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Which Bra Components Contribute to Incorrect Bra Fit in Women Across a Range of Breast Sizes?

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Abstract

The purpose of this study was to investigate whether different components of encapsulation-style bras contribute to incorrect bra fit among women and whether this was influenced by breast size. The fit of five key bra components of 309 women's own encapsulation bras was assessed using professional bra fit criteria among four breast size categories. Overall, incorrect fit prevalence was greatest among the cups, front band, and strap components of the bra. Although no significant difference was observed in overall bra fit between the four breast size categories, a significant difference was observed between groups for the front band, underwire, and strap components of the bra. Individual components of encapsulation-style bras are associated with incorrect bra fit and these vary with breast size. Incorporation of three-dimensional breast volume/shape and torso dimension data into bra component design could improve bra fit and breast support for women across the size spectrum.

Keywords

bra components, encapsulation bra, bra fit, breast volume, breast size, bra design

A poorly fitted bra can lead to numerous negative health outcomes including poor posture, headaches, and back ache (BeLieu, 1994; Greenbaum, Heslop, Morris, & Dunn, 2003; Kaye, 1972; Ryan, 2000). The symptoms associated with poor bra fit can be so severe as to lead women to seek reduction mammoplasty (BeLieu, 1994; Greenbaum et al., 2003; Ryan, 2000), as well as inhibit some women, particularly those with large breasts, from participating in physical activity (Lorentzen & Lawson, 1987; Mason, Page, & Fallon, 1999; McGhee, Steele, Zealey, & Takacs, 2013; Scurr, White, & Hedger, 2010). Therefore, incorrect bra fit is an important women's health issue. Although

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a high prevalence of incorrect bra fit has been reported in women across a range of bra sizes (Greenbaum et al., 2003; McGhee & Steele, 2010, 2011; McGhee, Steele, & Munro, 2010; Wood, Cameron, & Fitzgerald, 2008), the consequences of insufficient breast support have been reported to be much greater for women with large breasts (Findikcioglu, Findikcioglu, Ozmen, & Guclu, 2007; Greenbaum et al., 2003; Letterman & Schurter, 1980; McGhee et al., 2013; Ryan, 2009).

Literature Review

Several factors have been identified as contributing to the high prevalence of incorrect bra fit. These factors include insufficient knowledge of bra fit because of a lack of education on how to correctly fit a bra (McGhee & Steele, 2010; McGhee et al., 2010), a lack of standardization in bra sizes among manufacturers (Fechter, 1998; Kanhai, Hage, & Pechter, 1999; McGhee & Steele, 2006), and a lack of use of professional bra fit services (Brown, White, Brasher, & Scurr, 2014; McGhee & Steele, 2010; McGhee et al., 2010; White & Scurr, 2012). Because incorrect bra fit can negatively impact women's health, several strategies have been established to try to resolve this problem. These strategies have included the development of resources to educate women on how to correctly fit their bras (McGhee & Steele, 2010, 2012, 2013; McGhee, Steele, & Munro, 2008) and recommendations for women to use professional bra fit services (McGhee & Steele, 2010). Women are, however, reluctant to use such services. In fact, 75% of adolescent females have reported that they have never used professional bra fitting services (McGhee et al., 2010), and 66% of women reported choosing to independently fit and purchase their own bras (McGhee & Steele, 2010; White & Scurr, 2012). Therefore, it is imperative that factors that might impede women from selecting a correctly fitted bra are minimized.

One factor that is likely to contribute to the high prevalence of poor bra fit is how a bra is designed. Bras are most commonly designed in one of the two ways: (a) as a compression-style bra or (b) as an encapsulation-style bra (Figure 1). Women can wear either compression-style bras or encapsulation-style bras (or a combination of both), when they participate in physical activity. The function of the two bra styles, however, is different (Zhou, Yu, & Ng, 2013). Compression-style bras are designed to compress both breasts against the chest wall as a single unit to limit breast motion, whereas encapsulation-style bras are comprised of numerous individual components that are pieced together to form bras that support each breast individually in separate, structured cups (Loehr, 2013; Yu & Zhou, 2016; Zhou et al., 2013). Encapsulation bras can be designed to be worn for daily use and/or physical activity. These bras are the focus of the current study.

The main components of an encapsulation bra include the cups, front band, underwire, backband, and straps (Figure 1; Bowles & Steele, 2013; Chen, Labat, & Bye, 2011; Cummings, 1987; McGhee & Steele, 2010; Page & Steele, 1999; Pandarum, Yu, & Hunter, 2011; Yu & Zhou, 2016). Given the unique function that each component of an encapsulation-style bra is designed to perform, it is important to understand how these different components affect overall bra fit. Furthermore, considering the wide range of breast sizes that bras must support (Coltman, Steele, & McGhee, 2017), it is also important to determine whether the fit of these unique components differs with respect to breast size. For example, for a bra to fit properly, the size of a bra cup must match the volume of the breast that it is to contain (Chen et al., 2011; Lee, Hong, & Kim, 2004; Pandarum et al., 2011). Only McGhee and Steele (2011) have related breast volume data ($N = 107$; volume range: 125—1,900 mL, per breast) to the participants' professionally fitted bra sizes (in the one style and make of bra; McGhee & Steele, 2011). McGhee and Steele (2011) found that a range of breast volumes corresponded to the same professionally fitted bra cup size (McGhee & Steele, 2011). Furthermore, the range of breast volumes corresponding to the same bra cup size was greater for women with large breasts (defined as volumes >500 mL; McGhee & Steele, 2011). Based on the results of these studies, it appears that selecting the correct bra cup size could be confusing, particularly for women with large breasts,

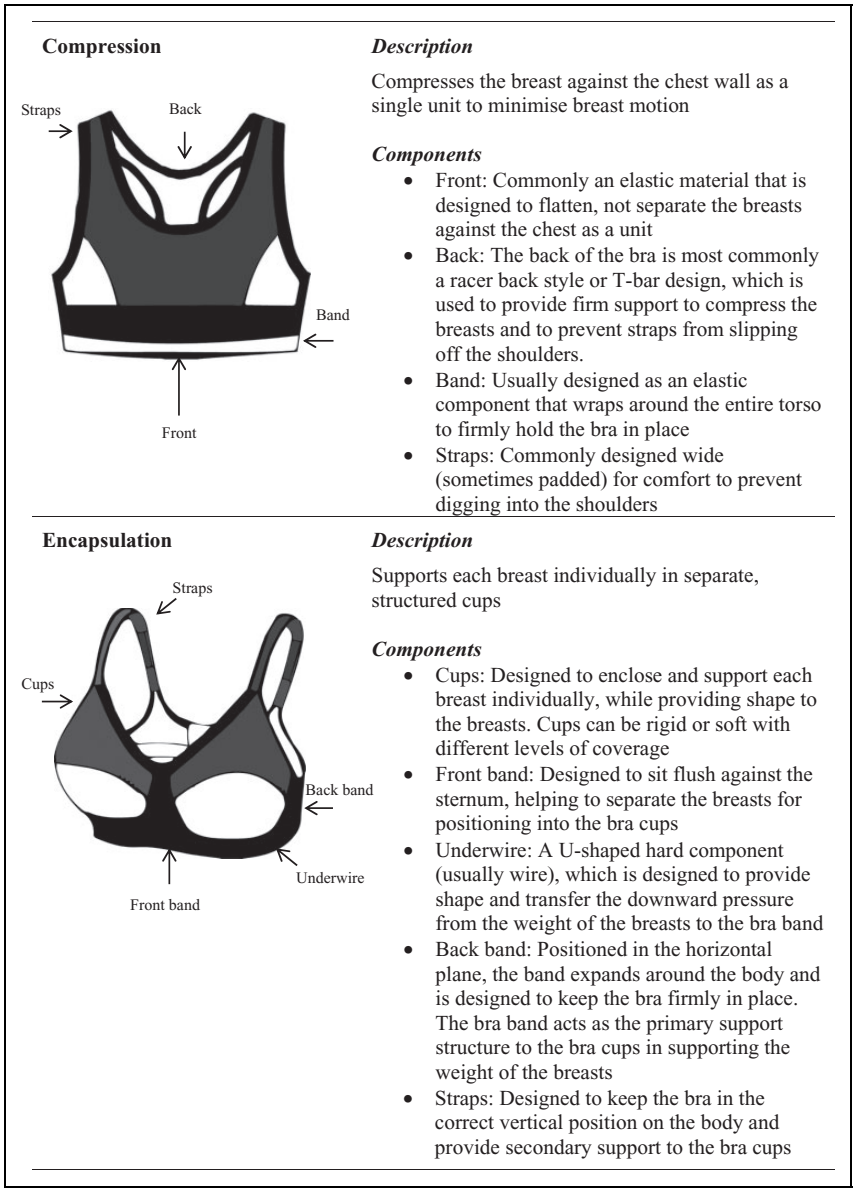

Figure 1. The two main styles of bras: (a) compression and (b) encapsulation (Loeher, 2013; diagrams adapted from Zhou, Yu & Ng, 2013).

possibly contributing to incorrect bra size selection. Thus far, no study has established which components of encapsulation bras are associated with poor bra fit.

Research Questions

The aim of this study was to determine which components of encapsulation-style bras were associated with incorrect bra fit in women across a range of breast sizes. The following research questions were formulated:

Table 1. The style of bra worn by the participants who attended the testing session.

Bra Style Worn	Number of Participants	Age (Years; Mean ± *SD*)	BMI (kg/m^2; Mean ± *SD*)
Encapsulation	309	45 ± 20	28 ± 6
Compression	23	31 ± 13	24 ± 4
Noncompression/unstructured (e.g., Ahh bra)	10	60 ± 16	32 ± 8
No bra or singlet top	7	50 ± 7	26 ± 4

Note. $N = 378$. BMI = body mass index.

1. What is the prevalence of incorrect bra fit in an encapsulation-style bra among women of different breast sizes?
2. Does the frequency of incorrect fit of various bra components differ with respect to breast size?

Materials and Method

Participants

Women from a broad range of breast sizes (very small-to-very large breasts) were recruited to participate in the study. Therefore, the study was advertised broadly throughout the local community via media sources (including television, radio, and newspapers), across all sectors of the university campus and at selected Women's Health Centers. Three hundred and seventy-eight women volunteered to participate in the study. Each woman subsequently attended a 1-hr testing session that was held at the university campus or at selected Women's Health Centers over an 11-month testing period (May 2014 to April 2015). Prior to attending the test session, participants were informed that they would be involved in several different tests, which would quantify their breast characteristics and bra size and how this information would be ultimately used to improve breast support. The participants were given no specific instructions as to the style of breast support they should wear to the test session, and they were not told that the fit of their bra would be assessed during the test session. This enabled demographic profiling of the type of breast support worn by women in the community and ensured that the participants did not change their bra-wearing habits in anticipation of being assessed. The type of breast support worn by the women who participated in this study is shown in Table 1.

The published criteria used to assess bra fit were designed for encapsulation-style bras (McGhee & Steele, 2010). Therefore, participants who wore to the test session any form of unstructured bra (e.g., compression-style bra, noncompression-style breast support such as the Ahh bra, no bra, or a singlet; $n = 37$; 11%), rather than an encapsulation-style of bra, were excluded from analysis. In addition, participants who had undergone breast surgery (e.g., lumpectomy and mastectomy) were excluded ($n = 32$) from analysis as breast asymmetry, which is a common consequence of breast surgery, was considered to be a confounding variable that would affect bra fit (as bras are symmetrical). This reduced the analyzed study sample size to $n = 309$ (age range: 18.1–83.7 years, mean: 43.5 ± 19.6 years; body mass index [BMI] range: 19.0–55.0 kg/m^2, mean: 27.6 ± 6.1 kg/m^2). Each participant's height was measured using a Seca 214 portable stadiometer (Seca Corp., Hanover, MD), and body mass was measured using a Tanita Body Composition Analyzer (Model: TIS-C24OMA, Tanita, IL). From these data, BMI was calculated as mass (kg)/height^2 (m) and classified as normal (18.5–24.99 kg/m^2), overweight (25–29.99 kg/m^2), and obese (>30 kg/m^2; World Health Organization, 2006). The University Human Research Ethics Committee granted approval for the study (HE 13/424). All participants provided written informed consent prior to testing, and all

Table 2. Characteristics of Participants Who Were Classified Into the Four Breast Size Categories.

Group	*n*	Breast Volume (Median ± IQR; mL) Right	Breast Volume (Median ± IQR; mL) Left	Age (Years; Mean ± *SD*)	BMI (kg/m^2 Mean ± *SD*)	Bra Cup Size[a] Range	Bra Band Size[a] Range
Small (breast volume <350 mL)	96	222 ± 81	229 ± 72	35 ± 16	22 ± 3	A–DD	8–16
Medium (breast volume 350–700 mL)	130	500 ± 130	503 ± 130	41 ± 20	26 ± 4	B–G	8–20
Large (breast volume 701–1,200 mL)	83	909 ± 188	921 ± 144	52 ± 20	31 ± 5	C–J	8–22
Hypertrophic (breast volume >1,200 mL)	37	1,669 ± 498	1,665 ± 437	51 ± 16	35 ± 7	DD–K	12–22

Note. Total *I* = 346. IQR = interquartile range; BMI = body mass index.
[a]Bra sizes were measured using the Australian sizing system (for international sizing conversions, see McGhee & Steele, 2006).

testing was conducted according to the National Health and Medical Research Council (2007) *Statement on Human Experimentation*.

Breast Volume Measurement

The size of each participant's breasts was quantified by directly measuring the volume of both of their breasts using a handheld three-dimensional scanner (Artec™ Eva 3D Scanner, Artec Group, San Jose). Breast volume was measured while each participant lay prone with their breasts suspended in a gap between two tables and following the procedure described in detail by Coltman, McGhee, and Steele (2017). Prior to scanning, adhesive markers (approximately 1 cm in diameter) were placed directly on each participant's skin to outline the borders of their breasts. One scan was taken of each participant and visually inspected immediately after capture to ensure both breasts were visible and the scan was suitable for analysis. If any problems were detected with the scan, the procedure was repeated with one scan per position for each participant and subsequently imported into Geomagic Studio® software for analysis (Version 12; 3DSystems, Rock Hill, SC). Within this software, a three-dimensional model of each breast for every participant was created by tracing around the breast borders. The volume (mL) of each breast model was subsequently calculated (Geomagic Studio software; Version 12; 3DSystems). Based on the breast volume data, the participants were divided into four breast size categories: (a) small, (b) medium, (c) large, and (d) hypertrophic breasts (Coltman, Steele, et al., 2017). Participant characteristics for the four breast size categories are shown in Table 2.

Bra Fit Assessment

The fit of the bras of all participants who wore encapsulation-style bras to the test session was assessed, once, using professional bra fit criteria (McGhee & Steele, 2010), which were developed to assess the fit of key components of encapsulation bras (cups, front band, underwire, backband, and straps; see Table 3). These criteria enabled the chief investigator, who performed all assessments, to determine whether each component of the participants' own encapsulation bra fitted them correctly or incorrectly. The chief investigator received extensive one-on-one training over a 6-month period

Table 3. The Professional Bra Fit Criteria Used in This Study to Assess the Fit of Each Participant's Own Bra (McGhee & Steele, 2010).

Component	Criteria
Backband	☐ Too tight: flesh budging over the top of band; subjective discomfort "feels too tight"
	☐ Too loose: band lifts up when arms are moved above head, posterior band not level with inframammary fold
Cup	☐ Too big: wrinkles in cup fabric
	☐ Too small: breast tissue bulging above, below, or at the sides
Underwire	☐ Incorrect shape: underwire sitting on breast tissue laterally (under armpit) or anterior midline; subjective complaint of discomfort
Straps	☐ Too tight: digging in, subjective complaint of discomfort; carrying too much of the weight of the breasts
	☐ Too loose: sliding down off shoulder with no ability to adjust the length
Front band	☐ Not all in contact with the sternum
Rating of bra fit	☐ Pass: no errors or if hooks or straps can be adjusted to allow correct fit
	☐ Fail: any other ticks

in assessing bra fit by the expert who developed the professional bra fit criteria. Data collection only commenced when the expert deemed the chief investigator to be highly proficient and consistent in performing the validated bra fit assessment. If all five bra components fitted the participants correctly, they were awarded an overall pass for the bra fit assessment. However, if any one or more bra component was rated as fitting incorrectly, the participant was awarded an overall fail for the bra fit assessment (McGhee & Steele, 2010), and no adjustments to fit were made by the assessor. The frequency with which each bra component was rated as fitting correctly and incorrectly, as well as the number of components that failed and the frequency of overall passes or fails being awarded for the bra fit assessment, was recorded.

Statistical Analysis

The frequency of incorrect fit of each of the five bra components and the overall bra fit assessment result (pass or fail) was reported for every participant and then grouped according to the four breast size categories (small, medium, large, and hypertrophic). chi-squared analyses were performed on the bra fit data recorded for the four breast size categories to determine whether breast size (small, medium, large, and hypertrophic) significantly ($p < .05$) affected the frequency of correct and incorrect results for overall bra fit, as well as the fit of each of the five bra components. All statistical calculations were conducted using the Statistical Package for the Social Sciences (Version 23.0; SPSS Inc., Chicago).

Results

Of those women wearing encapsulation-style bras ($n = 309$), six did not have straps (strapless) and 22 did not have underwire (wire free), reducing the number of participants who were assessed for the fit of these bra components. The women who wore strapless bras had an average age of 29 years (range: 20–46 years) and an average BMI of 24 kg/m^2 (normal; range: 20–28 kg/m^2), whereas the women who wore wire-free bras had an average age of 65 years (range: 28–83 years) and an average BMI of 32 kg/m^2 (obese; range: 20–48 kg/m^2). Only 10.03% of the women who were wearing encapsulation-style bras ($n = 309$) wore a bra that was rated overall as fitting correctly. When examined by breast size category, 9.10% of women with small breasts, 11.76% of women with medium breasts, 6.31% of women with large breasts, and 14.70% of women with hypertrophic

Table 4. The Number and Percentage (in Parentheses) of Incorrectly Fitting Components of the Participants' Encapsulation Bras Are Shown for Each Breast Size Category (Small, Medium, Large, and Hypertrophic) and for the Total Cohort.

Number of Features Incorrectly Fitting	Small $n = 77$	Medium $n = 119$	Large $n = 79$	Hypertrophic $n = 34$	Total $n = 309$
Failed on 0 component	7 (9.01)	14 (11.76)	5 (6.33)	5 (14.71)	31 (10.03)
Failed on 1 component	16 (20.78)	17 (14.29)	9 (11.39)	2 (5.88)	44 (14.24)
Failed on 2 components	25 (32.47)	27 (23.08)	15 (18.99)	9 (26.47)	76 (24.60)
Failed on 3 components	9 (11.69)	30 (25.21)	19 (24.05)	6 (17.65)	64 (20.71)
Failed on 4 components	9 (11.69)	22 (18.49)	12 (15.19)	8 (23.53)	51 (16.50)
Failed on 5 components	11 (14.29)	9 (7.56)	19 (24.05)	4 (11.76)	43 (13.92)

Note. $N = 309$.

breasts wore a bra that was rated overall as fitting correctly (Table 4). The number of incorrectly fitting components, on average, of the encapsulation-style bras that the participants wore to the test session is shown in Table 4.

There was no significant difference in the percentage of women rated as wearing an incorrectly fitting encapsulation bra among the four breast size categories, $\chi^2(3, n = 309) = 2.63$, $p > .05$ (Figure 2). In contrast, when rating the fit of individual bra components, women with medium, large, and hypertrophic breasts were more likely to have an incorrectly fitting front band, $\chi^2(3, n = 309) = 35.29$, $p < .05$, and underwire, $\chi^2(3, n = 287) = 17.45$, $p < .05$, whereas women with small breasts were more likely to have incorrectly fitting bra straps, $\chi^2(3, n = 303) = 23.16$, $p < .05$ (Figure 2). Although no significant differences were found in the fit of the backband or bra cups among the four breast size categories, the prevalence of incorrect fit of these components was high across all categories (Figure 2).

Discussion

The components of encapsulation-style bras that are associated with incorrect bra fit have been identified. The prevalence of incorrect fit has been shown to vary across both component type and breast size categories. The implications of these findings in terms of bra fit and bra design are discussed below.

The high percentage of participants who were found to be wearing an ill-fitting encapsulation-style bra (90% of cohort) was consistent with the findings of previous researchers (Greenbaum et al., 2003; McGhee & Steele 2010; McGhee et al., 2010; White & Scurr, 2012). Interestingly, it was discovered that most participants failed on more than one component of the bra fit assessment, suggesting that women have difficulty fitting several components of their bra or that the fit of these components are interrelated (Table 4), although this notion warrants further investigation. This finding has implications for the level of breast support these women are receiving on a daily basis given the role that each individual component of an encapsulation-style bra plays in supporting the weight of the breasts (Figure 1). If one or more components of the bra is not correctly fitted, the wearer will have a reduced level of breast support, which can be uncomfortable and can lead to the development of musculoskeletal pain (Findikcioglu et al., 2007; Greenbaum et al., 2003; Letterman & Schurter, 1980; McGhee & Steele, 2011; McGhee et al., 2008, 2013; Ryan, 2009).

Although no significant differences were found among breast size categories in terms of whether their bras fitted correctly or not overall, the specific bra components that did not fit differed significantly among the four breast size categories. Compared to the women with small breasts, a significantly higher percentage of women with medium, large, and hypertrophic breasts had

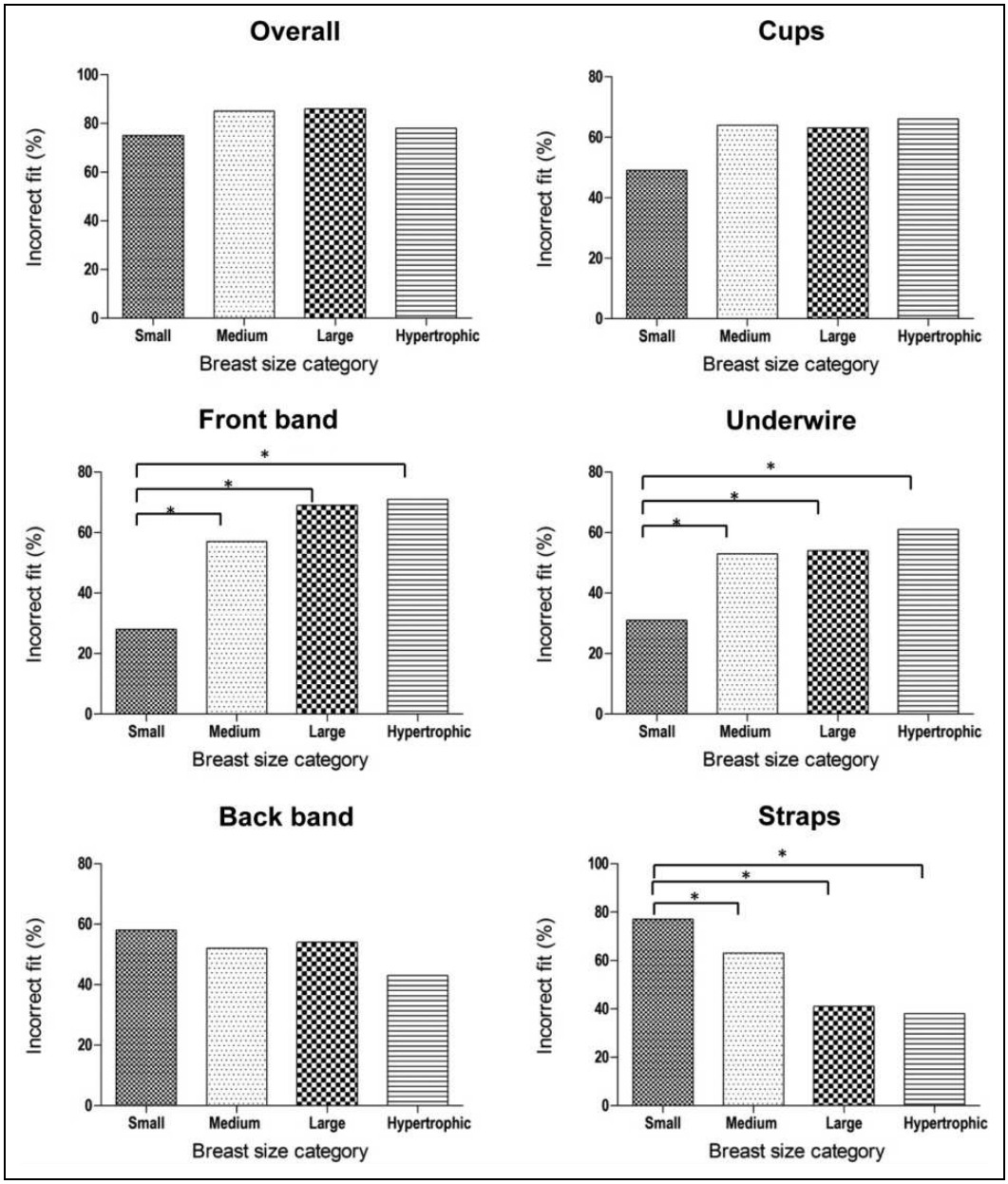

Figure 2. The percentage of overall incorrect encapsulation-style bra fit ($n = 309$) for the four breast size categories and for the five bra components (cups, $n = 309$; front band, $n = 309$; underwire, $n = 287$; backband, $n = 309$; and straps, $n = 303$). *Indicates a significant difference between breast size categories ($p < .05$).

incorrectly fitting front bands and underwire (Figure 2). Conversely, a significantly higher percentage of women with small breasts had incorrectly fitting bra straps compared to women with medium, large, and hypertrophic breasts (Figure 2). Although the fit of the bra cups was not significantly different among categories, there was a trend for a higher percentage of incorrect fit of the bra cup with increased breast size (increasing from 49% among women with small breasts through to 66%

among women with hypertrophic breasts; Figure 2). The high percentage of incorrect fit related to the bra cups that was observed across the four breast size categories, however, highlights that there is a problem with the fit of bra cups across all breast sizes, not just medium, large, and hypertrophic (Figure 2). According to the professional bra fitting criteria (McGhee & Steele, 2010), a fail in the fit of the bra cup resulted when the bra cup was either "too big" or "too small" (Table 3). The researchers observed that women with large and hypertrophic breast sizes tended to wear bra cups that were too small, whereas women with small breasts tended to wear bra cups that were too big. Although not part of the bra cup fitting criteria, we speculate that differences in breast shape across the breast size (volume) spectrum may have influenced the fit of breasts into the bra cup, resulting in the poor prevalence of incorrect bra cup fit among all four breast size categories. The health consequences of insufficient breast support due to poor cup fit, however, are acknowledged to be much greater for women with large breasts than for women with small breasts (Findikcioglu et al., 2007; Greenbaum et al., 2003; Letterman & Schurter, 1980; McGhee & Steele, 2011; McGhee et al., 2008, 2013; Ryan, 2009).

The high prevalence of incorrect fit among the underwire (31–61%) and front band (28–71%) components, which are related to the bra cup (Figure 1), was found to be significantly higher among women with medium, large, and hypertrophic breast sizes compared to women with small breasts (Figure 2). This finding is likely to be related to the shape of the breast, with previous researchers suggesting that as breast volume increases the shape of breasts changes, which will influence how the breast fits into a bra cup (McGhee & Steele, 2011). It is therefore suggested that the anthropometric dimensions used to design and size current front bands, underwire, and, by association, bra cups are not matching the true volume and shape of the breasts of women with medium, large, and hypertrophic breasts. To improve bra fit for these women, bra designers and manufacturers need to base the designs of these bra components on realistic breast volume and shape data of women who are likely to purchase their bras. Improving the design and fit of the bra front band and underwire, as well as the bra cups, could in turn also improve the long-term health of these women. This is particularly important for those women with large and hypertrophic breasts because these women commonly experience higher levels of musculoskeletal pain and discomfort than women with small breasts (BeLieu, 1994; Greenbaum et al., 2003; Kaye, 1972; Ryan, 2000; Spencer & Briffa, 2013).

The prevalence of incorrectly fitting bra straps was found to be significantly greater in women with small breasts (77%) compared to women with medium (63%), large (41%), and hypertrophic breasts (38%). To fit correctly, bra straps must match the dimensions of a woman's torso and the position of her breasts relative to her torso (Bowles & Steele, 2013; Coltman, McGhee, & Steele, 2015). The length of the straps on most encapsulation bras can be adjusted, although some bra straps are a set length and cannot be adjusted. Although bra strap designs incorporating a wide, nonelastic padded region aim to reduce pressure (force per unit area) at the strap–shoulder interface, this strap design can limit the length over which a strap can be adjusted (Bowles & Steele, 2013; Coltman et al., 2015). Furthermore, convertible straps, which allow different bra strap orientations, sometimes have insufficient length range when set in the crossover orientation compared to the vertical orientation. This lack of length may cause the straps to be too tight, increasing the downward force and, subsequently, the pressure experienced at the bra strap–shoulder interface at the crest of the shoulder. Bra strap pressures in previous studies have been found to range from 6.2 to 13.8 kPa in vertical bra strap orientation and 5.7 to 14.9 kPa in crossover bra strap orientation (Bowles & Steele, 2013; Coltman et al., 2015).

The range of encapsulation-style bras the participants wore to the test session included bras with adjustable and set length straps, convertible straps, and straps with shoulder pads. If bra straps are too long and cannot be shortened sufficiently, they will be too loose, which will affect the support offered by the bra, as straps provide secondary breast support (Bowles & Steele, 2013). When bra straps are too short and cannot be adjusted to fit correctly, the straps will be too tight, increasing the

strap–shoulder interface pressure and making them uncomfortable to wear (Bowles & Steele, 2013). In fact, previous researchers have found that straps are the most disliked feature of sports bras due to their tendency to slip off or cut into the shoulders as a consequence of being too loose or too tight, respectively (Bowles, Munro, & Steele, 2012). Considering that varying torso dimensions and bra strap orientations (vertical vs. crossover) will affect the strap length requirements (Coltman et al., 2015), bra designers and manufacturers could improve bra fit and breast support for women by basing strap dimensions on torso and breast height dimensions.

There were no significant differences among the four breast size categories in terms of the fit of the backband. Despite this, the fit of this component was poor across all breast size categories (43–58% incorrect fit). Given that a bra is a close-fitting garment, measurements of not only the breasts, but also the torso, must be highly accurate. Despite the anatomical variation in torso shape that is observed among women, the circumference of the backband must match the breadth of the woman's torso. This is particularly important because the backband is the primary structure assisting the bra cups in supporting the weight of the breasts (Loehr, 2013; McGhee et al., 2010; Figure 1). A backband that is too loose will reduce the level of breast support afforded from the bra, whereas a backband that is too tight will cause discomfort. Therefore, this measurement needs to be accurate across all breast sizes in order to ensure correct bra fit and, subsequently, sufficient breast support.

Given that bras are typically worn during activities of daily living for long durations (12–14 hr per day) over a lifetime (up to 60 or 70 years), it is important to ensure they fit properly. The front band and underwire components of the participants' own bras failed to fit significantly more women with medium, large, and hypertrophic breasts, whereas the bra strap design component failed to fit significantly more women with small breasts. The fit of the bra cup and backband were poor, irrespective of breast size. It is recommended that bra designers and manufacturers incorporate three-dimensional breast volume/shape and torso dimension data obtained for women across the breast size spectrum into their bra designs to improve the bra fit, breast support and, in turn, the long-term health of women.

Limitations and Future Research

As with all research, the results of the current study must be interpreted in light of the study limitations. The professional bra fit criteria used were for encapsulation-style bras. Consequently, the breast support of 11% of the cohort was not assessed because these women wore compression-style crop tops, singlet tops, or no bra to the test session. The development of professional bra fit criteria for this unstructured bra style is recommended for future research. Furthermore, two components of encapsulation-style bras, the backband and the straps, have the ability to be adjusted. However, in the current study, the bra fit assessment procedure did not assess whether adjusting these components would enable correct bra fit. Therefore, the incorrect fit prevalence of these two components of the encapsulation-style bra was potentially overestimated, and we are unsure as to whether the incorrect fit was too big or too small. Finally, given that the bra fit assessment was performed at one point in time, more frequent assessment over a greater duration of time is likely to increase the accuracy of the prevalence of incorrect bra fit of each component, and subsequently the conclusions drawn. We recommend future researchers assess bra fit in a large cohort of women who are followed longitudinally to confirm whether the bra fit habits of women vary over time.

Conclusions

Given that bras are typically worn during activities of daily living for long durations (12–14 hr per day) over a lifetime (up to 60 or 70 years), it is important to ensure they fit properly. The front band and underwire components of the participants' own bras failed to fit significantly more women with

medium, large, and hypertrophic breasts, whereas the bra strap design component failed to fit significantly more women with small breasts. The fit of the bra cup and backband were poor, irrespective of breast size. It is recommended that bra designers and manufacturers incorporate three-dimensional breast volume/shape and torso dimension data obtained for women across the breast size spectrum into their bra designs to improve the bra fit, breast support and, in turn, the long-term health of women. It is also recommended that women use professional bra fit services or educational resources/tools designed to assist women to fit their bras correctly.

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Declaration of Conflicting Interests

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