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Identification of Regional Body Shapes of Indian Plus-Size Women

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ABSRACT

The Indian plus-size clothing market is experiencing remarkable growth, driven by increasing obesity prevalence and the body positivity movement. However, this growth is paralleled by a concerning trend - a high rate of returns for online clothing purchases. The primary reason for returns is often the improper clothing fit, stemming from a lack of consideration for diverse body types. This study addresses this challenge by understanding the diversity of body shapes prevalent in various Indian regions. Pan-India data from the INDIAsize project and modified FFIT mathematical formulas were used to identify nine body shapes. The frequency distribution and Chi-square analysis revealed significant variations in body shape distribution across six regions. The findings provide valuable insights for Indian fashion brands to reduce returns and promote sustainable fashion practices. The research emphasizes the importance of aligning clothing styles with the prevalent body shapes in specific regions, contributing to a more sustainable fashion industry.

Keywords: Body Shape, Plus-Size, Female Figure Identification Technique (FFIT)

1. Introduction

The plus-size clothing market is a colossal and highly profitable segment within the fashion industry. Projections indicate that the global plus-size market is poised to experience a compounded annual growth rate (CAGR) of 5.9% between 2021 and 2027(Sharma, 2022). This trend is mirrored in the Indian fashion market. According to Statista, a German market and consumer data firm, the plus-size category, which includes sizes beyond 0-12, accounts for roughly 50% of India's total consumer base(Sharma, 2022). Furthermore, the Indian plus-size clothing market is expected to show a CAGR of 5.7% from 2022 to 2032, as reported by the Apparel Resources news agency(Apparel Resources, 2022). The surge in demand for plus-size apparel is primarily attributed to the increasing prevalence of obesity and overweight individuals. Moreover, the body positivity movement has gained momentum, fostered acceptance of diverse body types, and fueled the demand for inclusive fashion(Credence Research, 2018).

However, this growth in the fashion industry is accompanied by a concerning issue—the increasing rate of returns for clothing items purchased online, currently standing at 30-40%(Kethireddipalli & Wilson, 2023). This troubling trend carries significant environmental consequences, primarily in the

form of a two-fold impact: the carbon footprint generated by additional transportation and the fate of returned items, often ending up in landfills(Amritha & Suresh, 2020). Sizing and fit discrepancies have emerged as key drivers of returns (Bennett, 2021). Many past studies have suggested that the incorporation of body shapes while developing of size chart provides higher fit satisfaction(Song & Ashdown, 2012; Hidayati et al., 2021). Furthermore, online shoppers typically view clothing worn by professional models, as an unrealistic representation that fails to account for the diverse range of body shapes among consumers (Sattar et al., 2019). Therefore, understanding the body shape and the true representation of clothing on realistic bodies will become critical in preventing such discrepancies and reducing return rates.

This study elaborates on the importance of addressing the implications of fashion returns, with a specific emphasis on the kind of body shapes prevalent in India. By collecting pan-India anthropometric data and applying modified Female Figure Identification Technique, this research delved into the diversity of female body shapes across various Indian regions. Statistical analysis was used to uncover significant differences among body shapes in six regions.

2. Literature Review

In India, it's observed that approximately one in five women falls into the plus-size category(Rao, 2016). According to the National Family Health Survey (NFHS-4) for India, the prevalence of obesity among women in 2017 was 20.7% (Meharda et al., 2017). Responding to the increasing demand in this category, retailers have started expanding their plus-size offerings, particularly in Tier I cities like Delhi, Mumbai, and Bengaluru(Rao, 2016). With the growth of e-commerce following the COVID-19 pandemic, many retailers now offer their products online, as urban women are more likely to make purchases from virtual platforms. Online shopping is especially attractive to plus-size women, as it allows them to try on clothes in the comfort of their own homes(Otieno et al., 2005). Besides that, safe payment, and free returns have contributed to the increasing consumption of online fashion(Candeloro, 2020). These conveniences also lead to challenges in selecting the right size, style, or fit, resulting in higher return rates(Candeloro, 2020). Research indicates that up to 40% of online purchases end up being returned(Bertram & Chi, 2018). The rate of clothing returns can vary significantly depending on the type of clothing and the country where it's sold. For instance, it ranges from 10% for everyday basics like white T-shirts to over 60% for high-fashion items. Furthermore, research suggests that factors like demographics, including gender, age, and income, play a role in these return rates(Harris, 2010; Cullinane & Cullinane, 2021). In the Indian context, people typically return around 25% to 40% of the clothing they buy(Gandhi, 2020).

Further, the unavailability of a standard size chart makes this more complicated in terms of size and fit identification for customers in India. Clothing brands develop their size charts as per their understanding to cater to their targeted (regional) population (Kumari & Anand, 2020). Most of them grade the average size into bigger sizes, but plus-size bodies will not grow proportionally(Boorady, 2014). Therefore, it is essential to understand the kind of body shapes that exist in the plus-size segment. Kumari and Anand too emphasized the role of body shape while purchasing plus-size clothing by the consumers (Kumari & Anand, 2023). Gupta (2020) argues that the key factors contributing to unsatisfactory fit are a lack of awareness about different body shapes and an over-representation of ideal body shapes online(Gupta, 2020). It becomes more difficult when the customer has to evaluate garment fit in terms of body type(Chrimes et al., 2022). Since online shoppers can't physically try on garments, the sight of a model wearing the clothing becomes a crucial

indicator for their evaluation(Xia et al., 2020). Generally, online consumers evaluate the fit of a garment based on a model's body, which often does not represent the true body shape of the consumer(Sattar et al., 2019). To get the appropriate size and color, online customers purchase multiple size samples of the same clothing item to try them on and select the one that fits best to them. This involves ordering various size and color variations of the same fashion product to identify their preferred options and returning the rest. This phenomenon in customer behavior is commonly referred to as "sized sampling"(Candeloro, 2020). Surveys conducted by Piron and Young in 2000 and by Rosenbaum and Kuntze in 2005 discovered that approximately 20% of consumers were intentionally purchasing products to use them and then returning them(Piron & Young, 2000; Park 2008). Thus, this has raised concerns about the environmental impact caused by factors like transportation, packaging, and returns.

These clothing sizes and fit-related returns can be minimized by getting an idea of accurate measurements and the kind of body shape acquired by the customers. Singh's (2015) studies examine the factors contributing to returns in the Indian online marketplace Flipkart, where up to 30% of women's clothing was returned due to sizing issues. Providing accurate size charts/ measurements itself helped to reduce return rates by 9%(Singh, 2015). Further, Kristensen et al. (2013) introduced TrueFit, a system designed to ascertain accurate body measurements, which potentially reduced the returns by 30%(Kristensen et al., 2013). The software operates by amalgamating the data supplied by customers, details like height, age, and weight, along with information about previously purchased clothing, such as manufacturer, model type, and size, to determine the best fit. While the system attempts to mitigate biases from both customers and manufacturers, its iteration does not account for changes in body shape over time(Kristensen et al., 2013). Therefore, it is critical to know the accurate measurements and the body types to reduce the size and fit-related returns which further be the step towards sustainable fashion. Hence, understanding and accommodating the diversity of body shapes in the plus-size segment can lead to a reduction in clothing fit-related returns.

2.1 Body Shape Identification

Simmons et al. (2004) introduced a software called the Female Figure Identification Technique (FFIT©) for apparel. This software utilized Visual Basic code, which was generated through mathematical formulas based on six key girth measurements (bust, waist, hip, abdomen, stomach, and high hip) to create nine distinct body shapes(Simmons et al., 2004b; Simmons et al., 2004a). Each of these shapes was defined based on specific measurements, and the differences, and ratios between them as illustrated in Table 1.

Table 1. Female Figure Identification technique's definitions(Simmons et al., 2004a; Simmons et al., 2004b)

Body Shape	Definition
Hourglass	A small difference among hip & bust AND if the ratios of bust-to-waist and hips-to-waist were about equal and significant.
Bottom hourglass	Hip girth must be greater than bust girth AND if the ratios of bust-to-waist and hips-to-waist significant enough to produce a definite waistline.
Top Hourglass	Bust girth must be greater than hip girth AND if the ratios of bust-to-waist and hips-to-waist significant enough to produce a definite waistline.
Spoon	A large difference among hips and bust AND if the bust-to-waist ratio is lower than the hourglass shape AND the high hip-to-waist ratio is high.
Rectangle	Bust and hip girths are fairly equal AND the ratios of bust-to-waist and hips-to-waist are low with no definite waistline.
Diamond	The average stomach, waist, and abdomen measurements should be greater than bust girth and have several large rolls of flesh at mid-section.
Oval	The average stomach, waist, and abdomen measurements should be less than bust girth.
Triangle	Hip girth must be greater than bust girth AND if the ratio of hips-to-waist is small without having a defined waistline.
Inverted Triangle	Bust girth must be greater than hip girth AND if the ratio of bust-to-waist is small without having a defined waistline.

The analysis of these body shapes typically follows a specific order: Hourglass, Spoon, Diamond, Bottom Hourglass, Top Hourglass, Oval, Inverted Triangle, Triangle, and Rectangle. The first shape that meets all the criteria serves as the identifying factor(Staton S, 2019). Then, Sokolowski and Bettencourt collaborated with a leading USA-based apparel company to reevaluate 3D body scans and adapt the FFIT mathematical formulas to cater to plus-size women(Sokolowski & Bettencourt, 2020). Modified Female Figure Identification Technique (FFIT) mathematical formulas were used to identify body shapes for this study. Table 2 illustrates the modified FFIT's mathematical formulas for plus-size women.

Table 2. Modified FFIT Formulas in inches (Sokolowski & Bettencourt, 2020)

Shapes	Mathematical Indicators				
	(Bust-waist)	(Hip-waist)	(Bust-hip)	(Hip-Bust)	(High hip/waist)
Hourglass	≥9	≥10	≤1	< 3.6	-
Bottom Hourglass		≥9		≥3.6 & <10	< 1.193
Top Hourglass	≥9		>1 &<10		
Spoon		≥7		>2	≥1.193
Rectangle	0 ≤ &< 9	0 ≤ & < 10	< 3.6	< 3.6	
Diamond	< 0	< 0			
Oval	≥ 0	< 0			
Triangle	< 0	0 ≤ & < 9 OR ≥ 0		≥3.6	
Inverted Triangle	< 9	≥ 0	≥3.6		

3. Methodology

3.1 Field Study

The Ministry of Textiles collaborated with NIFT to execute the INDIAsize initiative, a nationwide survey aimed at collecting data on body sizes within the diverse Indian population(INDIAsize, 2020). The project was aimed at developing a tailored sizing system that accommodates various body types found in India. Approximately 25,000 individuals between the ages of 15 and 65 participated in the project, with data collected from six cities representing different regions of the country using advanced 3D body scanning technology i.e. Size Stream SS14 (INDIAsize, 2020). Further, the Indian plus-size women's data was extracted from this INDIAsize project's database. The field study consisted of three components: Sampling, Data Collection Protocol, and Data Extraction from the INDIAsize project's database. The following is a chronological description of these three components:

3.2. The Sampling Process

Data was collected from six major Indian cities—Delhi, Mumbai, Kolkata, Chennai, Hyderabad, and Shillong—to ensure nationwide representation. Each of these cities represents one region. For example, the Northern region, represented by Delhi, includes Chandigarh, Delhi, Haryana, Himachal Pradesh, Jammu & Kashmir, Punjab, Uttarakhand, Uttar Pradesh, and Ladakh. The Southern region, represented by Chennai, covers Andhra Pradesh, Karnataka, Kerala, Puducherry, Tamil Nadu, and Andaman & Nicobar. The Eastern region, represented by Kolkata, comprises Bihar, Jharkhand, Odisha, and West Bengal. The Western region, represented by Mumbai, includes Rajasthan, Gujarat, Goa, Maharashtra, Dadra & Nagar Haveli, Daman & Diu, and Lakshadweep. The Central region, represented by Hyderabad, consists of Madhya Pradesh and Chhattisgarh. The North-East region, represented by Shillong, encompasses Arunachal Pradesh, Assam, Manipur, Meghalaya, Nagaland, Sikkim, Tripura, and Mizoram. This classification provided comprehensive coverage of subjects across India(INDIAsize, 2020). Cochran's formula was utilized to design the sampling framework of the study.

Using Cochran's formula:

$n_0=z^2\ pq/e^2$

where:

- n_0 = sample size
- z = selected critical value (1.96 for 95% confidence level)
- p = estimated proportion (0.5 for maximum variability)
- q = 1-p
- e = desired level of precision (0.05)

Substituting the values: $n_0 = (1.96)^2 \cdot 0.5*0.5/(0.05)^2$

For six regions: $n_0 \times 6=2304$

The total sample size was 2304 plus-size women, divided across six regions based on the proportion of overweight or obese women. This division utilized data from the National Family Health Survey-5 (NFHS-5), which was conducted during 2015-16 by the Ministry of Health and Family Welfare. The regional distribution was based on the percentages of women with a BMI ≥ 25 kg/m² in the selected cities, as reported in Table 3(NFHS-5, 2021).

Table 3. Division of Samples into Identified Cities (Regions)

Regions	Women with BMI >= 25.0 (overweight or obese) in % from NFHS-5 survey (2015-16)	Proportion ratio (%)	Required number of subjects per city	No. of subjects collected per region
Delhi (North)	33.2	(33.2/149.7) * 100 = 22.2	n_1 = (22.2*2304)/100 = 510	1048
Hyderabad (Central)	20.3	20.2	n_2 = 312	480
Mumbai (West)	25.9	25.3	n_3 = 399	1014
Chennai (South)	38.3	13.9	n_4 = 589	1024
Kolkata (East)	18.4	11.3	n_5 = 283	994
Shillong (North-East)	13.7	9.4	n_6 = 211	212
Total	149.7	100	2304	4772

The sum of these percentages (149.7) was calculated to further determine the proportion ratios. The proportion ratio is the average percentage proportion of overweight or obese women taken from each selected region. For instance, the northern region's proportion was calculated by dividing % value of overweight or obese with the cumulative value of all six geographical locations' overweight or obese women percentages and multiplied by 100. i.e., (33.2/149.7)*100=22.2%. Similarly, proportion ratios of all other regions were calculated, collectively accounting for 100% of sample subjects (n_0 = 2304). The proportion ratio was used to calculate the number of subjects per region by multiplying the proportion ratio with the total sample size and dividing by 100. For the northern region, it was calculated as (22.2 * 2304)/100 = 510. For simplification, the number of subjects required/city was coded from n_1 to n_6.

In the case of the north-east region, the average value of obese % was taken only from three states (Assam, Meghalaya, and Nagaland), since the majority of plus-size subjects belong to only these states, as evident from the extracted data of INDIAsize(INDIAsize, 2020).

3.3. Anthropometric training and Data collection protocol

Anthropometric data was extracted using both manual measurements and 3D body scanners. The measurements were collected following international standards: ISO 8559-

1:2017 for size designation of clothes and ISO 20685:2010-11 for 3D scanning methodologies to ensure compatibility with international anthropometric databases(Lee, 2018; ISO 20685, 2010; ISO 8559-1, 2017). The manual data was used to check the reliability and validity of the scanned data. Figure 1 illustrates the data collection process by employing both approaches. The process began with the calculation of the subject's weight, followed by vertical and horizontal measurements. The 3D body scanners captured detailed measurements and created a subject avatar within a quick 10-second scan.

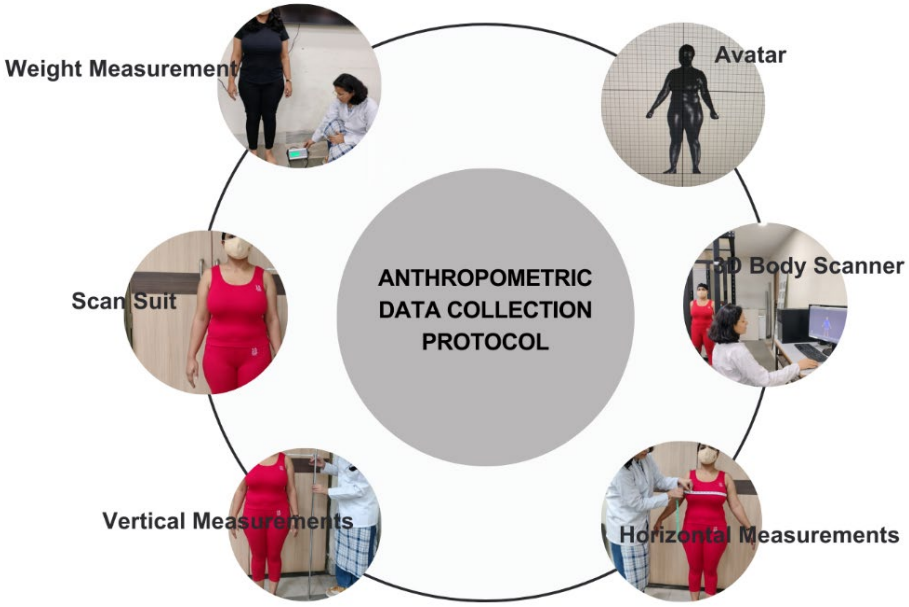

Figure 1. Anthropometric Data Collection Protocol

[Source: Courtesy INDIAsize unit, NIFT, Delhi]

3.4. Anthropometric Data Extraction

To identify plus-size female subjects within this extensive database, a Visual Basic code was developed. From the whole database of 26,342 subjects, a total of 4,772 individuals were identified as plus-sized, based on the Indian plus-sized women's definition (waist girth $\geq$ 34", BMI $\geq$ 25 kg/m^2). To ensure data uniformity, the measurements and weight data were distributed using the mean $\pm$ 3σ of weight and height. Subsequently, the extracted data went through a data-cleaning procedure, resulting in a final selection of 4,354 subjects. Four measurements Bust girth, Waist girth, Hip girth, and High-hip girth measurements were utilized to identify the body types using modified FFIT equations.

4. Results

Table 4 illustrates the national and regional percentage distribution of different body shapes. Nationally, the Rectangle shape dominates, comprising 76% of the population, followed by the Triangle shape at 15%. The Spoon, Bottom Hourglass, Diamond, Hourglass, and Inverted Triangle shapes each represent a small fraction of the population, with no representation of the Top Hourglass shape.

Table 4. National and Regional Distribution of Different Body Shapes

Region	Rectangle	Triangle	Spoon	Bottom Hourglass	Diamond	Hourglass	Inverted Triangle	Oval	Top Hourglass	Total
National	76%	15%	2%	1%	1%	2%	1%	2%	0%	100%
North	84%	9%	1%	1%	1%	1%	1%	2%	0%	100%
West	71%	17%	4%	2%	1%	3%	0%	2%	0%	100%
South	63%	27%	3%	2%	0%	3%	0%	1%	0%	100%
Central	64%	26%	4%	2%	1%	2%	0%	1%	0%	100%
East	87%	7%	1%	1%	1%	0%	1%	3%	0%	100%
North-East	89%	4%	0%	0%	1%	0%	1%	5%	0%	100%

Regional Variations:

- **North Region:** The Rectangle shape is significantly prevalent, accounting for 84% of the population, followed by the Triangle shape at 9%. Other shapes are minimally represented, each making up 1-2%.
- **West Region:** While the Rectangle shape remains dominant at 71%, the Triangle shape has a higher representation here at 17%. Specifically, the Spoon shape is relatively more common in this region (4%) compared to others.
- **South Region:** This region shows a significant presence of the Triangle shape (27%), although the Rectangle shape still leads at 63%. The diversity in body shapes is slightly higher, with Spoon and Hourglass shapes each at 3%.
- **Central Region:** The Rectangle (64%) and Triangle (26%) shapes are dominant, with the Spoon shape making up 4%. The region has a small representation of Diamond, Hourglass, and oval shapes.
- **East Region:** The Rectangle shape is most prevalent here, representing 87% of the population, with the Triangle shape at 7%. The Oval shape has a higher presence (3%) compared to other regions.
- **North-East Region:** The Rectangle shape is highly dominant at 89%, with the Triangle shape at 4%. The Oval shape shows a prominent representation at 5%, while other shapes are almost absent.

Chi-Square Analysis

Table 5 demonstrates the chi-square results to know the significant difference in shapes at the national and regional levels.

Table 5. Chi-Square Static results at National and regional levels

Chi-Square Tests			
	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	406.664[a]	42	0.000
Likelihood Ratio	433.276	42	0.000
Linear-by-Linear Association	0.513	1	0.474
N of Valid Cases	8708		
a. 9 cells (16.1%) have an expected count of less than 5. The minimum expected count is 1.27.			

From Table 5, the Pearson chi-square statistic is 406.664 with 42 degrees of freedom. The p-value associated with this statistic is reported as ".000," which means it's very close to zero. In standard practice, p-values less than 0.05 (or 0.05%) are considered statistically significant. Since the p-value is less than 0.05, conclude that there is a highly significant difference in the distribution of body shapes across regions. The likelihood ratio chi-square statistic is 433.276 with 42 degrees of freedom. Similar to the Pearson chi-square, the p-value associated with this statistic is "0.000," indicating a highly significant result. This result aligns with the Pearson chi-square result, further emphasizing the significance of the difference. In other words, there is a significant overall difference.

Discussion

The analysis identifies distinct regional body shape prevalence beyond the dominant Rectangle and Triangle shapes. The Spoon shape is notably prevalent in the West region (4%), South region (3%), and Central region (4%), indicating a demand for clothing designs accommodating wider hips. Similarly, the Hourglass shape is more common in the West (3%) and South (3%), suggesting a preference for apparel that accentuates balanced proportions and cinches at the waist. In contrast, the oval shape stands out in the East region (3%) and is most prevalent in the northeast region (5%), highlighting the need for clothing with relaxed fits around the waist. These findings corroborate Kumari and Anand's (2020) study on Indian plus-size brands, showing the prevalence of Rectangle and Triangle shapes in India.

This regional specificity is crucial for designers and retailers aiming to enhance consumer satisfaction by tailoring clothing lines to fit and flatter these diverse body shapes. Health professionals can use these insights to develop targeted wellness programs addressing specific body shape-related health concerns, such as hip mobility for Spoon shapes and waist health for oval shapes. Marketers can leverage this data to create advertising campaigns that resonate with the predominant body shapes in each region, thereby increasing engagement and conversion rates. The chi-square analysis further emphasizes the significance of these regional variations, with both Pearson and likelihood ratio chi-square tests yielding highly significant results ($p < 0.000$), affirming genuine disparities in body shape distributions across regions. This unique study not only adds new insights into regional body shapes but also provides a robust framework for future research and practical applications aimed at better understanding and catering to the diverse needs of plus-size women worldwide.

5. Conclusion

The high rate of clothing returns, which averages 30% to 40% for online purchases, leads to discarded garments ending up in landfills, posing a challenge to sustainable fashion efforts. The primary driver behind these returns is the issue of inappropriate fit, often stemming from a lack of consideration for the diversity of body types. This study aimed to address this concern by delving into the diversity of body types prevalent in various Indian regions, utilizing data from the INDIAsize project. Modified FFIT mathematical formulas were employed to classify women into nine distinct body shapes. Frequency distribution was employed to illustrate the distribution of body shapes both at the national and regional levels. Additionally, Chi-Square analysis revealed significant differences in body shapes between the national level and the six specific regions. On a broader scale, Rectangle and Triangle shapes emerged as the dominant body types across India. These findings enable fashion designers and retailers to create region-specific clothing lines, enhancing consumer satisfaction. Health professionals can develop targeted wellness programs, while marketers can craft regionally focused advertising campaigns. This study also provides a framework for

similar research globally, promoting inclusivity for plus-size women.

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