An investigation into breast support and sports bra use in female runners of the 2012 London Marathon

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Abstract

Although it is acknowledged that appropriate breast support during exercise is important, no published literature has assessed breast support usage in a cohort of female marathon runners. This study aimed to identify sport bra use and perceived importance of sports bra use in female marathon runners. Bra satisfaction, incidence of bra related issues and factors that influence the appropriateness of sports bras were also investigated. A 4-part, 30-question survey was administered to 1397 female runners at the 2012 London marathon registration and via an online survey. In total 1285 surveys were completed. Sports bra use and its perceived importance was high, however was lower in moderate compared to vigorous activity, and lower in participants with smaller breasts. Seventy-five per cent of participants reported bra fit issues. The most common issues were chaffing and shoulder straps digging in, with a higher incidence of issues reported by participants with larger breasts. Use of professional bra fitting was low, and perceived knowledge of breast health was poor. Engagement with sports bra use is high although sports bra design could be improved to alleviate bra fit issues experienced by female runners. Educational initiatives are needed to ensure females are informed regarding the importance of breast support and appropriate bra fit during activity.

Introduction

Participation levels in running have increased dramatically in recent years with an estimated 30 million runners worldwide (Harding, Swait, Johnson, & Cunliffe, 2009). More specifically, increased popularity in marathon running has been observed among individuals of all ages and abilities (Fredericson & Misra, 2007; Harding et al., 2009; Lieberman & Bramble, 2007). Females represent the marathon group with the largest growth (Chorley, Cianca, Divine & Hew, 2002), and a record 35.6% of 2012 London marathon finishers were female. Therefore, it is important to investigate factors that may influence female participation and performance during such events.

Being unique to the female, the breast is an evolving area of research in sports science and medicine. The effectiveness of appropriate breast support (sports bra) at reducing breast motion is recognised (Mason, Page, & Fallon, 1999; Page & Steele, 1999; Scurr, White, & Hedger, 2009; Scurr, White, & Hedger, 2011). Moreover, White, Scurr, and Smith (2009) suggested that breast support may alter running kinetics and kinematics, which may have implications for females running performance. Research on sports bra use during physical activity within the general community has been reported to be as low as 41% (Bowles, Steele, & Munro, 2008). However, to date, no literature has assessed sports bra use or levels of understanding of appropriate breast support in marathon runners, and the breast support needs of females participating in these endurance events are unknown. It is important to investigate these issues as the greatest strain (Haake & Scurr, 2011) and force (Mason et al., 1999) on the breast has been found to occur when an individual is running (compared to standing, walking and free jumping).

The appropriateness of a sports bra is yet to be determined in the literature and may be effected by a variety of factors, including (but not limited to), the type, style, fit and age of the bra and its thermal properties. Bra fit and sports bra replacement may be particularly important factors to consider for females participating in high volumes of exercise, such as when training for a marathon. It has been established that poorly fitted bras can lead to physical discomfort or more serious health problems, such as muscle fatigue or mastalgia (Chen, LaBar, & Bye, 2011). However, it is acknowledged that women do not always wear the correct-sized bra (McGhee & Steele, 2010a; Pechter, 1998; Wood, Cameron, & Fitzgerald, 2008).

In a study of 103 women referred for reduction mammoplasty, all women who reported wearing a bra (n = 102), were found to wear the wrong-sized bra (Greenbaum, Heslop, Morris, & Dunn, 2003). White and Scurr (2012) identified common bra fitting mistakes to be looseness in the underband of the bra and tightness in the bra cup. Furthermore, in a study of 115 adolescents, 25% reported knowingly wearing an incorrectly fitting bra during vigorous exercise (McGhee, Steele, & Munro, 2010). It is also recognised that although a bra may fit appropriately at the time of purchase, this may not be the case months or years later as the shape and structure of the bra may deteriorate with age, use and laundering (Pechter, 1999). Evidence-based standards to quantify how often a sports bra should be replaced have yet to be established. Anecdotally, it

has been suggested that a sports bra should be replaced after 100 workouts or 8 to 10 months of regular use (whichever comes first), or as frequently as footwear is replaced.

In addition to appropriate bra fit and sports bra replacement, the type of sports bra used by female marathon runners warrants investigation. Compression bras flatten the breasts and evenly distribute their mass across the chest, while encapsulation bras support each breast separately (Page & Steele, 1999). Additionally, combination bras are now available that both encapsulate and compress the breasts.

Previous research has claimed that encapsulation bras are more effective in reducing vertical breast displacement than compression bras (Gehlsen & Albohm, 1980; Lorentzen & Lawson, 1987; Starr et al., 2005). However, recent research has challenged these claims reporting no significant difference in the performance of these bra types with regard to reducing vertical breast displacement (McGhee & Steele, 2010b; White et al., 2009). Thus, identifying female's personal bra preference may be important with regard to consumer habits. It is also important to consider female marathon runners' satisfaction with current sports bra design, as dissatisfaction may lead to reduced sales and deter sports bra use. Without appropriate breast support (such as a sports bra), excessive breast motion during physical activity may result in pain and discomfort (Mason et al., 1999; Page & Steele, 1999; Scurr et al., 2011; White, Scurr, & Hedger, 2011).

Factors that may influence bra satisfaction may include issues experienced with particular bra components. For example, shoulder straps bear much of the load generated by exercise-induced breast movement (Campbell, Munro, Wallace, & Steele, 2007) and have been identified as the main features of sports bras that women disliked (Bowles et al., 2008; Bowles, Steele, & Munro, 2012). To prevent rubbing, chafing and abrasion injuries, seamless cups and fabric coverings of fasteners, hooks and underwire are important considerations of sports bra design (Page & Steele, 1999) and may be of particular importance for female marathon runners due to the repetitive motion of the breast during running.

In summary, female participation in marathon running has increased exponentially in recent years. To date, however, no literature has assessed breast support considerations for female marathon runners. Therefore, this study aims to survey females participating in the 2012 London marathon in order to:

- assess the perceived importance and use of sports bras.
- identify satisfaction with current sports bra design and incidence of bra issues.
- understand factors that might influence the appropriateness of sports bras, such as lack of knowledge, not replacing sports bras, inappropriate fit and choice of bra style.

Methods

Setting

Following institutional ethical approval, a team of 10 researchers distributed a self-administered 5-page survey (including participant information sheet) to a convenience sample of female volunteers passing through the registration zone of the 2012 London Marathon Exhibition. The researchers worked in rotation so that 3 to 4 researchers were administering surveys throughout the 4-day registration period. All researchers followed a standardised script when approaching potential participants to minimise selection bias. To ensure a high return, rate surveys were completed immediately in a designated area of the registration zone and collected. All data were anonymous.

Survey

The survey was designed to take no more than 10 min to complete and included multiple-choice, Likert scale, visual analogue scale and free-text format questions. Section 1 used a modified version of the Global Physical Activity Questionnaire (World Health Organization, 2005) and was designed to identify physical activity history and characterise marathon experience. Physical activity was categorised as moderate intensity (activities requiring moderate physical effort and causing small increases in breathing or heart rate) and vigorous intensity (activities requiring hard, physical effort and large increases in breathing or heart rate). Likert scales in section 2 assessed frequency and perceived importance of sports bra use and identified satisfaction with current sports bra design using a visual analogue scale (where 0 corresponded to “not at all” and 10 “completely”). It also explored the frequency of sports bra-related issues (Likert scale) and additional factors that may influence the appropriateness of sports bras. Section 3 related to experiences of mastalgia and its potential impact on marathon training, the results of which are reported elsewhere (Brown, White, Brasher, & Scurr, 2013). Finally, section 4 of the survey identified demographic data and information about breast health history (i.e. whether participants had ever been diagnosed with breast cancer, undergone any

surgical procedures to the breast and how they perceived their knowledge of breast health issues, such as breast pain, appropriate breast support and bra fit.

The survey was pilot-tested on amateur runners (n = 10), to evaluate ease of comprehension, ensure that wording elicited meaningful responses and to determine how long it took to complete the questionnaire (Harding et al., 2009). Minor amendments to wording and question order were made following feedback from the pilot testing and the survey took 7.9 ± 0.9 min to complete.

Participants who declined the invitation to complete the survey at the event were provided with a weblink to complete the survey online. The online survey remained accessible for 2 weeks following the marathon. Mixed-mode survey designs that utilise web-based surveys, additional to other modes of data collection have increased overall response rates and item non-response rates and quality of items/responses have been found to be similar between electronic and conventional survey modes (Borkan, 2009; Denscombe, 2008; Dixon & Turner, 2007). The questions and format of the online survey were identical to the paper-based survey to demonstrate equivalency and increase reliability of the mixed-mode strategy (Kaplowitz, Hadlock, & Levine, 2004). As an incentive to increase response rate, ethically approved prize draw entry (£250 of generic high street vouchers) was offered to all participants on completion of the survey (Singer, Van Hoewyk, Gebler, Raguhunathan, & McGonagle, 1999).

Data handling

Following standardised training, a team of 4 research assistants manually entered survey responses into Microsoft Excel (2010) and data were checked for accuracy by the principal investigator. A total of 1343 surveys were collected during the marathon exhibition and an additional 54 participants completed the survey online (n = 1397). All items had less than 3% of missing values. However, due to the large number of variables, the number of cases with at least one missing value represented 9.1% of the sample (n = 126). Listwise deletion, pairwise deletion and imputation can be used to handle incomplete data (Rafiq & Jaafar, 2007). Missing values were deleted listwise because (i) a pattern of missing values was not apparent indicating that incomplete cases did not behave differently from complete cases (Schafer, 1997), (ii) the remaining sample size was still large enough to satisfy potential bias concerns and provide useful insights

into the research questions (King, Honaker, Joseph, & Scheeve, 2001) and (iii) it is more clearly interpretable than pairwise deletion (Gamoran, 1987). This resulted in a final sample size of 1285 for all subsequent analyses.

Data analysis

Data were analysed descriptively to summarise participant's demographic profiles, assess the perceived importance and use of sports bras, identify satisfaction with current sports bra design and identify the incidence of bra issues. Further analysis using Predictive Analytic Software (PASW) was conducted with statistical significance set at 0.05 for all analyses. Wilcoxon signed-ranks tests were used to assess differences in sports bra use and perceived importance of sports bra use between moderate and vigorous physical activity. Chi-squared tests were used to assess the association of age and self-reported cup size with the following variables: frequency of sports bra use, perceived importance of sports bra use, frequency of bra fit issues, last purchase of a sports bra, last professional fit, choice of sports bra style and perceived breast health knowledge. Due to small frequency counts in the half-decade groups of 60–64 years, 65–69 years and 70–74 years, these were condensed to one group (≥60 years), in order to meet chi-square assumptions (Field, 2009). Grouping of knowledge level categories was also necessary with "extremely poor" and "below average" responses combined. Additionally, cup sizes AA and A were condensed to one group (≤A), as were cup sizes FF to HH (≥FF). Where these cup-size groupings still violated chi-square assumptions, participants were categorised as having smaller breasts (≤C cup) or larger breasts (≥D cup) (Dundas, Atyeo, & Cox, 2007; Lorentzen & Lawson, 1987).

Results

The face-to-face recruitment methodology employed resulted in a high response rate representing almost 10% of the 13,064 recreational female runners who completed the 2012 London Marathon. Age ranged from 18 to 74 years with 58.1% of participants aged 18 to 39 years. This provides a good representation of females who ran the 2012 London Marathon, of which 59% were aged 18 to 39 years (Virgin London Marathon, 2012). Self-reported physical characteristics and activity history of participants are reported in Table I.

Table I Self-reported physical characteristics and activity history (n = 1285)

	Mean ± SD
Height (m)	1.65 ± 0.7
Body mass (kg)	62.7 ± 8.9
Body mass index (kg · m−2)*	22.9 ± 3.0
Duration of typical exercise session (min)**	
Moderate intensity	72.9 ± 50.9
Vigorous intensity	70.3 ± 52.9
Number of days exercise in a typical week**	
Moderate intensity	3.8 ± 1.7
Vigorous intensity	2.9 ± 1.6

Notes: *calculated from participants' self-reported height and body mass. **moderate intensity defined as activities requiring moderate physical effort and causing small increases in breathing or heart rate; vigorous intensity defined as activities requiring hard physical effort and large increases in breathing or heart rate.

Fifty-six bra sizes were reported with cup size ranging from an AA cup to an HH cup and underband size ranging from 28 to 40 inches (Table II). The mode bra size reported was 34B, representing 15.5% of the study sample. Underband size was normally distributed; however, the distribution of cup size was positively skewed.

Table II Distribution of participants self-reported bra size (UK underband and cup size) (n = 1279*)

Underband (inches)	Cup size												Total
	AA	A	B	C	D	DD	E	F	FF	G	H	HH	
28								1		1			2
30			2	5	7	5	8	8	2	2	2	1	42
32	5	30	62	59	51	39	21	10	12	4	1	1	295
34	5	81	199	143	96	51	25	14	4	4			622
36	2	30	86	75	32	19	11	2	1	3	1		262
38			16	8	14	8		1					47
40			1	2	2	2	1	1					9
Total	12	141	366	292	202	124	66	37	19	14	4	2	1279*

Note: *6 participants reported they did not know their bra size.

Perceived importance of sports bra use and frequency of use

Ninety-one per cent of the 2012 London marathon female runners surveyed reported that they wear a sports bra when taking part in vigorous physical activity, with 86% of them considering sports bras to be essential. Both the frequency of sports bra use and the level of importance of sports bra use were rated significantly higher during vigorous physical activity compared to moderate physical activity (frequency: $Z = –9.518$, $P < 0.05$; importance: $Z = –13.360$, $P < 0.05$) (Table III). Breast size was significantly related to frequency of sports bra use in both moderate and vigorous physical activity (moderate: $\chi 2$ (4, N = 1285) = 21.497, P <

0.05; vigorous: $\chi 2$ (4, N = 1285) = 23.950, P < 0.05), with sports bra use more frequent in participants with larger breasts (≥D cup) (Table III). Importance ratings of wearing a sports bra during physical activity were also significantly higher in participants with larger breasts (≥D cup) (moderate: $\chi 2$ (3, N = 1285) = 60.050, P < 0.05; vigorous: $\chi 2$ (3, N = 1285) = 54.754, P <0.05) (Table III), but only 4% and 2% of all participants perceived it to be unimportant during moderate and vigorous physical activity, respectively.

Table III Frequency and perceived importance of wearing a sports bra during moderate and vigorous physical activity for participants with smaller (≤C cup) and larger (≥D cup) breasts (n = 1285)

		Smaller breasts (n = 811)		Larger breasts (n = 474)		All (n = 1285)	
Physical activity level*		Moderate	Vigorous	Moderate	Vigorous	Moderate	Vigorous
Frequency of sports bra use	Never	6%	4%	2%	2%	4%	3%
	Rarely	3%	1%	2%	1%	3%	1%
	Sometimes	7%	3%	3%	1%	6%	2%
	Very often	6%	4%	6%	1%	6%	3%
	Always	78%	88%	88%	96%	82%	91%
Perceived importance of wearing sports bra	Unimportant	5%	3%	3%	1%	4%	2%
	Somewhat important	13%	5%	5%	1%	10%	4%
	Very important	18%	12%	9%	3%	15%	8%
	Essential	64%	81%	84%	95%	71%	86%

Note: *moderate intensity defined as activities requiring moderate physical effort and causing small increases in breathing or heart rate; vigorous intensity defined as activities requiring hard physical effort and large increases in breathing or heart rate.

Bra satisfaction and experience of bra-related issues

The extent to which participants felt their bra/s met their needs when training was high, with half (51%) of participants rating their sports bra as a 9 or 10, and only 7% rating their bra ≤5. However, when asked about bra fit issues, 75% of participants reported experiencing at least one fit issue. Over a quarter (28%) of participants reported sometimes suffering from rubbing or chafing, and 22% reported experiencing issues with the shoulder straps digging into the skin (Table IV). With the exception of underwire digging into the skin, all bra issues were experienced significantly more by participants with larger breasts compared to those with smaller breasts (Table IV).

Table IV Frequency of bra issues during training reported by participants with smaller (≤C cup) and larger (≥D cup) breasts (n = 1285)

		Issue experienced as a result of bra use				
		Rubbing/chaffing	Shoulder straps dig into skin	Upper body pain	Poor posture	Underwire digs into skin**
All (n = 1285)	Never	38%	50%	73%	80%	75%
	Rarely	25%	24%	15%	15%	11%
	Sometimes	28%	22%	1%	4%	11%
	Very often	8%	4%	2%	1%	3%
Smaller breasts	Never	40%	56%	78%	84%	77%
(n = 811)	Rarely	24%	23%	13%	13%	11%
	Sometimes	29%	19%	7%	3%	10%
	Very often	7%	2%	2%	<1%	2%
Larger breasts	Never	35%	40%	65%	74%	72%
(n = 474)	Rarely	28%	26%	19%	18%	12%
	Sometimes	27%	26%	13%	6%	13%
	Very often	10%	8%	3%	2%	3%
$\chi 2$		9.041*	20.924*	22.841*	45.735*	3.256

Notes: *significant difference between participants with small and large breasts ($P \leq 0.05$). **excludes 241 participants that said this issue was "not applicable" to them due to them not wearing underwired sports bras.

Factors influencing the appropriateness of sports bras

Last purchased a sports bra

One-fifth of participants reported purchasing a sports bra within the last month, with 32% purchasing a new sports bra in the last 3 months, 21% in the last 6 months and 11% within the last year. Twelve per cent had not made a purchase for over a year with 2% unable to remember when they last made a purchase and a further 2% reporting they had never purchased a sports bra. Purchasing of sports bras was not related to cup size ($\chi 2$ (28, N = 1234) = 38.870, $P > 0.05$), or age ($\chi 2$ (56, N = 1279) = 36.660, $P > 0.05$).

Last professional fit

Over one-third (35%) of participants reported that it had been over a year since they were last professionally fitted and nearly one-fifth (19%) reported that they had never been fitted (Figure 1). Cup size was significantly related to the uptake of professional fitting services ($\chi 2$ (35, N = 1064) = 181.397, $P < 0.05$). The time that had elapsed since the last professional fitting decreased as cup size increased, and a higher proportion of participants with smaller breasts reported never being fitted compared to participants with larger breasts.

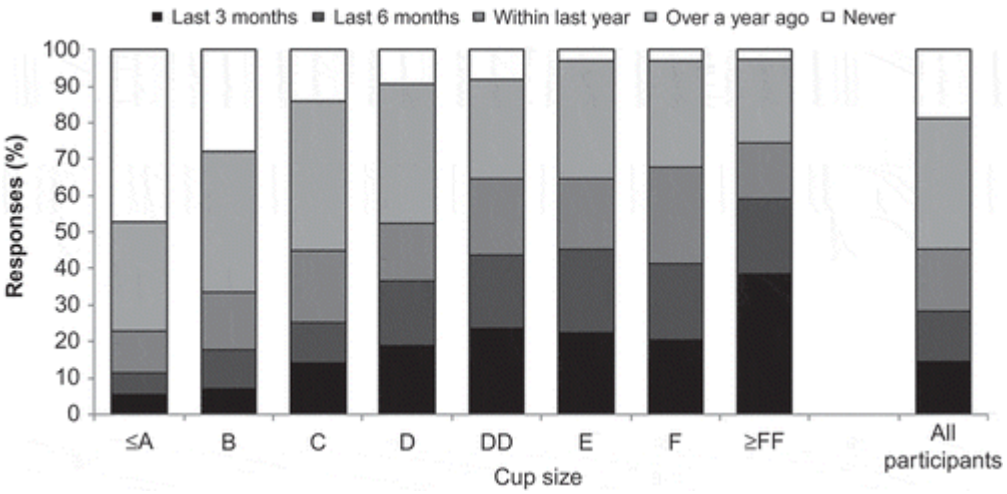

Figure 1 Self-reported cup size distribution of when participants were last professionally fitted (n = 1064*).

Choice of sports bra style

Thirty-three participants reported not wearing a sports bra during training. Of the remaining participants (n = 1252), 43% reported that the sports bra they wore most commonly during training was a compression bra, with 29% choosing an encapsulation and 24% choosing a combination bra most commonly (Figure 2). Bra choice was significantly related to cup size ($\chi 2$ (14, N = 1247) = 83.041, P < 0.05), with compression bras more popular in women with smaller cup sizes (Figure 2). Bra choice was also significantly related to age (age: $\chi 2$ (16, N = 1252) = 30.370, P < 0.05), with encapsulation bras increasing in usage as age increased and over half of all participants under 30 years wearing a compression bra most frequently.

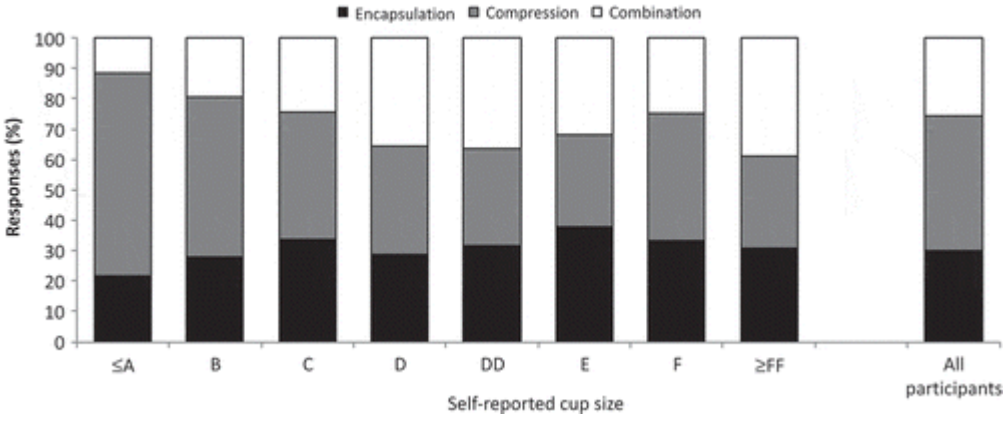

Figure 2 Self-reported cup size distribution of type of sports bra worn most commonly during training (n = 1252*)

Breast health knowledge

Less than a quarter (21%) of participants rated their knowledge of breast health (such as bra fit, appropriate breast support and breast pain), as above average, with just 6% reporting excellent knowledge levels (Figure 3). The remainder of participants rated their knowledge level as average (58%), below average (12%) or extremely poor (2%). Breast health knowledge level was not related to cup size ($\chi 2$ (21, N = 1279) = 30.806, P > 0.05), however, it significantly increased with age ($\chi 2$ (24, N = 1285) = 80.021, P < 0.05).

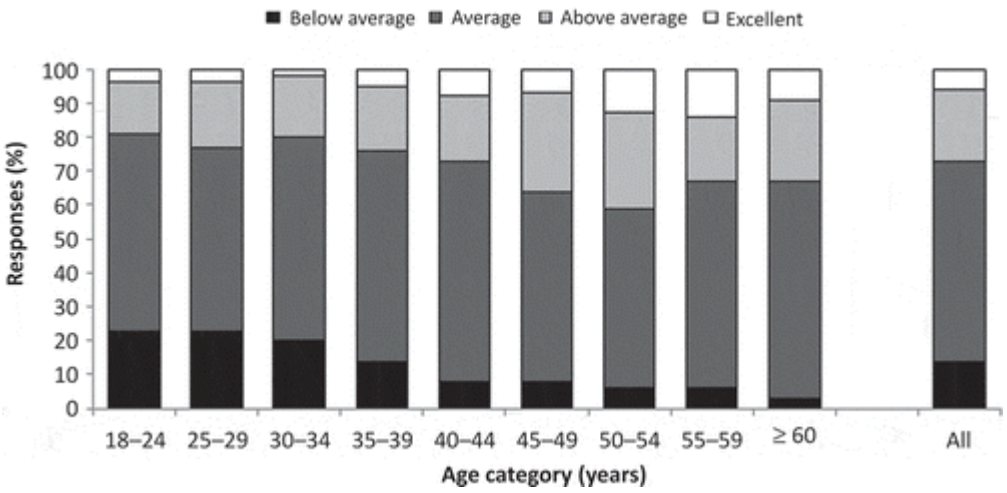

Figure 3 Age distribution of participants' rating of knowledge level of breast health issues (n = 1285).

Discussion

Importance and use of sports bras

The results of the study indicate that female marathon runners are engaging in sports bra use, with only 3% reporting that they never wore a sports bra when running, and only 3% perceiving wearing a sports bra as unimportant. This indicates that sports bra use during physical activity is greater in female marathon populations compared to the general community, which has been reported to be as low as 41% (Bowles et al., 2008). A possible explanation for these contrasting results may be the high volume and duration of both moderate and vigorous physical activity that the participants in the present study reported participating in. The frequency and perceived importance of sports bra use was lower in moderate physical activity compared to vigorous physical activity. Appropriate breast support has been shown to reduce breast displacement during low-level activities, such as walking (7 km · h−1) (Mason et al., 1999), suggesting that the importance of appropriate breast support at lower levels of physical activity should not be overlooked. There may be

scope to educate females engaging in exercise on the importance of breast support during all levels of physical activity.

During physical activity, sports bra use and the perceived importance of wearing a sports bra was greater in participants with larger breasts compared to those with smaller breasts. Although research has identified that breast displacement increases as cup size increases (Wood et al., 2012), breast motion is not an issue that is one experienced by women with larger breasts. In unsupported A and B cup participants, more than 7 cm of vertical breast displacement has been observed (Lorentzen & Lawson, 1987). Furthermore, high variation in breast displacement within a sample of 21 D cup participants (Scurr et al., 2011), suggests additional factors may contribute to breast displacement other than breast size. Therefore, it is important that all females, regardless of breast size, are educated about the importance of wearing appropriate breast support during physical activity.

Bra satisfaction and experience of bra-related issues

Despite the high use and importance of sports bras, 49% of participants rated their sports bra as inappropriate and 75% reported experiencing at least one issue relating to bra fit. This suggests consumer dissatisfaction with current sports bra design exists. Furthermore, the incidence of bra issues reported in the present study was significantly higher in participants with larger breasts compared to those with smaller breasts, suggesting that current sports bra design does not adequately meet the requirements of women with larger breasts. Over half of the participants in the current study reported experiencing issues with shoulder straps. Wider shoulder straps were more effective in limiting breast movement (Zhou, Yu, Ng, & Hale, 2009), and it is recommended that fabric straps in sports bras are wider than straps of fashion bras to allow a greater area for the force to be distributed over (Page & Steele, 1999). However, despite a rising number of patents in bra strap technology, optimal design features of shoulder straps (such as material properties and strap configuration) have yet to be established and more work is needed in this area.

Dermatological problems during running are common for marathon runners (Mailler & Adams, 2004), and the most prevalent bra fit issue reported in the present study was rubbing/chafing. This suggests an opportunity to improve sports bra design, perhaps with advancements in textile technology to alleviate these

issues. This may be particularly important for long-distance endurance events such as marathons that cause repetitive friction motion at the skin/bra interface. Additionally, 35% of participants with larger breasts reported having experienced upper body pain as a result of sports bra use with a further 60% having experienced postural-related issues. This highlights the need for improvements in breast support for exercising females with larger breasts to alleviate these negative health implications.

Factors influencing the appropriateness of sports bras

Last purchased a sports bra

In the current study, 270 participants had purchased a sports bra more than 6 months ago, with a further 150 having not purchased a sports bra for over a year. Although a loose approximation, using the training volumes reported by participants (Table I), it could be estimated that over a 6-month period, participants would participate in 208 h of physical activity over 174 sessions, or 416 h over 348 sessions in the course of a year. Thus, promoting awareness of the need to replace sports bras in highly active populations is a significant issue to consider as this may influence the effectiveness of the sports bra. Furthermore, as evidence-based standards to quantify how often a sports bra should be replaced have yet to be established; research should aim to develop these standards.

Last professional fit

The importance of wearing a well-fitted and supportive bra during physical activity is well established (Gehlsen & Albohm, 1980; Lorentzen & Lawson, 1987; Mason et al., 1999; Page & Steele, 1999; Starr et al., 2005). Despite this, 54% of participants reported it had been over a year since they were last professionally bra-fitted. It has been reported that women with larger breasts may avoid being professionally fitted due to embarrassment and self-consciousness (Wood et al., 2008). In contrast, the results of the present study indicated that women with larger breasts were twice as likely to have been fitted. Therefore, although it is considered more difficult for women with larger breasts to accurately size bras (Pechter, 1999), it is important to encourage all women to utilise professional bra fitting services and educate women on the importance of appropriate bra fit (Bowles et al., 2008; McGhee et al., 2010; White & Scurr, 2012).

Choice of sports bra style

In the present study, both age and breast size influenced breast support choice, with compression bras more popular with participants with smaller breasts, and popularity of encapsulation bras increasing with age. In agreement with recent research that bra requirements change with increasing age (Risius, Thelwell, Wagstaff, & Scurr, 2012), differences were also observed across age groups, with encapsulation bras increasing in popularity as age increased. Therefore, factors such as age and breast size should be considered in design and marketing as these factors may influence bra consumer behaviour and thus impact bra sales.

Breast health knowledge

Nearly three-quarters of participants reported average or below-average knowledge of breast health reinforcing the need to educate females on appropriate breast support and bra fit. Knowledge levels were higher in older age groups (≥45 years), thus age-specific initiatives may be of value.

Limitations

The authors are cognizant of the limitations of the face-to-face methodology employed in this study with regard to potential bias of participant's responses to the survey due to the presence of, and interactions with, the researchers (Groves & Peytcheva, 2008). Additionally, self-administered surveys are prone to recall bias (Choi & Pak, 2005), and it is important to acknowledge that not all individuals who train for a marathon are able to complete training and participate. Therefore, the results of the present study are biased towards those who completed training and attended the marathon registration.

Conclusion

This is the first study to assess the breast considerations of female marathon runners and the results indicate that engagement with sports bra use is high and is perceived as important. However, current dissatisfaction with sports bra design exists, and 75% of marathon runners experience bra-related issues which has important implications for bra manufacturers. Encouraging women to replace their sports bra regularly, use professional bra fitting services and improve breast health knowledge, may improve the appropriateness of female marathon runners' sports bras.

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Notes

Notes: *calculated from participants' self-reported height and body mass. **moderate intensity defined as activities requiring moderate physical effort and causing small increases in breathing or heart rate; vigorous intensity defined as activities requiring hard physical effort and large increases in breathing or heart rate.

Note: *6 participants reported they did not know their bra size.

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Notes: *significant difference between participants with small and large breasts ($P \leq 0.05$). **excludes 241 participants that said this issue was "not applicable" to them due to them not wearing underwired sports bras.

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