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Building Self-Confidence by Using a Sports Bra as an Everyday Bra - a Study Based on Pressure Analysis

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Abstract

Women often use sports bras when doing physical activities, but most women have recently shown interest in using sports bras as everyday bras. Therefore, this study used pressure analysis to identify a suitable sports bra that generates less pressure at the shoulder strap for all breast sizes. Among fashion design and engineering students, an interview was conducted at Zhejiang Sci-Tech University. Based on this random survey, women found more comfort in using sports bras as everyday bras, but the shoulder strap and waistband prevented them from doing it regularly. Therefore, this study emphasized only the shoulder straps because it was the most uncomfortable feature among others. More attention needs to be made to the strap width and neckline when selecting a sports bra because when it comes to females with breast sizes 34C and 36C, encapsulation types with cross-back designs are suitable. However, we noticed that the shoulder straps should be widened based on breast size. The encapsulation type with a racer back is recommended for women with breast size 38C.

Keywords

sports bra, pressure, comfortability, static motion, females.

1. Introduction

The comfort of garments has become a significant issue for fashion designers and consumers as women's lifestyles keep changing [1, 2]. Recently most women have paid close attention to undergarment comfort, and most people are using sports bras as everyday bras. A market research study done in 2019 by the NPD group noticed that shopping for sports bras rose from 8% in 2015 to 45% in 2018.

There are three types of sports bras: (a) compression, (b) encapsulation, and (c) a combination of both bras. Compression sports bras support the breast by firmly pressing both breasts against the breast wall, while encapsulation sports bras separate and support both breasts independently [3]. One primary importance of sports bras is to enhance women's stature by reducing the soft tissue's size to a basic breast shape. In as much as sports bras are designed to provide comfort to women's breasts, others with wrong-fitting effects can be enhanced to provide more confidence and comfort when using them as an everyday bra and during physical activity, given the suitable pressure ranges [4]. The pressure range required also shapes, sustains, and promotes good health [5-7]. Nevertheless, if the wrong sizes are used, women with bigger breasts usually get back, shoulder, and neck pain [7-10].

Pressure usually occurs when the body comes into contact with clothing. One can experience this type of pressure by wearing a tight sports bra [11, 12]. The pressure produced from sports bras varies based on the human posture, the motion involved, the structure and design of the sports bra, and the fiber components [13]. Sports bras have different features, but the shoulder strap was identified as the most uncomfortable feature [14]. It is in close contact with the human body and helps keep the bra's correct position [15-17]. The right sports bra size is required to prevent cutting in and slipping off. The fiber component used in making the strap is also an influencing factor in bra discomfort. Therefore, the material should be highly elastic [18, 19].

Zhou et al. [20] studied and analyzed breast motion during activities, and they finalized that compression sports bras with the following features are more comfortable and practical: the shallow neckline, cross back type, bound neckline, and nonadjustable wide strap. Also, Coltman et al. [18] studied vertically orientated and cross-back orientated straps based on standing static motion. They found that sports bras with vertically orientated straps (4.5 cm) are more suitable for women with larger breasts to reduce the pressure on the straps' encapsulation. Zhang et al. [21] suggested that the straps should be comprehensive with more cushions to acquire an even pressure distribution of the shoulder strap. Other sports bra features are equally essential, but research shows that more emphasis should be laid on the strap to limit discomfort. However, the above research was based on the three modes of locomotion. Thus, this study experimented on the strap and focused on static motion to confirm the sports bra that is most suitable for sedentary workers and students.

Researchers studied the features of sports bras and compared compression sports bras with encapsulation sports bras [22]. They deduced that the compression sports bra produces more significant breast elevation and increases breast comfort. Bowles et al. [23] found that compression sports bras with higher necklines restrict the upper movement of the breast more than encapsulation sports bras. However, Starr et al. [24] argued that encapsulation sports bras are more significant in breast movement than compression sports bras. Additionally, Wood K et al. [25] argued that encapsulation types are recommended for females with breast sizes C to D.

In contrast, compression types are designed for females with breast sizes A to B. A study on breast motion confirmed that compression sports bras are more comfortable when women run at 10.8 km/h [26]. Ayres et al. [27] also noticed that compression sports bras with nylon, polyester, and elastane reduce thermal discomfort compared to those with polyester fabrics.

Based on the above literature, most research has focused on breast motion, compression, and encapsulation sports bras when performing different physical activities. However, less emphasis has been placed on females who use sports bras as everyday bras. Nevertheless, it was identified that using a sports bra every day is essential because of its modesty, style, comfort, and support. Therefore, this study used pressure sensors to identify a sports bra that will make women with different breast sizes confident and comfortable when using sports bras as everyday bras.

2. Material and Methods

2.1. Study Participants

Sports bras are designed to provide comfort for all women. Hence, this study used twelve women with four different bra sizes, which include bra sizes 32C, 34C, 36C, and 38C. Women from Zhejiang Sci-Tech University were recruited for this study, with two participants for each bra size. All participants had no history of pregnancy, breastfeeding, or surgery.

Activity one Activity two

Fig. 1. Static motion of activities one and two

A pressure analysis was made because pressure from sports bras can lead to lousy breathing, stop or reduce the pulse and blood circulation, and cause damage to human physical and mental health. Therefore, this study aimed to test the pressure to stop these problems from occurring. In this study, a Novel Pliance® pressure machine was used in analyzing pressure. The pressure sensors were positioned on the left-center clavicle of the shoulder. A repeated test was done for all the subjects during all activities, which lasted for 10-20 sec. Each activity lasted about 97 sec with 5 minutes rest intervals before the next activity occurred. Before the experiment, a model demonstrated the position to all participants one after the other, after which all participants practiced it twice before the experiment, and all of them willingly chose to participate.

Furthermore, two static activities were used for this study. In activity one, participants sat on a comfortable chair with their hands on a desk, while in activity two, the participants placed their hands by their sides, as shown in Figure 1. These activities were selected because most people, especially sedentary workers and students, are in this position daily. It is justified because each participant had to undergo the activities three times to get the correct average mean. Table 1 shows details of the subjects used in the work. On the table, a mark was made on both sides, from which the participants got a fair idea where to put their arms.

2.2. Bra Sample

Four sports bras were used in this study, including two cross-back designs with the encapsulation bra type and two racerback designs with the compression bra type. The design features for all sports bras are shown in Figure 2. These sports bras were chosen among ten other sports bras because during the random interview conducted at Zhejiang Sci-Tech University, 90% of the women made it clear that they use these selected sports bras as everyday bras. Additionally, Zhou et al. [20] suggested that cross-back designs generate more comfort for women. Also, encapsulation sports bras are recommended for women with bra sizes L and XL. In contrast, compression sports bras are recommended for women with S and M bra sizes, but experimental data did not prove this [25]. Therefore, this study focused on all breast sizes [32C (s), 34C (m), 36C (l), and 38C (xl)] to identify which sports bra produces less pressure when females use sports bras as everyday bras.

Table 1 gives descriptive statistics of all the sports bras and activities. Regarding activity 1, women with bra size 32C

PRODUCTS DESIGN		A	B	C	D
	Front				
	Back				

		A	B	C	D
DESIGN FEATURES	Neckline Elongation	10cm	10cm	8.65cm	8.7cm
	Closure	Hook and Eye	Hook and Eye	No	No
	Inner Lining	Molded	Molded	Molded	Molded
	Back Design	Cross Back	Cross Back	Racer Back	Racer Back
DESIGN TYPE		Encapsulation	Encapsulation	Compression	Compression

Fig. 2. Sports bra type, structure, and features

Activity 1	SD	Mean	Total	Activity 2	SD	Mean	Total
SBAS	0.10247	1.1783	8.4988	SBAS	0.06310	1.2229	8.1627
SBBS	0.08513	2.9373		SBBS	0.05913	2.7470	
SBCS	0.08285	2.9181		SBCS	0.08044	2.8289	
SBDS	0.08180	1.4651		SBDS	0.05539	1.3639	
SBAM	0.04561	1.9289	8.341	SBAM	1.18943	4.8964	11.3289
SBBM	0.08741	1.3771		SBBM	0.09993	1.2398	
SBCM	0.17233	1.5205		SBCM	0.09768	1.7578	
SBDM	0.18020	3.5145		SBDM	0.27294	3.4349	
SBAL	0.07443	4.0627	13.735	SBAL	0.06487	5.1554	14.8831
SBBL	0.05657	2.3578		SBBL	0.04227	2.3771	
SBCL	0.09303	3.5157		SBCL	0.16658	3.6133	
SBDL	0.08189	3.7988		SBD2L	0.05344	3.7373	
SBAXL	0.17653	5.1133	11.3278	SBAXL	0.05205	5.5325	11.0529
SBBXL	0.05375	1.8253		SBBXL	0.03496	1.8108	
SBCXL	0.08225	2.9699		SBCXL	0.10271	2.3554	
SBDXL	0.07564	1.4193		SBXL	0.07208	1.3542	

Table 1. Descriptive Statistics for all sports bras and breast sizes

generated a total mean pressure of 8.5 kPa, while activity 2 came to 8.2 kPa. Concerning women with bra size 34C, activity 2 produced more pressure, with a total mean of 11.3 kPa, than activity 1, which produced 8.3kPa. Again, activity 2 generated more pressure than activity 1, with an absolute mean difference of 1.1 kPa. Lastly, for women with breast size 38C, activity 2 generated more pressure than activity 1, with an absolute mean difference of 0.3 kPa. Summing up all the subjects' means, activity 2 generated more pressure than activity 1, which may be due to the sitting position of the subjects.

3. Results and discussion

Table 2 shows the paired sample t-test for females with breast size 32C for all four sports bras during activities 1 and 2. During activity 1, sports bras A and B were paired because they have the same features. The mean difference between sports bras A and B was -1.75 kPa. Therefore, sports bra B's pressure was -1.75 kPa higher than that of sports bra A. There was a significant difference between sports bras A and B because their significance value was $p<0.05$. It is concluded that sports bra B generates

		Paired Differences			t	Sig. (2-tailed)
		Mean	95% Confidence Interval of the Difference			
			Lower	Upper		
Pair 1	SBA1 – SBB1	-1.75904	-1.78935	-1.72872	-115.423	0.000
Pair 2	SBA2 – SBB2	-1.52410	-1.54609	-1.50210	-137.863	0.000
Pair 3	SBC1 – SBD1	1.45301	1.42980	1.47623	124.519	0.000
Pair 4	SBC2 – SBD2	1.46506	1.44037	1.48975	118.027	0.000

SBA1 – Sports bra A, activity 1
SBA2 – Sports bra A, activity 2
SBC1 – Sports bra C, activity 1
SBC2 – Sports bra C, activity 2

SBB1 – Sports bra B, activity 1
SBB2 – Sports bra B, activity 2
SBD1 – Sports bra D, activity 1
SBD2 – Sports bra D, activity 2

Table 2. Paired samples T-Test for breast size 32C during activities 1 and 2

more pressure than sports bra A. Concerning activity 2, the mean pressure difference between sports bra A and B was -1.52 kPa, showing that sports bra B had a higher mean pressure than sports bra A. Also, the mean difference between the two bras was significant at $p<0.05$. It was concluded that there is a pressure difference between the two cross-back sports bras of the encapsulation type during both activities. It may be due to the strap's thickness and/or neckline design.

Regarding the racer back sports bras of the compression type chosen, sports bras C and D had a mean difference of 1.45 kPa during activity 1, which shows that sports bra D's mean pressure was 1.45 kPa lower than that of sports C. Both sports bras differed significantly at $p=0.05$. In regards to activity 2, both sports bras were significantly different. Sports bra D's mean pressure was 1.46 kPa lower than that of sports bra C, and both sports bras were significant at $p=0.05$. There was a massive difference between the two racer-back bras of the compression type during both activities. Therefore, the mean pressure should be used to identify a sports bra that produces less pressure.

The paired sample t-test for cross-back sports bras with encapsulation features and sports bras with compression features for females with breast size 34C are analyzed in Table 3. During activity 1, sports bra B generated a lower mean pressure than sports bra A at 0.55 kPa. There was a significant mean difference between the two sports bras at $p<0.05$. At this stage, sports bra B was more comfortable than sports bra A during activity 1. With activity 2, there was a substantial mean difference between the two sports bras because the mean pressure for sports bra B was 3.65 kPa lower than for sports bra A. Additionally, both sports bras were significant at $p<0.05$.

Regarding racerback sports bras of the compression type, sports bra B generated a higher mean pressure difference of -1.99 kPa than that of sports bra A. There was a significant difference between the two sports bras at $p<0.05$, while activity 2 yielded a mean pressure difference of -1.67kPa between both sports bras. In this case, sports bra C generated less pressure than sports bra D, with a significance value of $p<0.05$. Further analysis was made to identify the sports bra that produces more comfort for females with breast size 34C, shown in Figure 4.

Table 4 represents the paired sample t-test for females with breast size 36C during activities 1 and 2. With cross-back sports bras of the encapsulation type, the mean difference between sports bra A and sports B was 1.70 kPa during activity 1. Sports bra B was 1.70 kPa lower than sports bra A. The significance value for both sports bras was $p<0.05$. With activity 2, sports bra B had a lower mean pressure difference of 2.77 kPa than sports bra A. The significance value for both sports bras was $p<0.05$.

Concerning racerback sports bras of the compression type, sports bra D generated a higher mean pressure of -0.28 kPa than sports bra C during activity 1. The significance difference between the sports bras was $p<0.05$. Regarding activity 2, the mean pressure difference between both sports bras was -0.12 kPa. The significance value for both sports bras was $p<0.05$. Among all the sports bras and activities tested, there is a significant difference between all paired sports bras. Therefore, further analysis was made to identify a sports bra women with breast size 36C can use as an everyday bra.

Table 5 shows the paired sample t-test for women with breast size 38C during activities 1 and 2. Sports bra B yielded a lower mean pressure difference of 3.28 kPa than sports bra A during activity 1. Both bras were significantly different at $p<0.05$, while activity 2 generated a mean pressure difference of 3.72 kPa between both sports bras. Sports bra B's mean pressure was 3.72 kPa was higher than sports bra A's. They generated a significance value of $p<0.05$.

Regarding racerback sports bras of the encapsulation type, the mean pressure difference between sports bras C and D during activity 1 was 1.55 kPa. Sports bra C generated less pressure than sports bra D with a significant difference, while with activity 2, sports bra D produced a lower mean pressure of 1.00 kPa than sports bra C. The significance value for both sports bras was $p<0.05$. Due to the difference in all paired sports bras, a more explicit graph is shown in Figure 6 to show the sports bra that produces less pressure for women with larger breasts who use sports bras as everyday bra.

		Paired Differences			t	Sig. (2-tailed)
		Mean	95% Confidence Interval of the Difference			
			Lower	Upper		
Pair 1	SBA1 – SBB1	0.55181	0.53241	0.57121	56.585	0.000
Pair 2	SBA2 – SBB2	3.65663	3.39781	3.91544	28.106	0.000
Pair 3	SBC1 – SBD1	-1.99398	-2.06793	-1.92002	-53.634	0.000
Pair 4	SBC2 – SBD2	-1.67711	-1.73481	-1.61940	-57.818	0.000

SBA1 – Sports bra A, activity 1
SBA2 – Sports bra A, activity 2
SBC1 – Sports bra C, activity 1
SBC2 – Sports bra C, activity 2

SBB1 – Sports bra B, activity 1
SBB2 – Sports bra B, activity 2
SBD1 – Sports bra D, activity 1
SBD2 – Sports bra D, activity 2

Table 3. Paired samples test for breast size 34C during activities 1 and 2

		Paired Differences			t	Sig. (2-tailed)
		Mean	95% Confidence Interval of the Difference			
			Lower	Upper		
Pair 1	SBA1 – SBB1	1.70482	1.67978	1.72986	135.457	0.000
Pair 2	SBA2 – SBB2	2.77831	2.76465	2.79197	404.575	0.000
Pair 3	SBC1 – SBD1	-0.28313	-0.30571	-0.26056	-24.951	0.000
Pair 4	SBC2 – SBD2	-0.12410	-0.16123	-0.08696	-6.648	0.000

SBA1 – Sports bra A, activity 1
SBA2 – Sports bra A, activity 2
SBC1 – Sports bra C, activity 1
SBC2 – Sports bra C, activity 2

SBB1 – Sports bra B, activity 1
SBB2 – Sports bra B, activity 2
SBD1 – Sports bra D, activity 1
SBD2 – Sports bra D, activity 2

Table 4. Paired samples test for breast size 36C during activities 1 and 2

		Paired Differences			t	Sig. (2-tailed)
		Mean	95% Confidence Interval of the Difference			
			Lower	Upper		
Pair 1	SBA1 – SBB1	3.28795	3.24396	3.33194	148.690	0.000
Pair 2	SBA2 – SBB2	3.72169	3.70761	3.73577	525.813	0.000
Pair 3	SBC1 – SBD1	1.55060	1.52282	1.57838	111.028	0.000
Pair 4	SBC2 – SBD2	1.00120	0.97721	1.02520	83.019	0.000

SBA1 – Sports bra A, activity 1
SBA2 – Sports bra A, activity 2
SBC1 – Sports bra C, activity 1
SBC2 – Sports bra C, activity 2

SBB1 – Sports bra B, activity 1
SBB2 – Sports bra B, activity 2
SBD1 – Sports bra D, activity 1
SBD2 – Sports bra D, activity 2

Table 5. Paired samples test for breast size 38C during activities 1 and 2

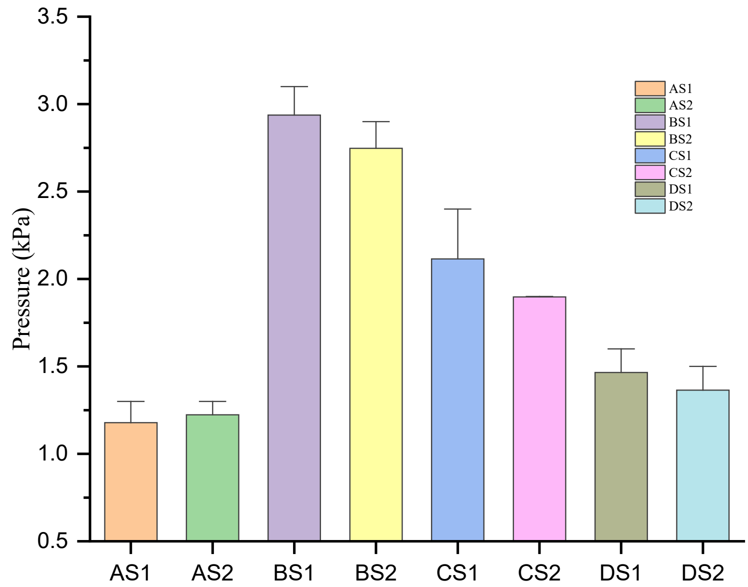
Figure 3 shows the pressure distribution of women with breast size 32C during activities 1 and 2. In analyzing the shoulder strap of sports bra A during activity 1, the mean pressure ± SD was 1.17 kPa ± 0.10 kPa, respectively, with a standard error mean (SEM) of 0.01. In contrast, activity 2 generated a mean pressure ± SD of 1.22 kPa ± 0.63 kPa, respectively, with an SEM of 0.00. Therefore, activity 1 produced less pressure than activity 2. In regard to sports bra B, as shown in the graph below, it is clearly shown that activity 2 produced less pressure than activity 1. Specifically, activity 1 produced a mean pressure ± SD of 2.93 kPa ± 0.08 kPa, respectively, with an SEM of 0.00, while activity 2 had a mean ± SD of 2.74 kPa ± 0.05 kPa respectively, with an SEM of 0.00.

Concerning sports bra C, the mean pressure ± SD of activity 1 was 2.91 kPa ± 0.08 kPa with an SEM of 0.00, while activity 2 originated a mean pressure ± SD of 2.82 kPa ± 0.08 kPa respectively with an SEM of 0.00. With sports bra C, activity 2 yielded less pressure than activity 1. Lastly, sports bra D in activity 1 generated a mean pressure ± SD of 1.46 kPa ± 0.08 kPa, respectively, with an SEM of 0.00. In contrast, activity 2 had a mean pressure ± SD of 1.36 kPa ± 0.05 kPa, respectively, with an SEM of 0.00.

The above analysis shows that sports bra A produced more comfort at the shoulder strap for women with breast size 32C during both activities. Therefore, females (breast size 32C) who prefer to use sports bras as everyday bras should purchase cross-back sports bras of the encapsulation type and with a shallow neckline (10.1cm).

Figure 4 shows the pressure distribution for women with breast size 34C during activities 1 and 2. Sports bra A led to a mean pressure ± SD of 1.92 kPa ± 0.04 kPa with an SEM of 0.00 during activity 1, while activity 2 yielded a mean pressure ± SD of 4.89 kPa ± 1.18 kPa with an SEM of 0.13. In this case, activity 1 generated less pressure than activity 2. In regard to sports bra B, activity 1 originated a mean pressure ± SD of 1.37 kPa ± 0.08 kPa with an SEM of 0.00, while activity 2 produced a mean pressure ± SD of 1.23 kPa ± 0.09 kPa with an SEM of 0.01. With sports bra B, activity 2 yielded less pressure than activity 1 with a mean interval difference of <0.1 kPa.

Thirdly, the mean pressure ± SD of sports bra C during activity 1 was 1.52 kPa ± 0.17 kPa with an SEM of 0.01, while in activity 2, the mean pressure ± SD was 1.75 kPa ± 0.09 kPa with an SEM of 0.01. Activity 1 generated less pressure than activity 2 with a mean interval <0.2 kPa. Lastly, the mean pressure ± SD of sports bra D during activity 1 was 3.51 kPa ± 0.18 kPa with an SEM of 0.01, while activity 2 led to a mean pressure ± SD 3.43 kPa ± 0.27 kPa and an SEM of 0.02. Activity 2 still generated less pressure than activity 1, with a mean interval of <0.1 kPa. Among the four sports bras, sports bra B was identified as the most comfortable sports bra for women with breast size 34C.



AS1 – Sports bra A, activity 1
AS2 – Sports bra A, activity 2
BS1 – Sports bra C, activity 1
BS2 – Sports bra C, activity 2
CS1 – Sports bra B, activity 1
CS2 – Sports bra B, activity 2
DS1 – Sports bra D, activity 1
DS2 – Sports bra D, activity 2

Fig. 3. Pressure distribution for breast size 32C during activities 1 and 2.

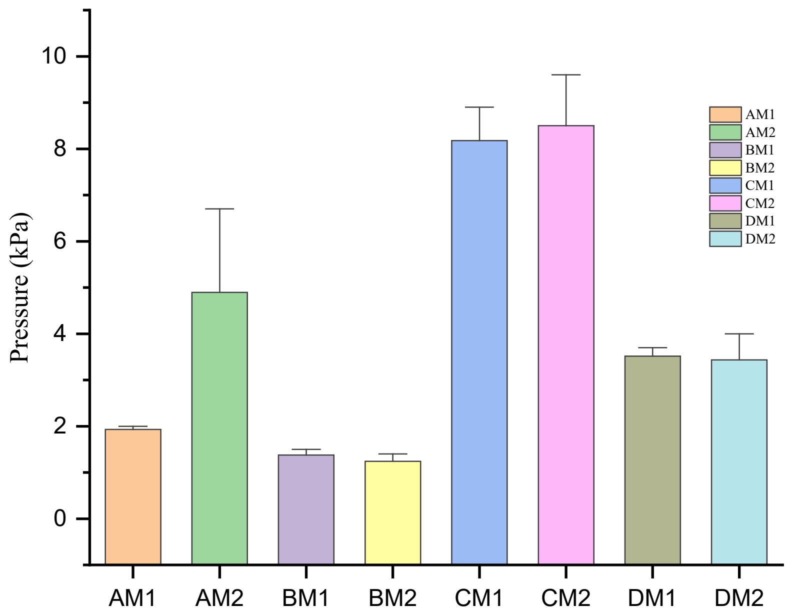


Fig. 4. Pressure distribution for breast size 34C during activities 1 and 2

The pressure distribution for females with breast size 36C during activities 1 and 2 is shown in Figure 5. Concerning sports bra A, activity 1 generated a mean pressure ± SD of 4.06 kPa ± 0.07 kPa with an SEM of 0.00, while activity 2 produced a mean pressure ± SD of 5.15 kPa ± 0.06 kPa with an SEM of 0.00. Among all the four sports bras tested, sports bra A generated more pressure. Activity 1 generated less pressure than activity 2, with a mean interval difference of <1.2kPa. During activity 1, sports bra B led to a mean pressure ± SD of 2.37 kPa ± 0.05 kPa with an SEM of 0.00, while activity 2 originated a mean pressure ± SD of 2.37 kPa ± 0.04 kPa with an SEM of 0.00. The same level of pressure was distributed for both activities. Regarding sports bra C, activity 1 produced a mean pressure ± SD of 3.51 kPa ± 0.09 kPa with an SEM of 0.01.

In contrast, in activity 2, the mean pressure ± SD was 3.61 kPa ± 0.16 kPa with an SEM of 0.01. Due to this, activity 1 generated more comfort than activity 2 with a mean interval of <0.1. Lastly, with activity 1, the mean pressure ± SD was 3.79 kPa ± 0.08 kPa with an SEM of 0.00. In contrast, activity 2 led to a mean pressure ± SD of 3.73 kPa ± 0.53 kPa and an SEM of 0.00 regarding sports bra D. Therefore, both activities generated the same pressure level. Based on the above analysis, a cross-back sports bra (B) of the encapsulation type is more comfortable for females with breast size 36C when a sports bra is used as an everyday bra.

Figure 6 shows the pressure distribution of females with breast size 38C during activities 1 and 2. Concerning sports bra A for activity 1, the mean pressure ± SD was 5.11 kPa ± 0.17 kPa with an SEM of 0.01, while activity 2 generated a mean pressure ± SD of 5.53 kPa ± 0.05 kPa with an SEM of 0.00. Therefore, activity 1 produced less pressure than activity 2, with a mean interval of <0.04 kPa. In regard to sports bra B, both activities distributed the same pressure. Specifically, activity 1 produced a mean pressure ± SD of 1.82 kPa ± 0.05 kPa with an SEM of 0.00, while activity 2 had a mean pressure ± SD of 1.81 kPa ± 0.05 kPa with an SEM of 0.00.

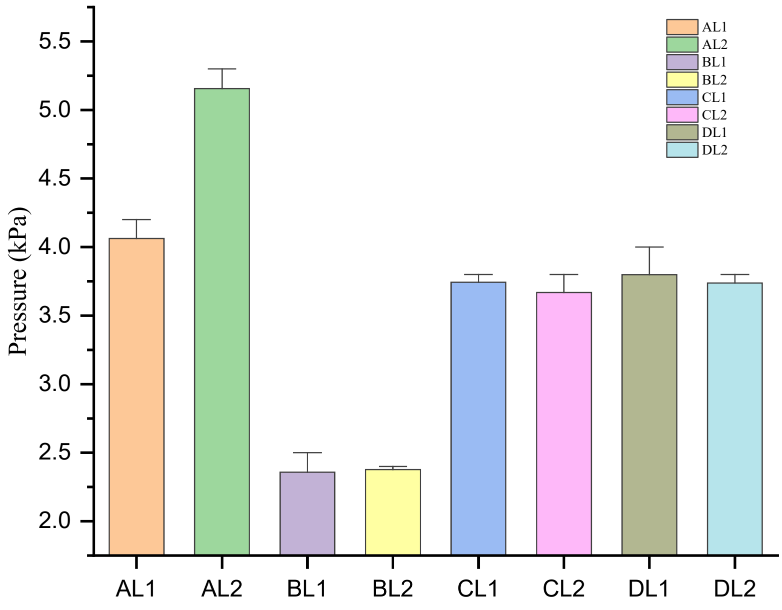


Fig. 5. Pressure distribution for breast size 36C during activities 1 and 2

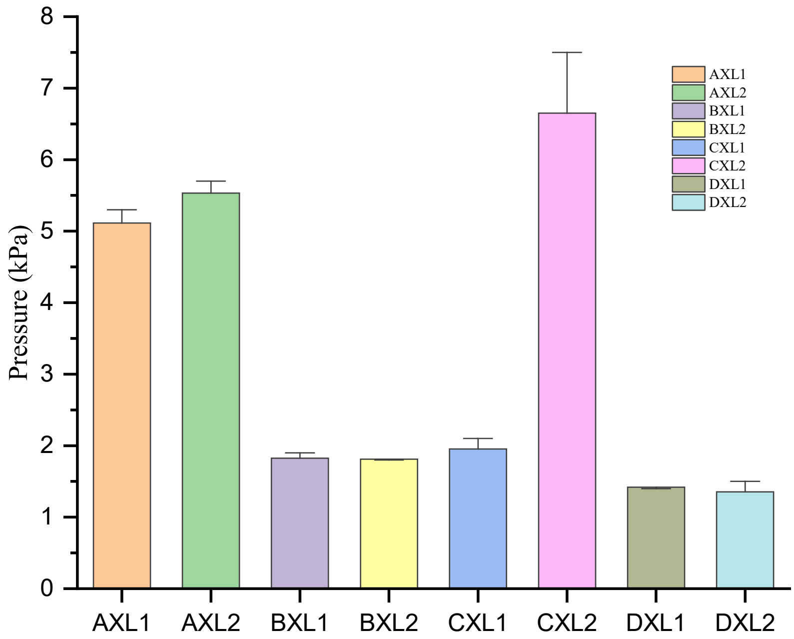


Fig. 6. Pressure distribution for breast size 38C during activities 1 and 2

Concerning sports bra C, the mean pressure ± SD of activity 1 was 2.96 kPa ± 0.08 kPa with an SEM of 0.00, while activity 2 generated a mean pressure ± SD of 2.96 kPa± 0.08 kPa and an SEM of 0.01. With sports bra C, activity 1 yielded more pressure than activity 2, with a mean interval of <0.5 kPa. Lastly, with sports bra D, activity 2 yielded less pressure with a mean pressure ± SD of 1.41k Pa ± 0.07 kPa with an SEM of 0.00, while activity 1 led to a mean pressure ± SD of 1.35 kPa ± 0.07 kPa and an SEM of 0.00. Based on the above analysis, it is shown that sports bra D is more comfortable for females with larger breast sizes. Therefore, females (breast size 38C) who prefer to use sports bras as everyday bras should purchase racer-back sports bras of the compression type.

4. Conclusion

The shoulder strap is an essential feature of a sports bra. Therefore, women must pay close attention to selecting appropriate sports bras that suit them best. One can select a comfortable sports bra by choosing a suitable size and relevant sports bra type with the proper features. Additionally, the sports bra should be considered because one suitable for dynamic motions might not be good enough for static motions; therefore, females should know when and where to wear a particular bra. Most researchers evaluated different sports bras using different physical activities. Li et al. [28] concluded that excessive breast motion automatically leads to high shoulder strap pressure and under-band pressure. Therefore, rigid shoulder straps with compression features should be used to reduce breast discomfort. On the other hand, Zhou and Yu [29] argue that a wider shoulder strap distributes an even pressure at the shoulder strap. Therefore, it will help in limiting pressure discomfort [30].

This study shows that different sports bras are required for different breast sizes. For females with breast size 32C, this study confirms that the encapsulation type with the following features is comfortable for females with smaller breast sizes: a cross back, shallow neckline (10 cm), hook and eye closure at the back, and a 2 cm shoulder strap width. At the same time, sports bras with the same features but wider shoulder straps (3.4 cm) are unsuitable for females with the same breast size. Therefore, females with smaller breast sizes should focus more on the shoulder strap width when using sports bras as everyday bras.

Concerning females with breast size 34C, the encapsulation type with the following features is recommended when the static motion is involved (sitting): cross back, shallow neckline (10 cm), hook and eye closure, and 3.4 cm strap width. However, racerback sports bras of the compression type, with a no closure, semi-shallow neckline (8.7 cm) and a 4 cm strap width are uncomfortable for females with breast size 34C when the static motion is involved.

Regarding females with breast size 36C, [29] stated that wider shoulder straps with compression features are suitable for females with larger breast sizes. This study confirms that wider straps are comfortable for females with breast size 36C, but with encapsulation features. This study also proves that sports bras with encapsulation features can provide comfort and discomfort simultaneously. Females with breast size 36C identified encapsulation sports bras with the following features as the most comfortable: a cross back, shallow neckline (2.5 cm), hook and eye closure, and a strap of 3.4 cm. At the same time, sports bras with the same features but different strap widths were identified to be uncomfortable for females with bigger breast sizes, with the difference in straps being 1.3 cm.

Lastly, the Wood K et al. [25] analysis concluded that encapsulation types are recommended for females with bra sizes C to D, but this study shows otherwise. This study shows that compression types with the following features are suitable for females with a more prominent breast size racer back, no opening, a semi-shallow neckline (8.65 cm), and a 3.1 cm strap width. While encapsulation sports bras with the following features are not recommended for females with enormous breasts: a cross back, shallow neckline (2.5 cm), hook and eye closure, and a strap of 3.4 cm. This study shows that encapsulation types with cross-back features and thinner straps are unsuitable for females with larger breasts.

Declaration of Conflicting Interests

The author declares no conflict of interest.

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