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Comparative Analysis of Upper Body Shape for Chinese and Bangladeshi Women Based on 3D and 2D Measurements

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***Keywords*— Anthropometry, Body shape classification, Garment sizing, Upper body Morphology.**

***Abstract*—** *This study aims to compare the upper body morphology of young Chinese and Bangladeshi women and to evaluate whether existing garment sizing methods adequately accommodate population specific upper body shape characteristics. An integrated anthropometric approach combining three dimensional (3D) body scanning, two dimensional (2D) image based measurement, and manual anthropometry was used to obtain 16 upper body descriptors (dimensional, circumferential, thickness, and angular) from women aged 18–30 years in China (n = 189) and Bangladesh (n = 20). Descriptive statistics, principal component analysis (PCA), factor analysis, and K means clustering were applied to extract dominant morphological factors and classify upper body shape types, which were then interpreted with reference to national and international sizing criteria. In this sample of young women, Chinese participants generally exhibited broader shoulders, greater chest convexity, wider thoracic dimensions, and comparatively flatter waist–hip profiles, whereas Bangladeshi participants tended to show more sloping shoulders, thicker neck regions, reduced anterior chest projection, deeper waists, and more prominent hips. Three principal components and three upper body shape categories were identified in each population, but the key contributing variables and the distribution of individuals across clusters differed between countries. Current sizing systems cover most Chinese body types in the sample, though they do not fully address extreme proportions, while in Bangladesh, the lack of a unified national sizing standard appears to be associated with greater size–shape mismatches. This research provides a cross national, data driven comparison of female upper body morphology using combined 3D and 2D measurement techniques and a shared set of upper body descriptors. The results support the development of population adapted sizing systems and body*

shape oriented garment design strategies aimed at improving apparel fit, wearer comfort, and production efficiency.

I. INTRODUCTION

Understanding human morphology is essential in a number of fields, such as fashion design, ergonomics, and healthcare. Population disparities in body measures are influenced by a variety of factors, including genetics, environment, lifestyle, and cultural norms. Comfortable, well-fitting clothing is becoming more and more popular as the global economy expands and material living standards rise. However, human comfort is influenced by clothing and the environment in a complex and subjective way (G. Song, 2011). The relationship between a garment's size and shape and the human body is known as apparel fit (Chen, 2007). In the apparel industry, clothing fit is regarded as the most important component in assessing clothing quality and consumer happiness (Xu et al., 2023). Clothing fit is influenced by the wearer's body form and dimensions. Shape analysis is connected to style design, pattern creation, production, and virtual fitting.

It is also important for creating personalized apparel. For standardizing the size (*ISO-TR-10652-1991*, n.d.), which is followed internationally. Physical measurements are the most often used technique for obtaining body measurements (Han & Nam, 2011). There are several methods for body measurements. While current methods use 3D scanners to automatically extract exact measurements from digital data, traditional equipment like calipers and tape measures allow for manual measuring (Bartol et al., 2021). The conventional apparel sector has been replaced by automation and digitalization due to the quick development of computer information technology, which propels the expansion of online retailing and electronic commerce (Gu et al., 2020). The women's clothing industry has long struggled with fit issues (Chen, 2007). The fashion business uses 3D human body scan data for virtual fitting, tailoring, mannequin construction, and sizing surveys (Kim & Kim, 2018). Researchers have classified female body types using different techniques in recent years, for example, principal component analysis, body surface angle classification, feature index classification, side profile classification, etc. Size surveys, size group formulation, and body shape classifications are the outcomes of attempts to create sizing standards. Body shape studies are conducted in tandem with sizing difficulties (Vuruskan & Bulgun, 2011). Age is one of the most crucial variables among the many factors generating shape and postural differences that affect clothing fit. One's body shape can be influenced by the amount of activity and work choices (Bolaji et al., 2025). People's discontent with how their clothes fit tends to grow as they become older (H. K. Song et al., 2022). The female upper body has a particularly complex shape due to its many elements, including neck anteversion, shoulder slope, and the convexity of the back, bust, and hip.

Female upper-body measurements have been the subject of several studies, but the majority have been limited to single-population analyses, age ranges, or anthropometric factors. Although there are limited cross-cultural studies that employ integrated 2D and 3D measurement frameworks to systematically compare female upper-body morphology, there is significant potential for research in this area. Notably, China and Bangladesh, two of the world's leading apparel manufacturers, are at the forefront. China is a global leader in apparel technology and body measurement research, while Bangladesh is one of the largest garment manufacturing countries in the world. Despite their prominent roles in the global apparel industry, comparative anthropometric studies between these two populations are scarce. Furthermore, Chinese and Bangladeshi women belong to distinct regional and ethnic groups East Asian and South Asian—resulting in significant differences in body proportions and upper-body morphology. By comparing these two populations, researchers can gain valuable insights for developing population-specific sizing systems and improving garment fit in international apparel markets. The selection of women from China and Bangladesh as experimental subjects is supported by both industrial and anthropometric considerations. To address this critical research gap, the present study provides a comprehensive cross-national comparison of upper-body shape characteristics between young adult women from China and Bangladesh. This study provides a more comprehensive description of upper-body morphology by using a single set of sixteen upper-body descriptors that include dimensions, circumferential, thickness, and angular factors. Advanced multivariate statistical techniques, including descriptive analysis, principal component analysis (PCA), factor analysis, and K-means clustering, were applied to extract dominant morphological features and identify representative upper-body shape types. Additionally, the study's usefulness for mass customization, virtual garment fitting applications, and worldwide apparel sizing systems was increased by evaluating the generated classifications against both national and international size standards.

II. METHODS

2.1 Anthropometry Experiment

Body measurements were collected using three different methods: photographic measurement, 3D body scanning, and manual measurement. The study subjects were female college students from Bangladesh and China, aged between 18 and 30 years, with sample sizes of 189 for China and 20 for Bangladesh.

For the 2D body measurement method, digital images of the subjects were captured using a Sony A6000 camera with a resolution of 4000 × 6000 pixels(Xu et al., 2023). Three-dimensional body measurements were obtained using the American [TC]² 3D body scanner, which collected human images, three-dimensional point cloud data, and body models. During the scanning process, the temperature and relative humidity of the experimental environment were maintained at 27 ± 3 °C and 60% ± 10%, respectively. Manual measurements were conducted using a height meter and a flexible measuring tape. During the measurement process, all participants were required to stand barefoot in a designated footprint position while maintaining normal breathing. They wore skin-colored, form-fitting clothing and covered their hair with a cap to minimize measurement interference. For front-view photographs, the subjects were instructed to raise their arms and slightly bend them. For side-view photographs, their arms were positioned close to their sides to clearly reveal the front of the abdomen and the back of the waist. The standing posture of the subjects during photography is illustrated in Figure 1(a). Figure 1(b) depicts the human body's standing positions during scanning on the American [TC]² 3D body scanner. To ensure precise scanning, the 3D scanner recommends specific footprint locations and hand hangers. Three-dimensional scanning data is extracted using ImageWare software.

Fig.1(a): 2D images

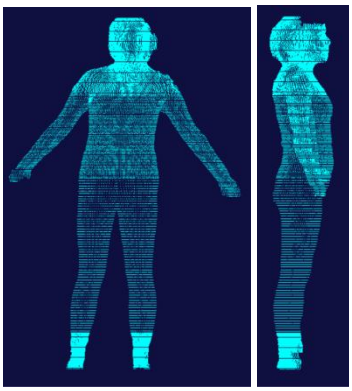

Fig.1(b) TC] ² 3D body scanning

Source(s): Author's own creation

2.2 Determination of shape descriptors

The area from the side neck line to the hip line, excluding the arms, was referred to as the upper body. The human upper body's shape variations are mainly centered in two areas for the front view, which are indicated by red lines in Figure 2. The curve that connects the armpit point (ArP), waist point (WP), and side hip point (HP) is one component; the other is the curve that forms the shoulder slope between the side neck point (SNP) and the shoulder point (SP). The bust's convexity and the back's "S" shape, which is composed of the hip convex, waist concave, and back convex, are the two primary ways the shape difference is visible from the side.

Height (H), neck width (NW), neck circumference (NC), shoulder width (SHW), back width (GW), bust thickness (BT), bust circumference (BC), waist width (WW), waist thickness (WT), waist circumference (WC), hip width (HW), hip thickness (HT), hip circumference (HC), back angle (GA), shoulder angle (SHA), and chest convex angle (BCA) are the sixteen interconnected elements which have been identified, taking into consideration both the upper body's overall and local characteristics.

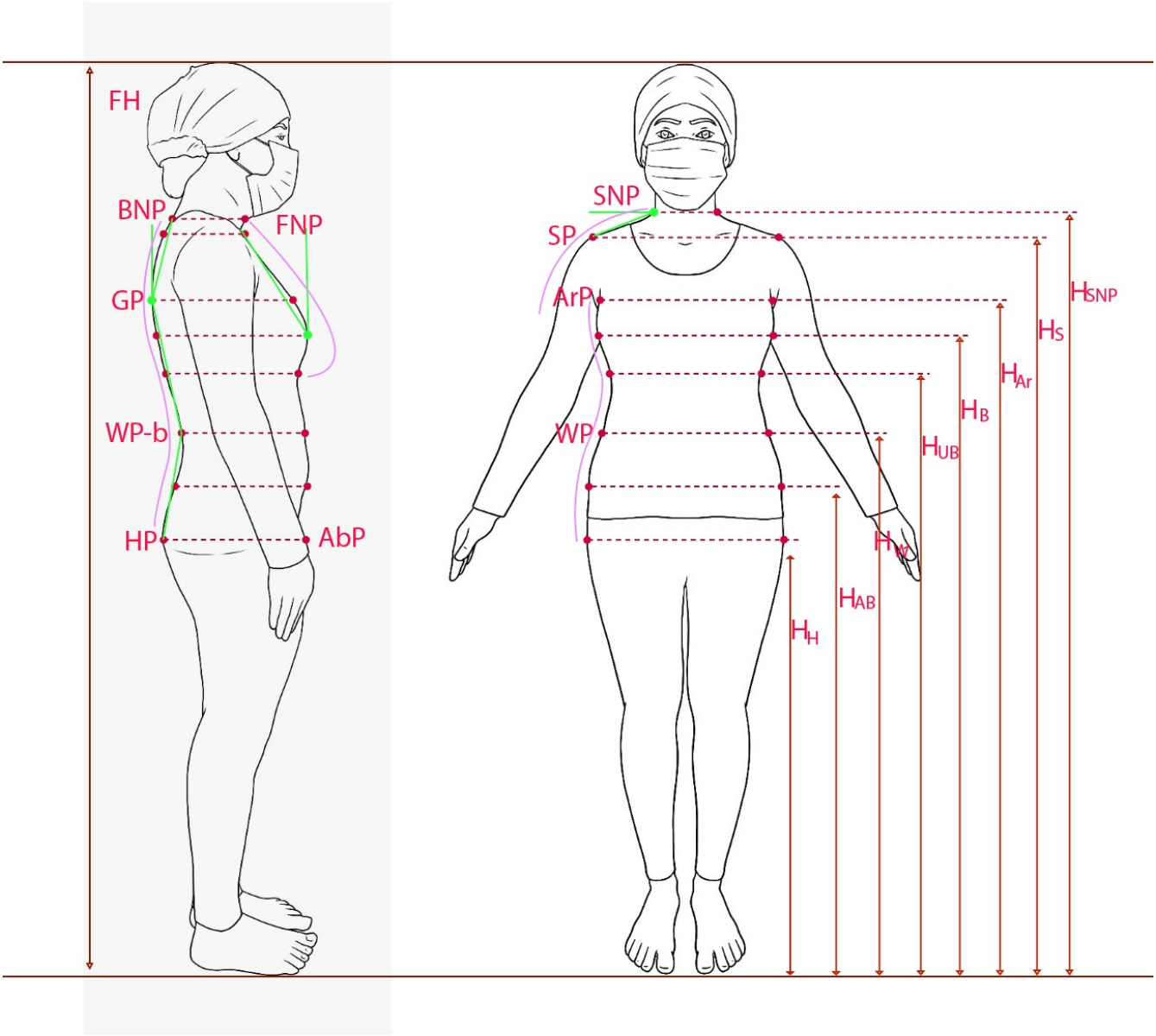

Fig.2

Source(s): Author's own creation

III. RESULTS AND DISCUSSION

3.1 Overall body type classification comparison

First, the data were assessed for normality using SPSS software to evaluate the distribution of women's upper body measurements from both China and Bangladesh.

A descriptive analysis was performed on the upper body shape data of young Chinese and Bangladeshi women. The basic descriptive statistical values of the body shapes of Bangladeshi and Chinese young women are presented in Table 1.

Table:1

Measurement point	Unit	Country	Minimum value	maximum value	mean	standard deviation	variance
Height	cm	Chinese	160.20	191.00	173.4820	5.39961	29.156
		Bangladeshi	148.00	168.00	153.1000	5.52411	30.516

Shoulder slope	cm	Chinese	19.07	36.12	26.5169	3.20371	10.264
		Bangladeshi	20.80	35.28	27.5850	3.82658	14.643
Back angle	Degree (°)	Chinese	7.49	23.66	15.6957	3.41567	11.667
		Bangladeshi	9.74	23.76	19.0125	3.41113	11.636
Bust convex angle	Degree (°)	Chinese	48.20	69.04	59.6401	4.40122	19.371
		Bangladeshi	18.07	40.83	27.0915	5.35223	28.646
Collar width	cm	Chinese	10.20	13.20	11.6571	0.475	0.226
		Bangladeshi	10.203	13.847	11.78	1.094	11.978
Collars thick	cm	Chinese	10.10	12.70	11.133	0.471	0.222
		Bangladeshi	10.124	13.782	11.657	1.1056	12.22
Collar circumference	cm	Chinese	30.20	45.10	37.2074	2.2914	5.251
		Bangladeshi	33.126	42.050	36.94551	2.5173	63.368
Shoulder width	cm	Chinese	34.60	46.20	39.4926	2.41021	5.809
		Bangladeshi	34.039	44.368	38.21291	2.6896	72.341
Curve shoulder width	cm	Chinese	29.50	56.20	48.4158	3.61364	13.058
		Bangladeshi	39.143	54.710	46.1293	4.34957	18.9188
Back width	cm	Chinese	32.40	51.00	43.9138	2.93196	8.596
		Bangladeshi	27.547	45.284	32.2808	4.00182	16.0146
Front width	cm	Chinese	28.30	43.00	35.0688	2.39595	5.741
		Bangladeshi	26.158	35.517	30.2703	2.35656	55.5340
Bust thick	cm	Chinese	16.60	34.60	24.9386	3.20919	10.299
		Bangladeshi	21.938	32.385	26.0477	2.95440	87.2851
Bust circumference	cm	Chinese	76.00	110.00	88.8476	6.30681	39.776
		Bangladeshi	82.354	113.169	93.4209	8.17756	66.8726
Waist width	cm	Chinese	21.70	39.70	27.4423	2.99027	8.942
		Bangladeshi	22.785	30.716	26.8622	2.26998	51.5283
Waist thick	cm	Chinese	15.70	30.70	20.7683	2.76254	7.632
		Bangladeshi	18.136	28.674	22.3517	2.88088	82.995
Waist circumference	cm	Chinese	56.70	106.90	74.9804	7.53752	56.814
		Bangladeshi	65.465	92.468	77.8726	7.65140	58.5440
Hip width	cm	Chinese	30.20	38.50	34.0624	2.04558	4.184
		Bangladeshi	30.679	38.993	35.3771	2.82717	79.9291
Back thick	cm	Chinese	19.70	29.80	24.5995	2.07630	4.311
		Bangladeshi	19.743	32.889	25.3013	3.43901	11.8268
Hips	cm	Chinese	81.00	115.00	94.5090	6.08642	37.045
		Bangladeshi	82.908	109.545	96.98121	8.36841	70.0303

3.2 Comparative analysis of national standard

China's standard women's sizing system follows the GB/T 1335 specification, which is a reference for the production and purchase of clothing. GB/T 1335 specification adopts a dual-indicator format based on height and bust/chest circumference (165/88A), where the first value represents body height (cm), the second indicates the key girth measurement (bust/chest, cm), and the final letter denotes the body type classification code. In this system, A corresponds to the standard body type, B represents a fuller body type, and C indicates a slimmer body type.

The body type classification codes and corresponding applicable ranges of this standard are shown in Table 2. The standard divides Chinese women's height into seven levels of 5 cm, starting from 155 cm.

Table:2

Body type classification code	Y	A	B	C
Bust-waist difference cm	17-22	12-16	7-11	2-6

According to the basic statistical analysis, the average bust-waist difference among Chinese young women is 13.86 cm, with a standard deviation of 4.8 cm. The maximum recorded value is 29.6 cm, while the minimum is -0.9 cm, indicating a wide range and a relatively dispersed distribution. This broad variability suggests significant diversity in body shapes within this demographic. The bust-waist differences have been further categorized and tallied to analyze the size distribution across various body types, as illustrated in Table 3. In summary, these findings underscore the importance of accommodating diverse body shapes when designing apparel for young Chinese women.

Table:3

Type	Chest-waist difference cm	Number of people	Type	Chest-waist difference cm	Number of people	Type	Chest-waist difference cm	Number of people
Y	17-22	42	B	7-11	47	not covered	>22	11
A	12-16	85	C	2-5	3	not covered	<2	1

According to the analysis, young Chinese women's body types fall primarily into categories A and B, with a broad range of waist circumferences and a height distribution between 150 and 160 cm. About 95.9% of young Chinese women's body types can be covered by the country's existing size standards; however, those with extremely wide chest-waist discrepancies and extremely small body types are not included in the size classification description.

Bangladesh's women's garment sizing system predominantly adopts a modified Western sizing framework, with bust/chest measurements in inch-based measurements, rather than adhering to a unified national sizing code. In industrial practice, garment manufacturers in Bangladesh commonly reference(*ISO-8559-1-2017*, n.d.), which provides standardized guidelines for anthropometric body measurements used in garment design.

The present study adopts (*ISO-TR-10652-1991*, n.d.) as the reference framework for comparative analysis of the sampled population. Under this ISO system, women's stature is categorized into five height levels, beginning at 164 cm and increasing by 6cm at each level.

Statistical analysis data showed that the mean chest–waist difference among young Bangladeshi women is 15.43 cm, with a standard deviation of 3.53 cm, indicating moderate variability in upper-torso shape. The observed values range from a minimum of 10.25 cm to a maximum of 20.79 cm, reflecting substantial diversity in body proportions within the study population.

The distribution of each body type within the ISO size framework is summarized in Table 4-5, providing a detailed representation of size prevalence and proportional characteristics among young Bangladeshi women.

Table: 4

Body shape	Chest-waist difference cm	Number of people
A	>=16	10
R	12-15	8

P	6-11	2
S	0-5	0
C	(-6) - (-1)	0

The Roche index is used to evaluate relative body fatness or thinness based on the relationship between body weight and height. It provides a preliminary assessment of overall body shape by standardizing weight against height. The Roche index is calculated as:

Roche index = 100 × weight (g) / height³ (cm³)

Higher values indicate a fuller body build, while lower values reflect a slimmer physique.

Table: 5

Body type category	Roche Index	China (number)	Bangladesh
Slender	<=1.29	126	7
Standard type	1.3-1.5	53	3
Squat type	>=1.51	10	10

3.3 Analysis of overall upper body shape characteristics

3.3.1 Analysis of Chinese women upper body shape characteristics

To identify the essential measurements that best represent overall body shape, sixteen elements were analyzed, including height, neck width and circumference, shoulder and back width, bust, waist, and hip width, thickness, and circumference, as well as back angle, shoulder angle, and chest convex angle. Factor analysis and principal component analysis (PCA) were performed using SPSS to reduce data dimensionality and to identify the principal factors influencing body shape characteristics.

The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy for young Chinese women was 0.851, with a significance level of $p < 0.001$, indicating strong correlations among the variables and confirming that the data-set was highly suitable for factor analysis. These components were therefore retained as the primary factors representing overall body shape variation.

The component matrix reveals that measurements related to body size, girth, and three-dimensional form exhibit high factor loadings, demonstrating their dominant contribution to body shape classification. The key variables associated with each principal component, along with their corresponding factor loadings and scores, are summarized in Table 6.

Factor analysis of Chinese women's upper body shape characteristics

Table: 6

Main factor	Factor	Score	Factor	Score	Factor	Score
Circumference factor	Waist circumference	0.885	Hips circumference	0.872	Neck circumference	0.844
Width & thick factor	Waist width	0.868	Waist thick	0.836	Hip width	0.753
Angle factor	Shoulder angle	0.836	Bust angle	0.748	Back angle	0.693

Based on the factor analysis results, three principal components were identified: 1. Circumference factor, 2. width & thickness factor, and 3. angle factor, which were extracted to represent the overall upper body shape characteristics of young Chinese women. Using the variables with higher factor loadings from these three principal components as clustering indicators, a K-means cluster analysis was conducted to classify upper body shape types.

Cluster analysis of Chinese women's upper body shape characteristics

Table: 7

	Category - 1	Category - 2	Category - 3
Waist circumference	83.2	75.4	68.6
Waist width	30.7	27.9	26
Shoulder angle	27.97	26.29	22.6
Number of people	57	52	80

The clustering results of the three upper body categories reflect a clear gradation in circumference, width, and structural expansion. Category -1 (Full Circumference–Wide Structure) is characterized by the largest waist dimensions and shoulder angle, indicating a fuller, laterally expanded, and robust upper body contour. Category -2 (Medium Proportion Balanced) exhibits intermediate measurements and well-proportioned relationships among circumference, width, and angular features, representing the average and most balanced upper body morphology. In contrast, Category -3 (Slim Circumference–Narrow Structure) displays the smallest waist dimensions and shoulder angle, corresponding to a slender, compact, and narrow upper body profile.

3.3.2 Analysis of Bangladeshi women's upper body shape characteristics

The same sixteen anthropometric variables were applied to examine upper body morphology among young Bangladeshi women. The KMO value of 0.649, together with a statistically significant Bartlett's test ($p < 0.001$), indicates acceptable sampling adequacy for factor analysis. According to the scree plot (Figure 4), the retention of three principal components collectively describes the major patterns of upper body shape variation.

The first principal component, designated the circumference factor, was strongly influenced by chest circumference, waist circumference, and collar circumference, emphasizing the prominence of upper torso girth in defining body shape. The second component, identified as the angle factor, was dominated by chest convex angle and shoulder angle, reflecting anterior chest projection and shoulder inclination. The third component, referred to as the width–thickness factor, was primarily associated with collar width, chest thickness, and waist thickness, capturing transverse and sagittal dimensional characteristics of the upper body.

Factor analysis of Bangladeshi women's upper body shape characteristics

Table: 8

Main factor	Factor	Score	Factor	Score	Factor	Score
Circumference factor	Bust circumference	0.94	Waist circumference	0.907	Neck circumference	0.889
Angle factor	Bust angle	0.913	Shoulder angle	0.822		
leniency factor	Neck width	0.868	Bust thick	0.867	Thick waist	0.862

Based on variables with high factor loadings, a K-means clustering analysis was conducted, resulting in three distinct upper body shape categories among young Bangladeshi women.

Cluster analysis of Bangladeshi women's upper body shape characteristics

Table: 9

	Category - 1	Category - 2	Category - 3
Bust circumference	93.3	91.44	82.82
Bust angle	29.5	25.12	20.94
Neck width	12.14	11.1	10.68
Number of people	12	3	3

The clustering results identify three distinct upper body morphology types primarily differentiated by chest circumference, anterior projection, and neckline width. Category -1 represents a large-circumference type with pronounced chest projection and a broad collar width, reflecting a strongly three-dimensional and prominent upper torso structure. Category -2 corresponds to a medium-circumference type, characterized by moderate chest projection and balanced proportions, indicating an intermediate and relatively harmonious upper body morphology. Category -3 defines a small-circumference, slim upper body type, marked by minimal chest projection and a narrow collar width, resulting in a slender and less volumetric upper torso profile.

3.4 Comparison of local body types

3.4.1 Analysis of shoulder and neck shape

The neck and shoulder region are crucial in clothing design, particularly for ensuring well-fitted garments. Variations in the anatomical structure of the neck and shoulders among different populations can affect clothing fit, especially in the upper torso and collar areas. This study examines the neck and shoulder shapes of Bangladeshi and Chinese women, using descriptive statistics and cluster analysis to better understand these variations and their impact on garment fitting.

Factors related to shoulder and neck shape characteristics include shoulder angle, shoulder width, neck width, neck thickness, and neck circumference, as detailed in Table 10.

Table10: Descriptive statistics of Shoulder and neck

China	Minimum value	Maximum value	Mean	standard deviation	Bangladesh	minimum value	maximum value	mean	standard deviation
Shoulder angle	19.07°	36.12°	26.52	3.21	Shoulder angle	20.8°	35.29°	27.59	3.83
Shoulder width	34.6	46.2	39.49	2.41	Shoulder width	34.04	44.37	38.21	2.69
Neck width	10.2	13.2	11.66	0.48	Neck width	10.2	13.85	11.78	1.09
Neck Thick	10.1	12.7	11.13	0.47	Neck Thick	10.12	13.78	11.66	1.11
Neck Circumference	30.2	45.1	37.21	2.29	Neck circumference	33.13	42.05	36.95	2.52

According to five key indices: shoulder angle, shoulder width, collar width, collar thickness, and neck circumference, Chinese subjects typically have slightly broader, visually flatter shoulders and a relatively slimmer neck, while Bangladeshi subjects show more sloping and narrower shoulders with a thicker neck, despite similar neck circumferences. Cluster analysis confirms that both populations can be categorized into three comparable shape types, ranging from broader, more sloping shoulders to narrower, more delicate shoulder-neck configurations. However, the distribution of these categories varies between countries: In China, Shape categories 1 and 3 together make up over four-fifths of the sample (42.3% and 41.3%, respectively), while in Bangladesh, Shape Type 3 is the most common (40.0%), followed by category 2 (35.0%) and category 1 (25.0%). These results indicate that although a common set of shoulder–neck shape categories apply to both populations, the dominant body types and upper-body proportional balance differ by country. For women's wear pattern development, Chinese size systems should prioritize slightly broader, less sloping shoulders and a comparatively slimmer neckline, while Bangladeshi size systems should accommodate more shoulder slope and greater neck thickness.

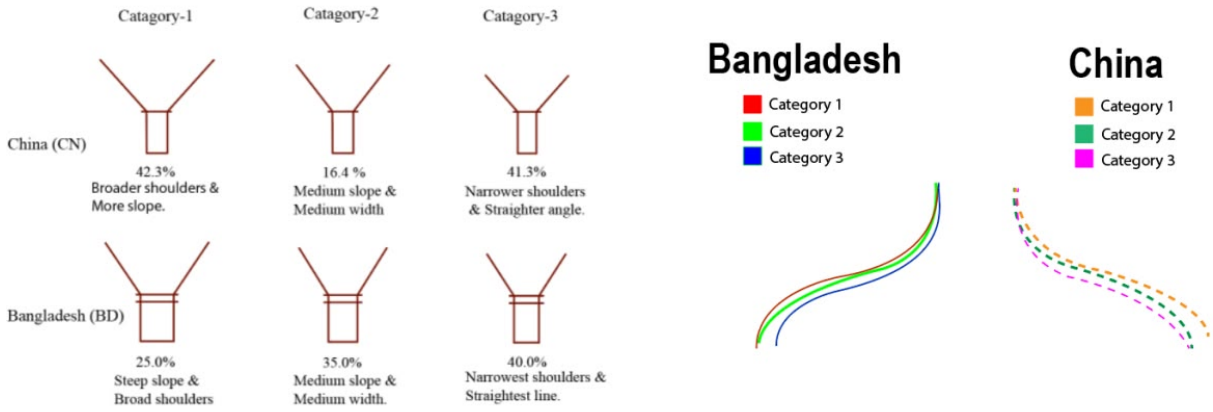

Fig.3: Shoulder & Neck shape of Chinese and Bangladeshi women

Source(s): Author's own creation

Chinese figures feature slightly broader, visually wider shoulders with slimmer necks; BD figures have more sloping, narrower shoulders with thicker necks. The outlines represent simplified visual depictions of shoulder-neck configurations based on the described shape types.

3.4.2. Bust shape analysis

It is believed that women's breasts indicate their physical attractiveness (Zhong et al., 2023). Anthropometric modeling, fit systems, and apparel design all depend on the bust. The bust morphology of Chinese and Bangladeshi women is examined in this study using descriptive statistics and cluster analysis. Four aspects of bust shape are considered, as shown in Table 11: bust convexity/angle, bust breadth, bust thickness, and bust circumference. Cluster analysis divides each population into three distinct bust-shaped groupings, each of which has a unique morphological pattern.

Table: 11

China	Minimum value	Maximum value	Mean	Standard deviation	Bangladesh	Minimum value	Maximum value	Mean	Standard deviation
Bust angle	48.2°	69.04°	59.64	4.4	Bust angle	18.07°	40.83°	27.09	5.35
Bust width	28.3	43	35.07	2.4	Bust width	26.16	35.52	30.27	2.36
Bust thick	16.6	34.6	24.94	3.21	Bust thick	21.94	32.39	26.05	2.95
Bust circumference	76	110	88.85	6.31	Bust circumference	82.35	113.17	93.42	8.18

Based on the combined descriptive statistics and cluster-analysis results, the chest/bust morphology of Bangladeshi and Chinese women exhibits clear population-level variations in convexity, width, depth, circumference balance, and distribution of shape categories.

Greater anterior convexity and wider thoracic width are the main characteristics of Chinese women's chest morphologies, resulting in a noticeably more rounded chest profile. Their clusters range from highly convex and broad to mildly convex and narrow, but all maintain considerably higher convex angles than the Bangladeshi groups. The distribution is relatively balanced across three categories, indicating a wide morphological spectrum and higher heterogeneity within the Chinese sample. The proportional increase in chest width, thickness, and circumference indicates that Chinese chest volume expands in both width and projection.

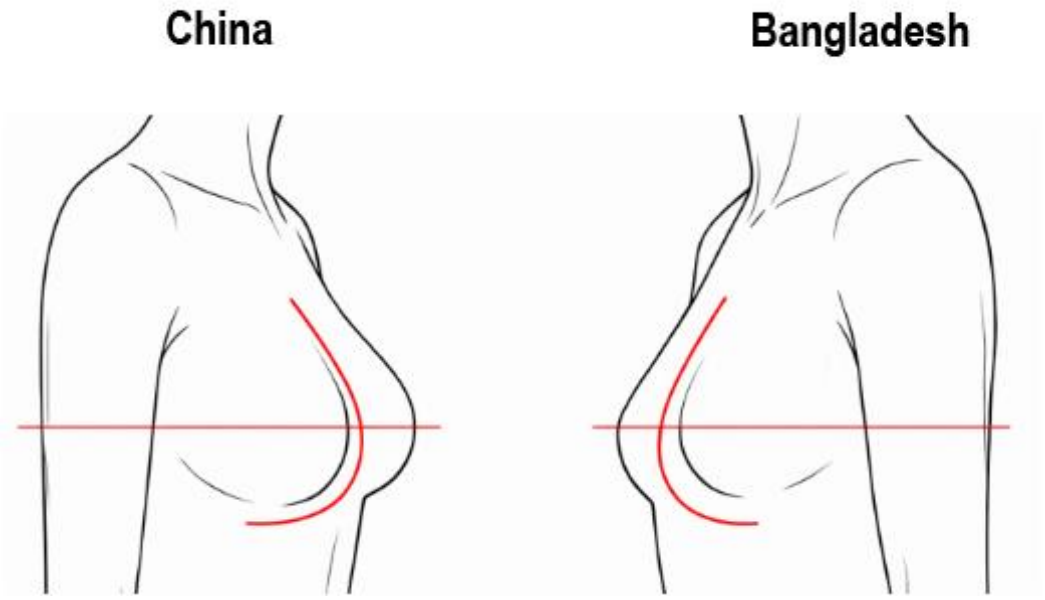

Figure 4: Bust shape of Chinese and Bangladeshi women

Source(s): Author's own creation

In contrast, Bangladeshi women have a chest morphology dominated by flat and narrow chest morphologies, with considerably lower convex angles and reduced mediolateral breadth. Despite this narrowness, many

Bangladeshi individuals demonstrate moderate chest thickness and relatively high circumference, indicating a pattern where thoracic volume is dispersed more across the ribcage rather than thrust forward. The overwhelming dominance of the flat–narrow group (75%) reveals lower shape variety among this population compared with the Chinese sample.

Overall, the two populations differ most significantly in chest convexity (high vs. low), width (wide vs. narrow), and cluster dominance (balanced three-way distribution vs. one overwhelmingly common shape). These variations point to thoracic structures that are unique to each population and may be influenced by somatic, genetic, and environmental variables.

Together, the findings underline the relevance of country-specific considerations in garment design, anthropometric modeling, and fit systems where chest volume distribution and projection play key functional roles.

3.4.3. Waist and hip body shape analysis

Anthropometric modeling, fit systems, and apparel design all depend on the shape of the waist and hips. This study uses cluster analysis and descriptive statistics to examine the hip and waist morphology of Chinese and Bangladeshi women.

Table: 12

China	Minimum value	Maximum value	Mean	Standard deviation	Bangladesh	Minimum value	Maximum value	Mean	Standard deviation
Waist width	21.7	39.7	27.44	2.99	Waist width	22.79	30.72	26.86	2.07
Waist thick	15.7	30.7	20.77	2.76	Waist thick	18.14	28.67	22.35	2.88
Waist circumference	56.7	106.9	74.98	7.54	Waist circumference	65.46	92.47	77.99	7.65
Hip width	30.2	38.5	34.06	2.05	Hip width	30.68	38.99	35.38	2..83
Back thick	19.7	29.8	24.6	2.08	Back thick	19.74	32.89	25.3	3.44
Hips	81	115	94.5	6.09	Hips	82.91	109.55	96.98	8.37

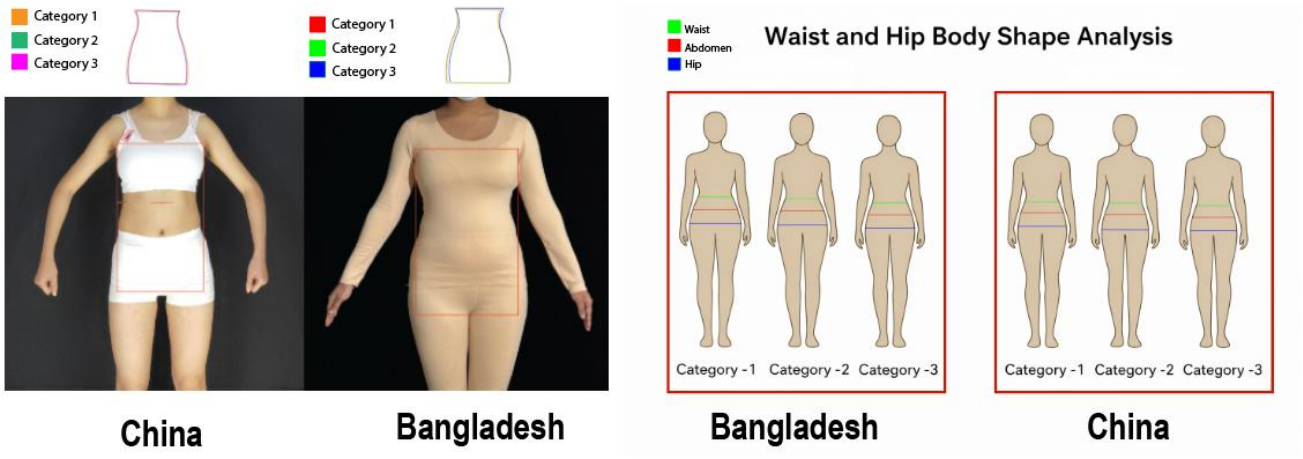

Fig.5: Waist and hip body shape of Chinese and Bangladeshi women

Source(s): Author's own creation

We looked at six anthropometric factors for both populations: hip width, hip thickness, hip circumference, waist circumference, and waist thickness. The findings indicate that Chinese women have flatter waistlines and narrower hips, while Bangladeshi women typically have deeper waists and rounder, wider hips. According to cluster analysis, each country has three different form categories, with Chinese groups exhibiting more balanced, straight-line contours and Bangladeshi groups exhibiting more lower-body prominence. The results show distinct morphological variations with implications for body-shape classification, ergonomics, and clothing design.

IV. CONCLUSION

This study used integrated 3D, 2D, and manual anthropometric measures to compare the upper body shape of young Chinese and Bangladeshi women. Through multivariate statistical analyses, key shape descriptors and structural differences between the two populations were systematically identified and classified.

The results show distinct population-specific characteristics. Chinese women are generally characterized by broader shoulders, higher chest convexity, wider upper-torso dimensions, and comparatively flatter waist–hip profiles, whereas Bangladeshi women exhibit more sloping shoulders, thicker neck regions, reduced chest projection, deeper waists, and more prominent hips. Although three principal upper body shape categories were identified in both populations, their defining variables and distribution patterns differed substantially, reflecting distinct morphological structures.

The majority of Chinese body types are sufficiently covered by current national and international sizing standards, however, people with extreme proportions are still underrepresented, according to the evaluation. In contrast, the absence of a unified national sizing system in Bangladesh results in a greater mismatch between standardized size frameworks and actual body shape characteristics.

Overall, the findings emphasize the limitations of applying uniform or imported sizing systems across diverse populations. The study supports the development of population-specific apparel sizing systems and body-shape–based garment design strategies. Such approaches can significantly improve garment fit, enhance consumer comfort, and increase industrial efficiency by relying on anthropometric standards tailored to specific populations rather than generalized sizing models.

Several limitations should be acknowledged. First, the study focused exclusively on young adult women, which limits the generalizability of the findings to other age groups. Second, some identified clusters particularly within the Bangladesh sample contained relatively small numbers of participants, which may affect statistical robustness. Additionally, the use of mixed measurement modalities may introduce methodological bias, even though consistent experimental controls were maintained.

Future research should aim to include larger and more diverse samples across different age groups. Furthermore, adopting fully standardized 3D body measurement protocols across populations would enhance methodological consistency and improve the reliability of comparative anthropometric analyses.

REFERENCES

[1] Bartol, K., Bojanic, D., Petkovic, T., & Pribanic, T. (2021). A Review of Body Measurement Using 3D Scanning. *IEEE Access*, *9*, 67281–67301. https://doi.org/10.1109/ACCESS.2021.3076595

[2] Bolaji, J., Qiu, J., McQuerry, M., & Kwon, C. (2025, January 13). A Comparative Anthropometric Analysis of Female Firefighters versus the General U.S. Female Population. *Making Waves Toward A Sustainable and Equitable Future*. Making Waves Toward A Sustainable and Equitable Future. https://doi.org/10.31274/itaa.18476

[3] Chen, C. (2007). Fit evaluation within the made-to-measure process. *International Journal of Clothing Science and Technology*, *19*(2), 131–144. https://doi.org/10.1108/09556220710725720

[4] Gu, B., Ahmed, M. K., Zhong, Z., & Jin, J. (2020). 3D female upper body modelling based on 2D images. *International Journal of Clothing Science and Technology*, *32*(4), 471–482. https://doi.org/10.1108/IJCST-03-2019-0042

[5] Han, H., & Nam, Y. (2011). Automatic body landmark identification for various body figures. *International Journal of Industrial Ergonomics*, *41*(6), 592–606. https://doi.org/10.1016/j.ergon.2011.07.002

[6] *ISO-8559-1-2017*. (n.d.).

[7] *ISO-TR-10652-1991*. (n.d.).

[8] Kim, M., & Kim, S. (2018). Development of a script-based versatile three-dimensional body measurement system. *International Journal of Clothing Science and Technology*, *30*(5), 598–609. https://doi.org/10.1108/IJCST-10-2017-0159

[9] Song, G. (Ed.). (2011). *Improving comfort in clothing*. Woodhead Pub.

[10] Song, H. K., Baytar, F., Ashdown, S. P., & Kim, S. (2022). 3D Anthropometric Analysis of Women's Aging Bodies: Upper Body Shape and Posture Changes. *Fashion Practice*, *14*(1), 26–48. https://doi.org/10.1080/17569370.2021.1879463

[11] Vuruskan, A., & Bulgun, E. (2011). Identification of female body shapes based on numerical evaluations. *International Journal of Clothing Science and Technology*, *23*(1), 46–60. https://doi.org/10.1108/09556221111096732

[12] Xu, K., Zhao, S., Zhang, J., & Gu, B. (2023). Quantifying shape similarity of female upper body silhouettes based on 2D images. *International Journal of Clothing Science and Technology*, *35*(6), 986–996. https://doi.org/10.1108/IJCST-10-2022-0137

[13] Zhong, Z., Zhang, B., Hu, Y., Zhang, L., Gu, B., & Sun, Y. (2023). Comparative Morphological Evaluation of Young Women's Breast-Bra Reshaping by Different Bra Cups. *International Journal of Environmental Research and Public Health*, *20*(5), 3856. https://doi.org/10.3390/ijerph20053856