra market.

92
93 Secular differences in breast size exist across different countries (Brown and Scurr, 2016) and
94 breast size is known to influence sports bra use, preferences and fit (Brown *et al.*, 2014). Thus
95 it is plausible that these factors may differ between countries, particularly as research
96 recognises that socio-cultural factors are influential in consumers purchasing behaviour (Koca
97 and Koc, 2016). In a review of breast size across different countries, Brown and Scurr (2016)
98 reported some of the smallest bust circumferences in a Chinese population and some of the
99 largest bust circumferences in a US population, with the UK positioned between China and the
100 US. Larger-breasted women are reported to experience more bra fit issues due to the large
101 range of breast mass and volume within a bra size making identifying an appropriate bra more
102 challenging (McGhee *et al.*, 2013). Rubbing and chaffing, shoulder straps digging in, upper
103 body pain, and poor posture were bra issues experienced significantly more frequently by
104 participants with larger breasts compared to those with smaller breasts (Brown *et al.*, 2014;

105 Burbage and Cameron, 2018). Furthermore, Brown *et al.* (2014) reported that sports bra use
106 was more frequent and perceived as more important in larger-breasted women ($\geq D$ cup). In
107 China, women with larger breasts were also more likely to wear sports bras (Chen *et al.*, 2019).
108 It is important to further investigate factors that both encourage and deter women from wearing
109 sports bras, particularly those factors related to sports bra design and fit, so that sports bras can
110 be modified accordingly within each market. This may increase their use, potentially increasing
111 the number of women exercising, in addition to offering commercial benefit to manufacturers
112 through increased sales. Obtaining correct bra-fit can be problematic for females with 70 to
113 100% of women reported to be wearing incorrectly fitting bras (Greenbaum, Heslop, Morris,
114 & Dunn, 2003; McGhee & Steele, 2010b; Pechter, 1998; Wood, Cameron & Fitzgerald, 2008).
115 Research has found the traditional method of a tape measurement to establish bra size to be
116 unreliable, with this method overestimating the underband size in 76% of cases and
117 underestimating the cup size in 84% of cases (White & Scurr, 2012). Literature now suggests
118 that females should be educated on professional bra fitting criteria to improve their ability to
119 independently choose a well-fitted bras (Brown *et al.*, 2018; Boschma, Smith & Lawson, 1996;
120 Chen *et al.*, 2019; McGhee & Steele, 2010; McGhee, Steele & Munro; White & Scurr, 2012),
121 although to date limited research has investigated sizing methods employed when purchasing
122 sports bras.

123
124 Regardless of the growth in the sports bra market, previous research suggests that a percentage
125 of active females are not engaging in sports bra use, despite the positive health benefits.
126 Furthermore, a high proportion of women experience fit issues relating to their sports bras and
127 cite the breast as a barrier to exercise. The US, UK and China represent the three regions with
128 the largest share in the global sports bra market and whilst literature exists highlighting sports
129 bra use, preferences and fit in the UK, limited data has been located for China and there is no

130 information for the US. Additionally, research indicates that these market regions may differ
131 with regard to breast size and it is recognised that socio-cultural factors may influence
132 purchasing behaviour. Therefore, in order to inform general and specific sports bra market
133 requirements, this study aimed to 1) establish breast-related barriers to physical activity, sports
134 bra use, preferences, and fit issues of exercising females in some of the largest and most diverse
135 underwear markets in the world (US, UK and China and 2) identify how these factors differ
136 between these markets.

137

138 **Methods**

139 *Setting and Sample*

140 This study had a cross-sectional survey design. Following full institutional ethical approval, an
141 on-line survey was administered via Qualtrics software to a sample of US, UK and Chinese
142 nationals. On-line surveys offer an increased sense of privacy resulting in high data quality, in
143 addition to allowing respondents to complete the survey at their convenience (Vehovar and
144 Manfreda, 2008). The surveys were distributed to participants in the US, UK and China
145 between March 2017 and October 2018 via an email invitation; the survey distribution was not
146 limited to specific regions within these countries. Participation was voluntary and participants
147 were free to withdraw at any point up until the final submission of survey responses. All data
148 were anonymous. A double opt-in process was used by Qualtrics; this consisted of a registration
149 process (participants are recruited by various methods, such as online portals, in-app
150 messaging, SMS and targeted email invitations) and then an email invitation to complete the
151 survey if participant's basic registration data matched the inclusion criteria; female, ≥ 18 years,
152 living in the US, UK or China, and physically active two or more days a week. In return for
153 survey completion, participants received points, which could be redeemed in a number of ways,
154 for example as gift cards or store credit.

155 *Survey Development*

156 A custom four-part, forty-question survey was developed based on a breast survey previously
157 utilised in a general population (Burnett *et al.*, 2015). Questions on demographics, breast and
158 bra issues, barriers to exercise and physical activity levels were taken from Burnett *et al.*'s
159 (2015) paper; more detailed questions on sports bra preferences were created for the current
160 study. At the beginning of the survey participants were provided with an information sheet that
161 explained the nature of the investigation. Completion of the survey was considered as consent
162 to participation in the study and at no point were participants asked for their name and/or
163 contact details. Section one of the survey identified participant's barriers to physical activity
164 and their levels of moderate- and vigorous-intensity activity; moderate-intensity activities were
165 defined as activities that require moderate physical effort and cause small increases in breathing
166 or heart rate, vigorous-intensity activities were defined as activities that require hard physical
167 effort and cause large increases in breathing or heart rate. Section two explored sports bra use
168 and bra preferences of exercising females. Section three of the survey captured information
169 about bra and breast issues exercising females experienced. The final section identified
170 demographic data and information about breast health history. The survey contained closed
171 questions (tick box), and was designed to take no more than 15 minutes to complete. Minor
172 alterations to some questions were made to ensure they were culturally relevant to each target
173 demographic, for example amending the types of exercise listed, and amending questions to
174 include relevant currency. Prior to distribution in China, the English survey was translated into
175 Mandarin Chinese, the official and standard spoken language in mainland China.

176

177 Responses were automatically downloaded to Microsoft Excel (2010) from Qualtrics and data
178 were checked for accuracy. Of the 3154 completed surveys, three cases were removed due to
179 respondents not meeting the inclusion criteria (female and exercising \geq twice a week), and one

180 case was removed due to nonsensical responses. Listwise deletion, pairwise deletion and
181 imputation can be used to handle incomplete data (Rafiq and Jaafar, 2007). Due to multiple
182 missing responses, these three cases were removed from the data set (listwise deletion). The
183 remaining cases had very few data missing ($< 2.5\%$), thus pairwise deletion was used, meaning
184 these cases were temporarily removed from the analysis only in respect of those entries for
185 which there was no response. This resulted in a final sample size of 3147 for all subsequent
186 analyses, comprised from the US ($n = 1060$), the UK ($n = 1050$) and China ($n = 1037$).

187

188 Descriptive and inferential analyses were carried out using Predictive Analytic Software
189 Statistics version 24.0 (SPSS, Hong Kong) and the alpha level for inferential analysis was set
190 at 0.05. Data were analysed descriptively to summarise participant's demographic profiles and
191 breast history. When participants were asked to rank the importance of sports bra features (e.g.
192 1 = most important, 10 = least important) Friedman tests were applied to establish mean ranks,
193 with a lower mean rank indicating higher importance.. Physical activity data were positively
194 skewed towards low levels, therefore differences in physical activity data between countries
195 were assessed using Kruskal Wallis H tests. Differences between countries in all other nominal
196 or ordinal variables were assessed using the Chi-square test of homogeneity. Where significant
197 differences between countries were identified, post hoc analysis involved pairwise
198 comparisons using the z-test of two proportions with a Bonferroni correction.

199

200 **Results**

201 *Demographics*

202 The mode age range was 18 to 29 years in the US (35.9%), UK (31.0%) and China (33.6%).
203 The mode body mass range for both the US (25.3%) and UK (26.0%) was 55 to 64 kg,
204 compared to 45 to 54 kg (38.9%) in China. The majority of participants were pre-menopausal

205 (64.3%) although a significantly higher proportion of post-menopausal women participated in
206 the US (28.6%) compared to the UK (22.1%) and China (20.0%). The proportion of women
207 who had given birth was significantly higher in China (68.2%) compared to the US and UK
208 where proportions were similar (57.8% and 59.5%, respectively) ($\chi^2(2) = 27.321, p < 0.001$).
209 Of those who had given birth ($n = 1944$), 69.7% reported breastfeeding. In all countries the
210 mode bra size was a 34B (Table I). Almost half of UK participants had a breast cup size $\geq D$,
211 which was significantly higher than the US (34.5%) and China (5.0%) ($\chi^2(2) = 470.356, p <$
212 0.001). Women with underband sizes ≥ 40 inches ranged from 6.8% in China, to 15.5% in the
213 US.

214

215 *Table I near here*

216

217 *Barriers to physical activity*

218 On average, participants participated in moderate physical activity for 3.7 ± 1.7 days per week,
219 and vigorous physical activity for 2.3 ± 1.9 days per week. There were no differences in
220 moderate physical activity participation between countries ($\chi^2(2) = 4.788, p = 0.091$), however
221 vigorous physical activity participation was higher in the UK, and lower in the US, compared
222 to China ($\chi^2(2) = 73.978, p < 0.001$). Walking/hiking was the most popular activity among US
223 (74.6%) and UK (58.5%) participants, whereas running was most popular in China (57.3%),
224 followed by walking/hiking (38.7%).

225

226 Of the breast-related barriers to physical activity (Table II) '*I can't find the right sports bra*'
227 was ranked highest (8/24 barriers), affecting 25.4% of participants. '*I don't like the look of my*
228 *breasts*' was the second highest ranked breast barrier (22.0%), with more UK participants
229 (23.6%) reporting this as a barrier compared to US participants (19.1%) ($\chi^2(2) = 8.010, p =$

230 0.018). Nearly a quarter (23.4%) of Chinese participants reported being embarrassed by breast
231 movement compared to UK (18.3%) and US (14.4%) participants ($\chi^2(2) = 27.437, p < 0.001$).

232

233 *Table II near here*

234

235 *Sports bra use and purchasing habits*

236 In the UK, less participants wore a sports bra to exercise (67.1%) compared to the US (77.5%)
237 and China (83.9%) ($\chi^2(2) = 78.833, p < 0.001$). Half of US (53.3%) and UK (50.1%)
238 participants 'always' wore a sports bra during exercise (Table III), which was higher than in
239 China (28.6%) ($\chi^2(2) = 137.380, p < 0.001$). More than 80% of all participants rated sports
240 bra use as 'essential' or 'very important' (Table III).

241

242 Most participants reported that they wore a sports bra (Table III) because it '*enables me to*
243 *exercise in comfort*' (69.6%), although this was higher in US participants (76.1%) compared
244 to Chinese and UK participants ($\chi^2(2) = 24.883, p < 0.001$). Interestingly, compared to US and
245 UK participants, less Chinese participants (46.0%) reported wearing a sports bra to '*reduce*
246 *breast movement*' ($\chi^2(2) = 130.996, p < 0.001$), and more wore a sports bra as it is '*less*
247 *embarrassing*' (38.0%) ($\chi^2(2) = 63.352, p < 0.001$). Over a third (35.1%) of all participants
248 wore a sports bra to 'reduce breast pain'. Almost four times as many Chinese (38.0%) reported
249 wearing a sports bra because it '*matches my sportswear*', compared to US and UK participants
250 ($\chi^2(2) = 232.210, p < 0.001$).

251

252 *Table III near here*

253

254 Compared to US and UK, more participants in China reported wearing an everyday (fashion)
255 bra under their sports bra (30%; $\chi^2(4) = 130.000$, $p < 0.001$), or wearing two sports bras during
256 exercise (9.8%; $\chi^2(4) = 25.406$, $p < 0.001$) (Table III). The majority of US (78.9%) and UK
257 (82.3%) participants wore the same sports bra for all activities, compared to 44.3% of Chinese
258 participants ($\chi^2(2) = 329.440$, $p < 0.001$) (Table III).

259

260 Twice as many Chinese participants purchased a sports bra '*in the last month*' (46.6%) (Table
261 IV), compared to US (22.6%) and UK (21.0%). Chinese participants replaced their sports bras
262 more regularly; 51.7% replacing them every 3 months, compared to 11.4% and 15.0% of US
263 and UK participants ($\chi^2(10) = 538.945$, $p < 0.001$). US participants most commonly own two
264 to three sports bras (31.3%) with UK and Chinese participants owning three to four (46.1%),
265 and four to five (44.6%). Around a third of US (37.5%) and UK (35.7%) participants would
266 spend ≤ 20 USD on a sports bra, compared to ≈ 30 USD reported by 19.9% of Chinese
267 participants.

268

269 *Table IV near here*

270

271 More US participants (68.6%) purchased sports bras from department stores compared to UK
272 (42.6%) and China (43.6%) ($\chi^2(2) = 137.104$, $p < 0.001$), whereas more Chinese participants
273 purchased sports bras from sports apparel stores (68.4%) ($\chi^2(2) = 317.866$, $p < 0.001$) (Table
274 IV). Online purchases were more popular in the UK (42.6%) and China (44.5%) compared to
275 the US (31.9%) ($\chi^2(2) = 317.866$, $p < 0.001$).

276

277

278

279 *Sports bra preferences*

280 Compression style sports bras were most frequently worn (48.2%), followed by combination
281 (26.7%) and then encapsulation style bras (14.8%). Encapsulation bras were less popular
282 among US participants (9.2%), with more than twice as many US participants wearing a
283 mixture of different styles compared to the UK and China ($\chi^2(7) = 70.456, p < 0.001$). The
284 majority of participants preferred racer back style (58.0%), which was significantly more
285 popular in US participants (63.9%) ($\chi^2(2) = 17.685, p < 0.001$) (Table V).

286

287 Most participants preferred wide (60.1%), thick (padded) (40.0%) sports bra straps with
288 adjustability (58.2%) (Table V), although thin (padded) straps were the dominant choice among
289 Chinese participants (45.4%). Non-wired sports bras were more popular among US
290 participants (73.6%; $\chi^2(4) = 30.997, p < 0.001$), with the Chinese preferring padded/moulded
291 cups (62.6%; $\chi^2(4) = 129.567, p < 0.001$). There was a clear preference for nipple concealment
292 among all participants, however more US and UK participants preferred maximum coverage
293 (64.8% and 71.5%, respectively), compared to the majority of Chinese participants who did
294 not want maximum coverage (68.6%) ($\chi^2(6) = 1446.545, p < 0.001$). Around a third of
295 participants in each country reported no preference when considering sports bra colour (Table
296 V), although among UK participants black sports bras were significantly more popular
297 (32.3%), and multi-coloured sports bras less popular (17%), compared to those in the US and
298 China ($\chi^2(10) = 55.640, p < 0.001$). Less than 10% of participants in each country expressed a
299 preference for white, nude, or bright neon coloured sports bras.

300

301 *Table V near here*

302

303 During moderate and vigorous activity *Comfort*, *Support* and *Fit* were the top three rated sports
304 bra features in all countries, (Table VI). *Brand* and *Colour* were consistently ranked the least
305 important sports bra features. During moderate intensity activities, *Price* was less important in
306 China (ranked 9th) compared to US and UK (ranked 4th), although during vigorous intensity
307 activities was deemed more important (ranked 6th)(Table VI). Nike™ was the most popular
308 sports bra brand in each country (Table VII).

309

310 *Table VI near here*

311 *Table VII near here*

312

313 *Sports bra fit issues*

314 Most US (65.6%) and UK (64.1%) participants had never been professionally fitted for a sports
315 bra (Table IX) compared to 21.6% in China ($\chi^2(12) = 800.942$, $p < 0.001$). Around one fifth of
316 participants sports bra's did not meet their exercising needs, with no differences observed
317 between countries ($\chi^2(2) = 1.317$, $p = 0.518$). The most common fit issue was '*shoulder straps*
318 *dig into the skin*' (Table VIII). The bra fit issues '*rubbing or chaffing*' was reported by more
319 Chinese participants (33.6%) than US and UK participants ($\chi^2(2) = 20.242$, $p < 0.001$).

320

321 *Table VIII near here*

322

323 **Discussion**

324 The aim of this research was to establish and compare breast-related barriers to physical
325 activity, sports bra use, purchasing habits, sports bra preferences and sports bra fit issues in
326 three major global underwear markets (UK, US and China). Within these three populations,
327 mode bra size (34B) was the same, supporting previous UK and Chinese research (Burbage
328 and Cameron, 2017; Chen *et al.*, 2019). Despite this, nearly half (48.7%) of UK participants

329 were large-breasted (\geq D cup). More US participants wore larger band sizes (\geq 40 inches),
330 supporting reports of secular increases in US and UK bust circumferences (Brown and Scurr,
331 2016). Interesting trends in bra sizing are visible, with UK participants wearing smaller band
332 sizes, but a larger range of cup sizes, US participants wearing larger band sizes, but a smaller
333 range of cup sizes, and Chinese participants wearing smaller band and smaller cup sizes.
334 However, these outcomes should be viewed with caution as reported bra sizes may reflect the
335 availability of sizes, rather than the sizes required and the majority of US and UK participants
336 reported never having their sports bra fitted and reported fit issues. Additionally, self-reported
337 bra sizes may be inaccurate (Greenbaum *et al.*, 2003; McGhee and Steele, 2010; White and
338 Scurr, 2012), in fact 35% of Chinese participants surveyed by Chen *et al.* (2019) did not know
339 their bra size.

340

341 More UK participants undertook vigorous activity each week, despite reporting larger cup sizes
342 than the US and China. Not being able to find the right sports bra was the highest breast-related
343 barrier to activity, suggesting the current market is not meeting consumer needs. '*I can't find*
344 *the right sports bra*' was previously reported as the highest breast-related barrier to exercise
345 for UK participants (Burnett *et al.*, 2015), although prevalence was much lower (3%),
346 compared to this study (24.9%). This may suggest that not being able to find the right sports
347 bra is even more of an issue now than in 2015. This may have health implications for women
348 who are reported to avoid exercise due to breast discomfort, breast sag and embarrassment
349 caused by breast motion (Bowles *et al.*, 2008; Mason *et al.*, 1999; Page and Steele, 1999; Starr
350 *et al.*, 2005). Interestingly many more Chinese participants were embarrassed by the
351 appearance of their breasts during exercise, despite smaller ranges of cup and band sizes,
352 suggesting that this might be due to cultural differences, rather than larger breast sizes. The
353 increased sensitivity of Chinese participants to their breast appearance during exercise may

354 impact the type of bra appropriate for this market and should be considered by product
355 developers when designing sports bras for this population.

356

357 Sports bra use was lowest in the UK (67.1%) and highest in China (83.9%), signifying that
358 more needs to be done in the UK to increase awareness of wearing appropriate breast support
359 during exercise. Although a smaller study (n = 404) in China only reported a 40% uptake of
360 sports bras (Chen *et al.*, 2019); this may be due to differences in socioeconomic status, age and
361 breast size between populations surveyed. Interestingly, only 28.6% of Chinese participants
362 always wore a sports bra during exercise and less Chinese participants rated sports bras as
363 essential, despite owning more bras and paying more for their sports bras than US and UK
364 participants.

365

366 The greatest motivation to purchase sports bras across all countries was to exercise in comfort.
367 More UK participants wore a sports bra to reduce breast movement, perhaps related to the
368 larger cup size ranges reported in the UK. Interestingly, almost four times more Chinese
369 participants wore a sports bra because it matched their sportswear. This may have implications
370 for brands active in the Chinese market, suggesting that the sports bra should not be viewed as
371 a product in isolation, but should be designed and marketed alongside other sporting apparel.
372 Worryingly almost 30% of Chinese participants wore an everyday bra under their sports bra,
373 and nearly 10% wore two sports bras to exercise. As less Chinese participants wore a sports
374 bra to reduce breast movement this behaviour may be due to embarrassment when exercising.
375 Although it has been reported that a single, well fitted and supportive bra can considerably
376 reduce embarrassment when exercising (Scurr *et al.*, 2011). More US (78.9%) and UK (82.3%)
377 participants wore the same sports bra for all activities compared to Chinese participants
378 (44.3%). Research has promoted sport-specific bras due to biomechanical variations across

379 activities such as running, jumping and agility-tasks (Risius *et al.*, 2014), yet cost may be
380 prohibitive. Chinese participants owned more sports bras, had purchased them more recently
381 and replaced them more frequently; this may be linked to price being one of the lowest ranked
382 sports bra features among Chinese participants. To increase purchasing behaviours in more price
383 sensitive regions such as the US and UK, retailers could consider stocking lower priced
384 products or offering more promotions to these regions. Although differences in price sensitivity
385 should be viewed with caution due to differences in the cost of living between countries, and
386 as participant's socioeconomic status was unknown. Bra purchase locations also varied
387 between countries indicating different purchasing habits that may further affect marketing and
388 education strategies; notably, participants in the US favoured department stores (69%), sports
389 apparel shops in China, and supermarkets in the UK. Overall, 40% of participants purchased
390 sports bras online.

391
392 In all countries, compression sports bras were most popular. However, a lack of adjustability
393 in these garments is a criticism, and as compression bras are pulled on and off over the
394 shoulders they may stretch reducing their lifespan. The style worn may however be reflective
395 of availability rather than choice. Shoulder straps digging in or slipping off were the most
396 disliked features of sports bras (Bowles *et al.*, 2012), which may be why more participants
397 preferred racer-back (58%) or cross-over styles which avoid these issues. Most preferred wide
398 sports bra straps, although more US and UK participants wanted thick (padded) straps in
399 contrast to Chinese participants who preferred thinner straps. Non-wired sports bras were
400 preferred across all countries. If such a bra does not fit correctly and underwire digs in, it will
401 be uncomfortable, which may deter use (Bowles *et al.*, 2012). More Chinese participants
402 preferred padded/moulded cups compared to the US and UK, which is concurrent with Chinese
403 participants desire for nipple concealment. Although, interestingly, most Chinese participants

404 did not prefer a sports bra with maximum coverage, despite embarrassment due to excessive
405 breast movement being a larger exercise barrier for Chinese participants. This suggests that
406 sports bra styles in China need to conceal the nipple, but not provide too much coverage of the
407 breast/chest; these preferences are despite previous Chinese research, which concluded the
408 most effective sports bras had a high neckline and no padding (Zhou *et al.*, 2012). The
409 combination of functionality, comfort and fashion requirements creates increased challenges
410 for product developers and designers (Dhanapala, 2015). The findings of the current study
411 provide insight into some of the requirements for sports bra design and how these may differ
412 across the three markets investigated here.

413

414 For all participants, comfort was the most important sports bra feature, corresponding with
415 previous UK research (Risius *et al.*, 2014). Support was the second highest sports bra feature
416 desired by UK and US women, although material was more important than support in China,
417 which may reflect the smaller range of breast sizes in this population. Fit was the third highest
418 feature for all countries; despite this, many participants reported sports bra fit issues. To meet
419 consumer needs, and provide sports bras that are comfortable, supportive and fit appropriately,
420 future research is needed to guide breast support and bra design for exercising females. Overall
421 Nike™ had the largest sports bra market share (40%), followed by Adidas™ (28%), which is
422 reflective of their global dominance in the sports apparel industry. However, a wide range of
423 brands were reported, but Brand was ranked very low as a sports bra feature (8th to 10th out of
424 10 features), suggesting that participants are not necessarily loyal to particular sports bra
425 brands.

426

427 Most UK (64.1%) and US (65.6%) participants had never been professionally fitted for a sports
428 bra, which corresponds to previous UK research (Brown *et al.*, 2014; Burbage and Cameron,

2018). In contrast, over half of Chinese participants were professionally fitted for a sports bra in the last month, or last three months. It would be useful to understand how sports bra fittings are promoted in China, and why the uptake is much higher, although this may be explained by the majority of Chinese participants purchasing sports bras from sports apparel shops specifically. Despite the increased prevalence of sports bra fittings in China, more Chinese participants experienced sports bra fit issues, suggesting the fitting processes could be improved. Traditional tape measure bra fitting was the most popular fitting method (58.5%), however, this method is reported as inaccurate (White and Scurr, 2012) and instead professional best-fit criteria are promoted (McGhee and Steele, 2010; White and Scurr, 2012); ensuring participants have the knowledge to assess their own bra fit.

439

440 **Limitations**

441 This study has inherent limitations, which offer directions for future research. Firstly, the study is restricted to comparing US, UK and Chinese consumers. Future studies could extend the scope to include consumers from other countries. Secondly, other factors such as age, ethnicity, breast size and socioeconomic status were not included in the analysis. Future studies may seek to develop methods to evaluate the influence that these variables have on sports bra use, preferences and fit, which were beyond the scope of this study.

447

448 **Conclusion**

449 This is the first study to compare breast-related barriers to physical activity, sports bra use, purchasing habits, sports bra preferences and sports bra fit issues across large samples in the UK, US and China. Across the three markets, the most preferred sports bras were compression style, with a racer-back, non-wired and wide straps. In China participants had a smaller range of breasts sizes, purchased the most sports bras and were more likely to wear multiple bra

454 products whilst exercising. Thin straps, padded/moulded cups and nipple concealment was
455 preferred. US participants reported larger band sizes and preferred a racer-back, non-wired
456 compression style sports bra, with thick, padded straps and maximum coverage. UK
457 participants reported larger cup sizes yet were least engaged in sports bra use. Reducing breast
458 movement was perceived as the most important function of a sports bra, although participants
459 generally owned just one sports bra and wanted maximum breast coverage. Not being able to
460 find the right sports bra was the 8th (out of 24) highest barrier to exercise for all countries.
461 Sports bras were purchased to exercise in comfort. This study has reported interesting
462 differences in barriers to exercise across key global sports bra markets, with substantial
463 differences in sports bra use, purchasing habits, preferences and fit. The bra industry should
464 use this country-specific information to better understand consumer needs and target sports bra
465 design within each of these countries.

466 **References**

467 Bhandalkar, S. & Das, D. (2018), “Global women’s activewear market: Opportunity analysis
468 and industry forecast, 2018-2025”, available at: [https://www.alliedmarketresearch.com/womens-](https://www.alliedmarketresearch.com/womens-activewear-market)
469 [activewear-market](https://www.alliedmarketresearch.com/womens-activewear-market) (accessed 17 August 2020).

470 Boschma, A.C., Smith, G.A., and Lawson, L. (1996), “Breast support for the active woman:
471 relationship to 3D kinematics of running”, *Medicine and Science in Sports and Exercise*, Vol.
472 26, pp. 99.

473 Bowles, K.A. and Steele, J.R. (2013), "Effects of strap cushions and strap orientation on
474 comfort and sports bra performance", *Medicine and Science in Sports and Exercise*, Vol. 45
475 No. 6, pp.1113–1119.

476 Bowles, K.A., Steele, J. and Munro, B. (2008), “What are the breast support choices of
477 Australian participants during physical activity?”, *British Journal of Sports Medicine*, Vol. 42,
478 pp.670-673.

479 Bowles, K.A., Steele, J.R. and Munro, B.J. (2012), “Features of sports bras that deter their use
480 by Australian women”, *Journal of Science and Medicine in Sport*, Vol. 15 No.3, pp.195-200.

481 Brown, N. and Scurr, J. (2016), “Breasts are getting bigger. Where is the evidence?”, *Journal*
482 *of Anthropological Sciences*, Vol. 94, pp.237-244.

483 Brown, N., Burnett, E. and Scurr, J. (2016), “Is breast pain greater in active females compared
484 to the general population in the UK?”, *The Breast Journal*, Vol. 22 No. 2, pp.194-201.

485 Brown, N., Smith, J., Brasher, A., Risius, D., Marczyk, A., and Wakefield-Scurr, J. (2018),
486 “Breast health education for schoolgirls: why, what, when and how?”, *The Breast Journal*, Vol.
487 24(3), pp.377-382.

488 Brown, N., White, J., Brasher, A. and Scurr, J. (2014), “An investigation into breast support
489 and sports bra use in female runners of the 2012 London Marathon”, *Journal of Sports*
490 *Sciences*, Vol. 32 No. 9, pp.801-809.

491 Bridgman, C., Scurr, J., White, J., Hedger, W. and Galbraith, H. (2010), "Three-dimensional
492 kinematics of the breast during a two-step star jump", *Journal of Applied Biomechanics*, Vol.
493 26 No. 4, pp.465–472.

494 Burbage, J. and Cameron, L. (2017), "An investigation into the prevalence and impact of breast
495 pain, bra issues and breast size on female horse riders", *Journal of Sports Sciences*, Vol. 35 No.
496 11, pp.1091–1097.

497 Burbage, J., and Cameron, L. (2018). “An investigation of bra concerns and barriers to
498 participation in horse riding”, *Comparative Exercise Physiology*, Vol. 14 No. 1, pp.1-10.

499 Burnett, E., White, J. and Scurr, J. (2015), "The influence of the breast on physical activity
500 participation in females", *Journal of Physical Activity and Health*, Vol. 12 No. 4, pp.588–594.

501 Chen, X., Wang, J., Wang, Y., Gho, S.A. and Steele, J.R. (2019), "Breast pain and sports bra
502 usage reported by Chinese women: why sports bra education programs are needed in China",
503 *Fibres and Textiles in Eastern Europe*, Vol. 27 No. 4 (136), pp.17–22.

504 Dhanapala, S. (2015), “An overview of the sportswear market, in Hayes,S.G., Venkatraman,
505 P. (Eds.), *Materials and Technology for Sportswear and Performance Apparel*. CRC Press:
506 Boca Raton, FL; pp.1-22.

507 Greenbaum, A.R., Heslop, T., Morris, J. and Dunn, K.W. (2003), "An investigation of the
508 suitability of bra fit in women referred for reduction mammoplasty", *British Journal of Plastic
509 Surgery*, Vol. 56 No. 3, pp.230-236.

510 Lorentzen, D. and Lawson, L. (1987), "Selected sports bras: a biomechanical analysis of breast
511 motion while jogging", *The Physician and Sportsmedicine*, Vol. 15 No. 5, pp.128-139.

512 Marci, K. (2020), "The lingerie market explained in 7 charts", available at:
513 <https://edited.com/resources/lingerie-market-2/> (accessed 17 August 2020).

514 Mason, B., Page, K. and Fallon, K. (1999), "An analysis of the movement and discomfort of
515 the female breast during exercise and the effects of breast support in three case studies",
516 *Journal of Science and Medicine in Sport*, Vol. 2, pp.134-144.

517 McGhee, D.E. and Steele, J.R. (2010), "Optimising breast support in female patients through
518 correct bra fit. A cross-sectional study", *Journal of Science and Medicine in Sport*, Vol. 13 No.
519 6, pp.568-572.

520 McGhee, D.E., Steele, J.R., and Munro, B.J. (2010), "Education improves bra knowledge and
521 fit, and level of breast support in adolescent female athletes: a cluster-randomised
522 trial", *Journal of Physiotherapy*, Vol. 56(1), pp. 19-24.

523 McGhee, D.E., Steele, J.R., Zealey, W.J. and Takacs, G.J. (2013), "Bra-breast forces generated
524 in women with large breasts while standing and during treadmill running: Implications for
525 sports bra design", *Applied Ergonomics*, Vol 44 No. 1, pp.112–8.

526

527

528 NPD, (2019). The evolution of bra shopping, available at:
529 [https://www.npd.com/wps/portal/npd/us/news/press-releases/2019/shopping-for-a-bra-is-](https://www.npd.com/wps/portal/npd/us/news/press-releases/2019/shopping-for-a-bra-is-more-about-comfort-than-sexiness--reports-npd/)
530 [more-about-comfort-than-sexiness--reports-npd/](https://www.npd.com/wps/portal/npd/us/news/press-releases/2019/shopping-for-a-bra-is-more-about-comfort-than-sexiness--reports-npd/)
531 <https://edited.com/resources/lingerie-market-2/>
532
533 O'Connell, L. (2019), "Women's activewear market value worldwide from 2017 to 2025
534 (in million U.S. dollars)", available at: [https://www.statista.com/statistics/1040979/](https://www.statista.com/statistics/1040979/women-s-activewear-market-value-worldwide/)
535 [women-s-activewear-market-value-worldwide/](https://www.statista.com/statistics/1040979/women-s-activewear-market-value-worldwide/) (accessed 17 Aug 2020).
536 Page, K. and Steele, J. (1999), "Breast motion and sports bra design: implications for future
537 research", *Sports Medicine*, Vol. 27, pp.205-211. Pechter, E.A. (1998), "A new method for
538 determining bra size and predicting postaugmentation breast size", *Plastic and Reconstructive*
539 *Surgery*, Vol. 102(4), pp. 1259–1265.
540 Rafiq, M. and Jaafar, H.S. (2007), "Measuring customers' perceptions of logistics service of
541 3PL service providers", *Journal of Business Logistics*, Vol. 28, No. 2, pp.159–175.
542 Risius, D., Milligan, A., Mills, C. and Scurr, J. (2015), "Multiplanar breast kinematics during
543 different exercise modalities", *European Journal of Sport Science*, Vol. 15 No. 2, pp.111–117.
544 Scurr, J., White, J. and Hedger, W. (2010), "The effect of breast support on the kinematics of
545 the breast during the running gait cycle", *Journal of Sport Sciences*, Vol. 29, pp.55-61.
546 Scurr, J., White, J. and Hedger, W. (2011), "Supported and unsupported breast displacement
547 in three dimensions across treadmill activity levels", *Journal of Sports Sciences*, Vol. 29 No.
548 1, pp.55–61.

549 Scurr, J., Brown, N., Smith, J., Brasher, A., Risius, D. and Marczyk, A. (2016), “The influence
550 of the breast on sport and exercise participation in schoolgirls in the UK”, *Journal of*
551 *Adolescent Health*, Vol. 58 No. 2, pp.167-173.

552 Starr, C., Branson, D., Shehab, R., Farr, C., Ownbey, S. and Swinney, J. (2005),
553 “Biomechanical analysis of a protocol type sports bra”, *Journal of Textile and Apparel*
554 *Technology and Manufacture*, Vol. 4, pp.1–14.

555 Vehovar, V. and Manfreda, K.L (2008), “Overview: online surveys”, in Fielding, M., Lee,
556 R.M., Blank, G. (Eds.), *The SAGE handbook of online research methods*, SAGE Publications:
557 London, UK; pp.177-194.

558 White, J. and Scurr, J. (2012), “Evaluation of professional bra fitting criteria for bra selection
559 and fitting in the UK”. *Ergonomics*, Vol. 55 No. 6, pp.704-711.

560 White, J., Scurr, J., and Hedger, W. (2011), “A comparison of three-dimensional breast
561 displacement and breast comfort during overground and treadmill running”, *Journal of Applied*
562 *Biomechanics*, Vol. 27 No. 1, pp.47-53.

563 White, J., Scurr, J. and Smith, N. (2009), “The effect of breast support on kinetics during
564 overground running performance”, *Ergonomics*, Vol. 52 No. 4, pp.492-498.

565 White, J., Mills, C., Ball, N. and Scurr, J. (2015), “The effect of breast support and breast pain
566 on upper-extremity kinematics during running: implications for females with large breasts”,
567 *Journal of Sports Sciences*, Vol. 33 No. 10, pp.2043-2050.

568 WinterGreen Research (2020), “Sports bra: Market shares, strategies, and forecasts,
569 worldwide, 2020 to 2026”, available at: <https://www.reportlinker.com/p05841313/Sports-Bra->

570 [Market-Shares-Strategies-and-Forecasts-Worldwide-to.html?utm_source=PRN](#) (accessed 17
571 August 2020).

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

574 Zhou, J., Yu, W. and Ng, S-P. (2012), "Identifying effective design features of commercial
575 sports bras", *Textile Research Journal*, Vol. 83 No. 14, pp.1500–1513.

576

577

578

579

580

581

582

583

584

585

586

587

588 **Table I.** Distribution of US, UK and China participants self-reported bra size (underband and cup)

589 (n = 2869). Mode size highlighted.

Underband (inches)	Cup size													Total		
	AA	A	B	C	D	DD/ E	DD D/F/ FF	G/G G	H/H H	J	K	L				
24			1													1
26																0
28				1												1
30				1	1	1	1									4
32		15	35	32	14	5	2									103
34		26	120	85	44	22	5									302
36		11	66	114	43	24	10		2							270
38		3	28	57	48	24	5									165
40		1	6	15	22	13	2									59
42			3	11	12	7	5	1		1			2			42
44			2	7	7	12	5	1	1							35
46				1	1	2	1	1								6
48			1	1	1	5										8
50					2		1									3
52				1			1									2
54																0
56																0
58																0
Total		0	57	263	325	195	115	37	3	3	1	0	2			1001
24																0
26																0
28							2									2
30		2	3		1	3	3		1							13
32	3	26	37	25	18	23	4	1	2	1						140
34		22	93	76	50	59	15	10		1						326
36		11	58	79	61	53	7	4	2	1						276
38		2	19	22	34	35	7	6								125
40		1	5	13	17	21	9	3	2							71
42			2	2	6	5	2		1							18
44			1	2	2	4	1	1								11
46																0
48												1				1
50							1									1
52					1											1
54												1				1
56			1													1
58					1											1
Total		3	64	219	219	191	206	48	25	8	3	2	0			988
24																0
26																1
28			7	6	1											14
30			19	28	9	1										57
32		49	64	41	5	1										160
34		45	151	113	11	3										323
36		20	92	74	11											197
38		7	24	31	6											68
40			1	6	1											8
42			2	27	1											30
44				1												1
46				15												15
48				2												2
50		1		1												2
52			1													1
54																0
56																0
58					1											1
Total		0	148	369	323	36	4	0	0	0	0	0	0	0	0	880

590

591 **Table II.** Percentage of the population who report each barrier to physical activity and the rank order
 592 of each barrier reported in the US (n = 1060), UK (n = 1049[†]) and China (n = 995[†])

Barrier to physical activity	Response (%)				χ^2
	US (n = 1060)	UK (n = 1049*)	China (n = 995 [†])	All (n = 3104 [†])	
I need to rest or relax in my spare time	36.1 ^{3a}	40.4 ^{2a}	51.7 ^{1 b}	43.3 ¹	71.017*
I'm not the sporty type	44.2 ^{1a}	43.5 ^{1a,b}	22.4 ^{11a}	37.0 ²	133.570*
There's no one to do it with	35.8 ^{4a}	34.1 ^{5a,b}	30.1 ^{2b}	33.4 ³	8.126*
I haven't got the energy	42.0 ^{2a}	34.7 ^{4b}	22.0 ^{12c}	33.1 ⁴	94.204*
I haven't got the time	32.5 ^{5a}	37.2 ^{3a}	27.4 ^{5b}	32.5 ⁵	22.100*
I'd never keep it up	32.2 ^{6a}	30.7 ^{6a}	25.4 ^{6b}	29.5 ⁶	12.228*
I've got young children to look after	28.0 ^{8a}	31.2 ^{7a}	27.6 ^{4a}	29.0 ⁷	3.797
I can't find the right sports bra	28.8 ^{7a}	25.1 ^{11a,b}	22.0 ^{12b}	25.4 ⁸	12.472*
I'm too shy or embarrassed	25.8 ^{9a}	31.2 ^{7b}	17.8 ^{14c}	25.1 ⁹	49.226*
I don't have time because of my work	20.9 ^{11a}	25.3 ^{10b}	27.5 ^{3b}	24.9 ¹⁰	16.445*
I don't like the look of my breasts when I exercise	19.1 ^{17a}	23.6 ^{12b}	23.3 ^{10a,b}	22.0 ¹¹	8.010*
I can't afford it	25.7 ^{10a}	28.5 ^{9a}	10.9 ^{20b}	21.9 ¹²	165.570*
I haven't got the right clothes or equipment	20.1 ^{12a,b}	19.3 ^{15a}	24.0 ^{8b}	21.1 ¹³	7.888*
I am too fat	20.0 ^{14a}	22.4 ^{13a}	15.3 ^{18b}	19.3 ¹⁴	17.160*
My breasts are too big	19.2 ^{16a}	20.0 ^{14a}	16.4 ^{15a}	18.6 ¹⁵	4.846
I am embarrassed by excessive breast movement	14.4 ^{19a}	18.3 ^{17b}	23.4 ^{9c}	18.6 ¹⁶	27.437*
There are no suitable facilities nearby	13.8 ^{20a}	15.1 ^{20a}	25.2 ^{7b}	17.9 ¹⁷	54.417*
My health is not good enough	16.1 ^{18a}	18.7 ^{16a}	15.0 ^{19a}	16.6 ¹⁸	5.351
I don't enjoy physical activity	19.9 ^{15a}	17.8 ^{18a}	9.9 ^{21b}	15.8 ¹⁹	41.710*
I have an injury or disability that stops me	20.1 ^{12a}	17.1 ^{19a}	7.3 ^{22b}	15.0 ²⁰	70.985*
I suffer with breast pain	10.0 ^{23a}	13.0 ^{22a,b}	16.2 ^{16b}	13.0 ²¹	17.356*
I might get injured or damage my health	10.3 ^{22a}	12.1 ^{23a,b}	15.5 ^{17b}	12.6 ²²	12.907*
I'm too old	10.8 ^{21a}	13.3 ^{21a}	7.0 ^{23b}	10.4 ²³	21.927*
Other	5.2 ²⁴	5.2 ²⁴	6.2 ²⁴	5.5 ²⁴	

593 [†]one participant from the UK and 45 participants from China did not provide responses.

594 Barriers highlighted grey are breast specific barriers. Superscript numbers denote the rank order of
 595 barriers reported.

596 *denotes significant difference between countries at 0.05 level. Values in the same horizontal row not
 597 marked with the same superscript letter are significantly different at 0.01 level

598

599

600

601 **Table III.** For participants that reported wearing a sports bra, the frequency, perceived importance and
 602 reason for sports bra use during exercise in the US (n = 795), UK (n = 705) and China (n = 870).

	Response (%)				χ^2
	US (n = 795)	UK (n = 705)	China (n = 870)	All (n = 2370)	
Frequency of sports bra use					
Rarely	2.9 ^a	4.4 ^a	4.0 ^a	3.8	137.380*
Sometimes	18.5 ^a	20.7 ^{a,b}	23.6 ^a	21.0	
Very Often	25.3 ^a	24.8 ^a	43.8 ^b	31.9	
Always	53.3 ^a	50.1 ^a	28.6 ^b	43.3	
Perceived importance of sports bra use					
Not at all important	1.9 ^a	1.7 ^a	1.0 ^a	1.5	38.447*
Somewhat important	14.3 ^a	12.3 ^a	14.6 ^a	13.8	
Very important	36.7 ^a	40.4 ^a	49.5 ^b	42.5	
Essential	47.0 ^a	45.5 ^a	34.8 ^b	42.1	
Reason for sports bra use					
Enables me to exercise in comfort	76.1 ^a	65.1 ^b	67.2 ^b	69.6	24.883*
Reduces breast movement	70.4 ^a	68.9 ^a	46.0 ^b	61.0	130.996*
Reduces breast pain	32.6 ^a	37.2 ^a	35.9 ^a	35.1	3.753
Less embarrassing	21.0 ^a	25.7 ^a	38.0 ^b	28.6	63.352*
It improves my sporting performance	23.0 ^a	21.1 ^a	38.4 ^b	28.1	72.688*
I like the way it looks	25.7 ^a	18.9 ^b	24.7 ^a	23.3	11.211*
Matches my sportswear	13.0 ^a	9.9 ^a	38.0 ^b	21.3	232.210*
I don't know	1.8 ^a	2.3 ^a	1.0 ^a	1.6	3.768
Wear an everyday (fashion bra) under sports bra					
Yes	10.8 ^a	13.3 ^a	28.4 ^b	18.0	130.000*
No	79.1 ^a	74.0 ^a	55.9 ^b	69.0	
Sometimes	10.1 ^a	12.6 ^{a,b}	15.7 ^b	12.9	
Wear two sports bras					
Yes	5.8 ^a	8.9 ^{a,b}	9.8 ^a	8.2	25.406*
No	84.4 ^a	84.4 ^a	78.2 ^b	82.2	
Sometimes	9.8 ^a	6.2 ^b	12.1 ^a	9.6	
Wear different sports bra styles for different sports/activities					
Yes	21.1 ^a	17.7 ^a	55.7 ^b	32.8	329.440*
No	78.9 ^a	82.3 ^a	44.3 ^b	67.2	

603 *denotes significant difference between countries at 0.05 level. Values in the same horizontal row not

604 marked with the same superscript letter are significantly different at the 0.01 level

605

606 **Table IV.** For those that reported wearing a sports bra; when participants last purchased a sports bra
 607 and how often participants replace their sports bra in the US (n = 795), UK (n = 705) and China (n =
 608 870).

Sports bra purchase and replacement	Response (%)				χ^2
	US (n = 795)	UK (n = 705)	China (n = 870)	All (n = 2370)	
Sports bra purchase					
In the last month	22.6 ^a	21.0 ^a	46.6 ^b	30.9	267.961*
Last three months	26.3 ^a	29.2 ^{a,b}	33.4 ^b	29.8	
Last six months	14.1 ^a	15.0 ^a	8.7 ^b	12.4	
Within the last year	16.7 ^a	15.3 ^a	5.6 ^b	12.2	
Over a year ago	14.8 ^a	14.6 ^a	2.4 ^b	10.2	
Can't remember	5.4 ^a	4.8 ^a	3.2 ^a	4.4	
Sports bra replacement					
Every 3 months	11.4 ^a	15.0 ^a	51.7 ^b	27.3	538.945*
Every 6 months	21.3 ^a	25.5 ^a	25.9 ^a	24.2	
At least once a year	31.3 ^a	29.5 ^a	6.7 ^b	21.7	
Over a year ago	15.8 ^a	12.6 ^a	4.1 ^b	10.6	
I can't remember	13.8 ^a	8.8 ^b	8.0 ^b	10.2	
I have never replaced my sports bra	6.3 ^a	8.5 ^a	3.6 ^b	5.9	

609 *denotes significant difference between countries at 0.05 level. Values in the same horizontal row not
 610 marked with the same superscript letter are significantly different at the 0.01 level

611

612

613 **Table V.** For participants that report wearing a sports bra; sports bra preferences (%) for style,
 614 components and colour in the US (n = 795), UK (n = 705) and China (n = 870).

	Preference (%)				χ^2
	US (n = 795)	UK (n = 705)	China (n = 870)	All (n = 2370)	
Sports bra strap configuration					
Racer back	63.9 ^a	53.9 ^b	56.0 ^b	58.0	17.685*
Cross-over	27.7 ^a	23.8 ^a	39.4 ^b	30.8	50.044*
T-back	24.8 ^a	16.6 ^b	30.6 ^c	24.5	41.232*
U-back	12.5 ^a	14.6 ^a	22.3 ^b	16.7	32.113*
Vertical back	17.4 ^a	15.3 ^a	15.7 ^a	16.2	1.320
Adjustable combination	10.2 ^{a,b}	7.9 ^b	12.5 ^a	10.4	8.849*
No preference	14.2 ^a	14.8 ^a	9.0 ^b	12.4	15.390*
Other	1.0	0.1	0.5	0.5	
Sports bra strap thickness					
Wide	58.7 ^a	62.8 ^a	59.2 ^a	60.1	4.036
Narrow	17.0 ^a	13.9 ^a	16.6 ^a	15.9	
No preference	24.3 ^a	23.3 ^a	24.3 ^a	24.0	
Sports bra strap padding					
Thick (padded)	42.8 ^a	51.2 ^b	28.4 ^c	40.0	114.594*
Thin	32.2 ^a	22.6 ^b	45.4 ^c	34.2	
No preference	25.0 ^a	26.2 ^a	26.2 ^a	25.8	
Adjustable shoulder straps and underband					
Yes	51.4 ^a	58.4 ^b	64.1 ^b	58.2	50.532*
No	27.0 ^a	17.9 ^b	13.9 ^b	19.5	
No preference	21.5 ^a	23.7 ^a	22.0 ^a	22.3	
Underwire					
Yes	15.0 ^a	21.1 ^b	17.8 ^{a,b}	17.8	30.997*
No	73.6 ^a	62.4 ^b	63.7 ^b	66.6	
No preference	11.4 ^a	16.5 ^b	18.5 ^b	15.5	
Padding/moulded cups					
Yes	43.4 ^a	42.1 ^a	62.6 ^b	50.1	129.567*
No	41.3 ^a	38.7 ^a	18.3 ^b	32.1	
No preference	15.3 ^a	19.1 ^a	19.1 ^a	17.8	
Maximum coverage					
Yes	64.8 ^a	71.5	0.0	43.0	1446.545*
No	13.0 ^a	5.8	68.6	27.9	
I prefer low cut tops	12.6 ^a	6.2	16.1	12.0	
No preference	19.6 ^a	16.5	15.3	17.1	
Nipple concealment					
Essential	37.7 ^a	31.8 ^b	41.1 ^a	37.2	122.281*
Very important	31.7 ^a	30.9 ^a	43.3 ^b	35.7	
Important	15.5 ^a	18.0 ^a	10.2 ^b	14.3	
Somewhat important	9.7 ^a	10.5 ^a	4.3 ^b	7.9	

Not at all important	5.4 ^a	8.8 ^a	1.0 ^c	4.8	
Sports bra colour					
No preference	32.5 ^a	28.6 ^a	29.3 ^a	30.2	
Black	22.9 ^a	32.3 ^b	23.8 ^a	26.0	
Multicolours	23.3 ^a	17.0 ^b	29.0 ^c	23.5	55.640*
Bright neon colours	9.9 ^a	7.5 ^a	7.4 ^a	8.3	
White	5.3 ^a	8.8 ^b	6.2 ^{a,b}	6.7	
Nude	6.2 ^a	5.8 ^a	4.3 ^a	5.4	

615 *denotes significant difference between countries at 0.05 level. Values in the same horizontal row not

616 marked with the same superscript letter are significantly different at the 0.01 level

617

618

Accepted version

619 **Table VI.** Meanrank and rank order of important sports bra features (1 = most important, 10 = least
 620 important) during moderate-intensity activities and vigorous-intensity activities reported by participants
 621 in the US (n = 789), UK (n = 700) and China (n = 2356).

Sports bra feature	US (n = 789)	UK (n = 700)	China (n = 867)	All (n = 2356)
Importance during moderate-intensity activity				
Comfort	2.87 ¹	3.08 ¹	3.34 ¹	3.11 ¹
Support	3.63 ³	3.72 ³	4.38 ²	3.93 ²
Fit	3.52 ²	3.39 ²	4.76 ³	3.94 ³
Material	5.98 ⁵	6.10 ⁷	5.10 ⁴	5.69 ⁴
Price	5.07 ⁴	5.51 ⁴	6.70 ⁹	5.80 ⁵
Shape	6.09 ⁶	5.82 ⁵	5.95 ⁶	5.96 ⁶
Adjustability	6.36 ⁸	6.03 ⁶	5.58 ⁵	5.98 ⁷
Lift	6.27 ⁷	6.36 ⁸	6.03 ⁷	6.21 ⁸
Brand	7.69 ¹⁰	7.52 ⁹	6.26 ⁸	7.12 ⁹
Colour	7.50 ⁹	7.46 ¹⁰	6.89 ¹⁰	7.26 ¹⁰
Sports bra feature	US (n = 608)	UK (n = 649)	China (n = 798)	All (n = 2055)
Importance during vigorous-intensity activity				
Comfort	3.11 ¹	3.42 ²	3.52 ¹	3.37 ¹
Support	4.02 ³	4.00 ³	4.65 ²	4.26 ³
Fit	3.12 ²	3.16 ¹	4.70 ³	3.74 ²
Material	5.94 ⁷	6.27 ⁸	5.36 ⁴	5.82 ⁶
Adjustability	5.78 ⁴	6.19 ⁷	6.82 ¹⁰	6.32 ⁸
Lift	5.89 ⁵	5.81 ⁶	5.93 ⁷	5.88 ⁷
Shape	5.92 ⁶	5.67 ⁴	5.41 ⁵	5.64 ⁴
Price	5.99 ⁸	5.77 ⁵	5.56 ⁶	5.75 ⁵
Brand	7.62 ¹⁰	7.46 ¹⁰	6.34 ⁸	7.07 ⁹
Colour	7.61 ⁹	7.26 ⁹	6.70 ⁹	7.15 ¹⁰

622 Superscript numbers denote barrier rank order.

623

624

625 **Table VII.** For those that reported wearing a sports bra; the percentage of participants that
 626 frequently wear each sports bra brand and the rank order of sports bra brands worn in the US
 627 (n = 795), UK (n = 705) and China (n = 870).

Brand	Response (%)			
	US (n = 795)	UK (n = 705)	China (n = 870)	All (n = 2370)
Nike	40.9 ¹	39.4 ¹	39.1 ¹	39.8 ¹
Adidas	22.9 ³	27.0 ²	32.3 ²	27.6 ²
Under Armour	24.2 ²	8.5 ¹⁰	14.4 ⁹	15.9 ³
Victoria Secret	22.0 ⁵	7.0	12.5	14.1 ⁴
New Balance	14.1 ⁸	9.6 ⁶	16.3 ⁴	13.6 ⁵
Reebok	15.2 ⁶	15.7 ³	9.5	13.3 ⁶
Puma	9.1 ⁹	12.1 ⁴	15.4 ⁶	12.3 ⁷
Triumph	1.0	9.1 ⁹	21.0 ³	10.8 ⁸
Champion	22.4 ⁴	4.1	4.3	10.3 ⁹
H&M	5.0	11.6 ⁵	13.2 ¹⁰	10.0 ¹⁰
I don't know	14.2 ⁷	9.5 ⁷	3.3	8.8
Athleta	6.7 ¹⁰	1.3	7.2	5.3
Amoena	0.9	1.1	10.2	4.4
Shock Absorber	1.09	9.1 ⁸	2.6	4.0
Lululemon	4.2	2.0	3.9	3.4
Zella	1.8	1.8	5.7	3.2
Berlei	1.1	2.3	3.0	2.2
Freya Active	0.9	2.3	2.9	2.0
Title Nine	0.9	1.6	3.2	1.9
Brooks/Moving Comfort	1.5	1.1	2.5	1.8
Panache	1.1	1.8	2.2	1.7
Enell	0.8	1.6	2.2	1.5
Other	13.7	16.9	4.8	11.4
Decathlon	-	-	16.0 ⁵	5.9*
Anta	-	-	14.9 ⁷	5.5*
Li Ning	-	-	14.5 ⁸	5.3*
Xtep	-	-	11.0	4.1*

628 Superscript numbers denote brand rank

629 *denotes brands that were added for the China survey

630

631

632 **Table VIII.** When participants were last professionally fitted for a sports bra in the US (n = 1060), UK
 633 (n = 1050) and China (n = 1037).

	Response (%)				χ^2
	US (n = 1060)	UK (n = 1050)	China (n = 1037)	All (n = 3147)	
Last professional sports bra fit					
In the last month	4.5 ^a	4.7 ^a	28.8 ^b	12.6	800.942*
Last three months	6.6 ^a	7.0 ^a	25.0 ^b	12.8	
Last six months	4.7 ^a	6.1 ^{a,b}	8.5 ^b	6.4	
Within the last year	5.8 ^a	4.9 ^a	2.2 ^b	4.4	
Over a year ago	6.7 ^a	6.9 ^a	5.0 ^a	6.2	
Can't remember	6.0 ^a	6.2 ^{a,b}	8.9 ^b	7.0	
I have never been fitted	65.6 ^a	64.1 ^a	21.6 ^b	50.6	
Sports bra issues					
Shoulder straps dig into the skin	39.6 ^a	32.5 ^a	32.9 ^a	35.1	6.025
Rubbing or chafing	26.1 ^a	21.9 ^a	33.6 ^b	27.6	20.242*
Poor posture (as a result of bra use)	17.0 ^a	17.1 ^a	34.5 ^b	23.1	93.298*
Underwire digs into skin	25.0 ^a	20.0 ^a	23.1 ^a	22.8	3.594
Upper body muscle pain (as a result of bra use)	19.1 ^a	20.3 ^{a,b}	24.2 ^b	21.3	9.664*
Other	13.0 ^a	7.9 ^a	10.1 ^a	10.3	5.435

634 *denotes significant difference between countries at 0.05 level. Values in the same horizontal row not

635 marked with the same superscript letter are significantly different at the 0.05 level