Kumari and Anand, J Fashion Technol Textile Eng 2020, 8:3
DOI: 10.37532/jftte.2020.8(4).194.

Journal of Fashion Technology & Textile Engineering

Research Article

A SCITECHNOL JOURNAL

Development of Size Chart of Key Measurement for Plus Size Women Category in India

Kumari A* and Anand N

Abstract

Taking clue from Romeo who relate obesity to plus size clothing and examined 30 obese by calculating BMI index of teenage female with age group 12- 17 years of U.S. and used 3–D Body scanner for anthropometric data calculation by considering body measurements, shape and apparel size using 'Interview' as data collection method and concluded that an updated sizing charts for plus-size is an immediate requirement of concerned obese girls population. Review of current literature was undertaken to understand interaction between Obesity Plus-size, and Body Shape to develop a new sizing system.

Keywords

Size chart; Key measurement; Plus size

Introduction

The IBIS world states that plus size women's market is worth a whopping nine billion dollars and in Indian context, it is seen that on an average, every fifth woman is a plus size women [1]. According to report published by Credence Research; the global plus size women's clothing market stood at US$165.2 billion in 2017 and expected to expand at a CAGR of 4.4% during the forecasted period of 2018 to 2026 with Asian Pacific domination [2]. Nischal Puri, Managing Director, 'Brands India' roughly estimated that the Indian apparel overall market size is US$ 58 billion and plus size market belongs to US$ 12 billion and further growing annually by 9% [1]. Sivaram Kowta, vice-president, menswear, Myntra (stocks over 10,000 styles in the plus-size category on its website) also mentioned that: "The plus-size segment is estimated to account for $5-6 billion in the $40-billion Indian online fashion apparel market by 2020, that is, 10-12% of the overall market [3]". Rising prevalence of obesity and being overweight is main reason of hike in plus-size apparel market and along with the increasing body confidence among the plus size women is fueling the demand for trendy plus size apparels [2]. According to National Family Health Survey (NFHS-4) for India reported that the prevalence of obesity among female is 20.7%, for male it is 14.1% in2017 [4]. Owing the aforementioned rising demand of the category, many retailers came forward to cater the needs of consumers. The concept of plus size clothing is picking up fast especially in Tier I cities Like Delhi, Mumbai and Bengaluru etc. in India [1]. With growth of ecommerce many retailers are preferring to offer the goods online as urban women are most likely to purchase from virtual platforms especially it appeals to plus size women; it provides an opportunity to try on clothes with comfort of their own home [5]. In response to it, Designers and retailers have launched a brand-new clothing range to fulfil the consumer demands. Data indicates a potential in India for plus size category and motivates them to invest more in this segment.

The standardization of sizing system is a basic necessity for the ready-to-wear industry [6]. Anand mentioned that in lack of existence of standardized Indian body size chart; retailers are left with little option but to use size charts of some other countries and tweaked them as per their instinct or experience which results is confusion among consumers due to different body measurements followed by each brand [7]. In fact, it is not an issue faced by India alone. Gill and Brownbridge undertook a research into sizing practices of UK plus-size women's wear by collecting sizing data from individual retailers with qualitative feedback of women's experiences of available sizes with the key measurements bust, waist, and hip. The researchers found that there is no standardization in sizing among retailers [8]. In US Dunn conducted research on top 100 selected U.S. retailers from U.S. National Retail Federation's plus-size women's size, assessed them in comparative manner and found huge dissimilarities in sizes, size labelling from brand to brand [9]. Also, there was an attempt by Baczek to create universal system of plus-size garment codification by compare classifications systems prevailing in the various countries and found very haphazard dimensional variations among Spain, UK, Sweden or Poland sizing systems [10]. So, to resolve the issue faced by many countries have undertaken the sizing surveys to create standard size chart to cater to this specific segment.

Categorization of body types will allow more appropriate reorganization of sizing systems for mass customization [11]. Plus-size women category body proportions differ than normal people and an immediate need of further categorization as per body shapes in ASTM D6960-04, 2004 (standard table of body measurements designates to women's plus size figure type) [9]. Alexander et al. investigated women's plus-size body measurements and hip shape variation using Size USA data and while comparing it with plus-size ASTM standard; the findings showed variations in hip shapes within a given apparel size; which indicate sthe requirement of further bifurcation of body shapes [12]. A revised version of ASTM D6960 / D6960M - 16e1 was also introduced with subdivision into Straight and Curvy; based on body shapes [13,14]. Therefore, it was discovered that shape was one of the important criteria which should have been addressed while formulating the size chart.

Keeping the above facts in mind, the study was undertaken with an objective of analyzing the sizing charts adopted by plus-size clothing brands in India to identify the need of standardization of sizing system for this special segment. Study also attempts to propose a size chart for Indian plus size women category with inclusion of body shapes and their interaction with Obesity.

Definition of Obesity and Plus-Size

The definition of obesity derived through its determinants. Table 1 indicates determinants of obesity with their respective definitions and cut-off values devised by World Health Organization

***Corresponding author:** Kumari A, PhD Scholar at Fashion Technology department in National Institute of Fashion Technology, Delhi, India, Tel: 919306042934; E-mail: ajatyan48@gmail.com

Received: July 31, 2020 **Accepted:** August 16, 2020 **Published:** August 24, 2020

doi: 10.37532/jftte.2020.8(4).194

Table 1: Definition and cut-offs of determinants of Obesity used to define Plus-Size for the current research.

Determinants of Obesity	Definition	Cut-off
Body Mass Index (BMI)	It was calculated by dividing the weight of an individual in kg by the square of his/her height measured in meters. BMI is calculating by the formula, BMI= weight (kg)/height (m^2) [16]	Between 23 and 27.49 kg/m^2= overweight 27.5 kg/m^2 or above =Obese [17]
Waist Circumference (WC)	Measured as the midpoint between the top of the iliac crest and the lower margin of the last palpable rib in mid-axial line[18]	80 cm [18]
Waist to hip Ratio (WHR)	Waist: hip ratio (WHR) is a ratio of waist and hip circumference. [16].	0.80 [18,19]

(WHO) and other authentic sources in prospective to Asian women. Determination of cut-off score for a diagnostic test is the primary step; if a subject having higher value than cut-off may be considered as positive or diseased [15]. In obesity terms, exceeding the value of determinants from their respective cut off values will be considered as an obese [16-18].

BMI is the most commonly used indicator of obesity in population studies, although it is not a perfect one. It does not take into account body fat patterning at waist size [19,20]. Studies in various populations suggested that either WC alone or WHR may be better single anthropometric marker of chronic disease risk, as compared to BMI, because they may more specifically reflect abdominal body fatness [21,22]. It may be appropriate to use WC as an index for upper-body adiposity [23]. There are variations in body fat distribution on the basis of gender and age [18]. Usually, males have greater total lean mass and bone mineral mass and females have more total adipose tissue and fat mass; further cause of cardiovascular diseases [24].

On the other side, plus size can be defined as, 'A size of clothing designed for people who are larger than average' [25]. Larger than regular sizes, comes into plus size category.Plus-Size is other than regular size. Regular size is for a person who is neither tall nor short nor stout, and nor thin, and has a good posture [26]. This raises the key question who is plus size person?

International plus-size ASTM Standard D6960/D6960M-16e1 (2016) for female's defined plus-size category as 14W-32W with waist circumference ranges from 36 to 65.75 inches mainly derived using USA population [27]. Many other researchers also recommended that the female plus size clothing range lies between 14W to 32W for USA and UK population [12,28,29]. Hence, from the definitions; it's clear that the plus-size defined in accordance to either USA or UK population. But in Indian context same can be useful, a matter to investigate!

The aforementioned literature supported the definitions of the obesity and plus-size synonymously pointed towards a person with bigger body built than normal and WC used as one of the indicators to determine both obesity and plus-size. Hu stated that plus-size is associated with obesity and other related diseases [30] and Young stated that being a plus size should not be considered impairment relating obesity to plus size [31]. Further Romeo relate obesity to plus size clothing and examined 30 obese teenage female of U.S. and concluded that an updated sizing charts for plus-size is an immediate requirement of concerned obese girls' population [14]. All these studies pointing towards some sort of relationship among the two and the obesity determinants WC and WHR might help to device the same.

Female Body Shapes

Plus-size fashion is hard to execute; since all body types are different, it becomes critical to understand the customer's body before making a garment [3]. The most common way of identifying the shape of the body is to compare the silhouette and/or by calculating the difference between specific circumference measurements [32]. Chun compared the garment sizing systems published in USA, UK, Germany, Japan and Korea with respect to the way the body types were defined and found that women's body types were defined by hip proportion and the hip-bust drop value was used for it [26]. In similar line, Simmons et al. defined a total of 9 shapes; includes Hourglass, Bottom Hourglass, Top Hourglass, Spoon, Rectangle, Diamond, Oval, Triangle and Inverted Triangle with mathematical descriptors using drop values [11]. Lee et al. demonstrated mathematical equations to define shape in accordance to female figure identification technique (FFIT), as described in table 2 below [33]:

Size Label Perplexity

The clothing size label is a way to communicate sizing information to the consumer. The size label should assist the consumer in selecting the appropriate garment size [34]. More preferably in women's garment size will differ from one brand to other; where they need to try on each and every garment for taking buying decision [11]. Several other authors also mentioned, the clothing from separate companies differing so much that garment indicating the same size on the label, do not nearly have the same dimensions [34]. This miscommunication between clothing industries leads to confuse and dissatisfied the consumer's shopping experience, but may also induce negative feelings towards one's own body [35].

Research Gap and Objectives

Review of literature (ROL) revealed that very little research work undertaken on Indian plus-sized females. Therefore, some specific research gaps were identified in Indian context:

a) Lack of definitive measure to describe the plus-size women

b) Standardization of key measurements for plus-size sizing system

d) Interaction of body shapes and Obesity

c) Inclusion of female body shapes while creating size charts.

Therefore, the current study was undertaken with objectives of addressing the above research gaps.

Primary Objective

To develop size chart for plus size Indian women.

Secondary Objectives

Review of available online size chart offered by various brands for plus size women

To define plus-size women.

doi: 10.37532/jftte.2020.8(4).194

Table 2: Mathematical equation of FFIT (Female Figure Identification Technique) software to define female body shapes.

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

Understanding the prevalent body shapes of the online plus size brands

Development of a standard size chart with key anthropometric measurement.

Methodology

The methodology adopted for research was divided into three sections; as follows:

Study Design and Sampling

Research population was defined as 'Dedicated Plus-Size Female Clothing Brands;' either national or International servicing Indian Population. A total of 44 online plus-size brands were studied for research of which 14 were shortlisted for defining plus-size. Reasons for selection of brands were:

Availability of size Chart: The brands without size chart can't be included.

Comparable data: Brands which were giving body size charts were retained and ones giving garment size charts were ignored as there were no means of establishing it, the amount of ease used.

Comparable Size Labels: Brands having only alpha numeric size labels were shortlisted.

Furthermore; from 14 brands 10 brand's size charts were used for final analysis due to accessibility of all three key anthropometric measurements.

Selection of Key Anthropometric Measurements

Key dimensions like bust, hip and waist girths are common key anthropometric measurements frequently used by apparel experts and proven to be useful and important in developing new size tables [36,37]. According to Winks (1997) bust, waist and hip circumferences, vertical and girth dimensions constitute the most common parameters to carry out fit analysis [38]. Gupta and Zakaria found out using PCA analysis that 'Bust girth' as key dimension for upper body and 'hip girth' as key dimension for lower body [39]. The key measurements, chest/ Bust and hip for upper and lower body were assigned respectively by many others [40-42]. While collecting data, it was observed that many Indian retailers also rely on these measurements. Therefore, chosen key measurements for current study were also the ones which are unanimously used as key dimensions for various studies; includes Bust Circumference (BC), Waist Circumference (WC) and Hip circumference (HC).

Data Collection

For identifying the size range scale and interval of prevalent plus sizes, research data was collected through online websites of respective brands and arranged in excel with respect to key measurements in inches corresponding to their respective sizes as illustrated in Table 3. Here brand names were codified with Alphabetic naming to hide the brand's identity.

An additional set of data of key anthropometric measurements was collected from 84 plus sized (WC≥ 34 inches) Indian female subjects using convenience sampling for validation of body shapes. The age group and annual house hold income frequency distributions of sample is shown in tables 4 and 5 respectively.

Findings and Discussions

Data was analyzed in order to address research gaps and to create

Table 3: Collected data of key measurements of various selected Indian female plus-size brand's size charts.

Brands	XXS	XS	S	M	L	XL	2XL	3XL	4XL	5XL	6XL	7XL	8XL	9XL
	Bust													
A	39	41	43	45	47	49	51							
B		34	36	38	40	42	44	46	48	50	52			
C						40	42	44	46					
D		36	38	40	42	44	46	48	50	52	54	56		
E						40	42	44	46	48	50			
F						44	46	48	50	52	54	56	58	
G						41.5	43	47	51	55	60	66		
H					43	45	47	49	51	53	55	57	59	
I					43	46	48	51	54	57	59			
J					40	42	44	46	48	50	52	54	56	58
K						43	45	47	49	51	53	55	57	
L							40	42	44	46	48	50	52	
M							41	43	45	47	49	51	53	55
N					43	46	49	52	55	58	61	64		
	Waist													
A	32	34	36	38	40	42	44							
B		32	34	36	38	40	42	44	46	48	50			
C						32	34	36	38					
D		34	36	38	40	42	44	46	48	50	52	54		
E						34	36	38	40	42	44			
F						34	36	38	40	42	44	46	48	
G						34.5	36	40	44	48	53	59		
H					36	38	40	42	44	46	48	50	52	
I					36	39	41	44	47	50	52			
J					38	40	42	44	46	48	50	52	54	56
K						40	42	44	46	48	50	52		
L							40	42	44	46	48	50	52	
M							41	43	45	47	49	51	53	55
N					41	44	47	50	53	56	59	62		
	Hip													
A	42	44	46	48	50	52	54							
B		36	38	40	42	44	46	48	50	52	54			
C						42	44	46	48					
E						42	44	46	48	50	52			
G						44.5	46	50	54	58	63	69		
H					45	47	49	51	53	55	57	59	61	
I					46	49	51	54	57	60	62			
J					44	46	48	50	52	54	56	58	60	62
M								44	46	48	50	52	54	56
N					46	49	52	55	58	61	64	67		

Table 4: Frequency distribution of age group of selected 84 plus sized Indian female subjects.

Level	Age group (Years)	Count	Percentages
1	15-25	21	25
2	26-35	13	15
3	36-45	32	38
4	46-55	15	18
5	56-65	3	4
	Total	84	100

Table 5: Frequency distribution of annual house hold income of selected 84 plus sized Indian female subjects.

Level	Annual House hold Income (Indian Rupees)	Count	Percentages
1	Below 5 lakhs	18	21
2	5-10 lakh	19	23
3	10-20 lakh	21	25
4	Above 20 lakhs	26	31
	Total	84	100

Table 6: Determination of WC (Waist Circumference) cut-off for plus size in Indian context.

Class interval	Median value of class interval	Class frequency
[31,33)	32	3
[33,35)	34	4
[35,37)	36	2
[37,39)	38	1
[39, 41)	40	2
[41, 43)	42	2

a new sizing system based on findings.

Defining plus Size

The first challenge was to decide benchmark anthropometric measurement, which can be useful to define the plus size. For this purpose, collected data was sorted in terms of waist circumference among various brands. Since waist is the smallest circumferential measurement among all three key measurements and the most prevalent among retailer's sizing charts. Staton too used WC to define the plus-size for USA population [27]. For this purpose, the central obesity WC cut-off (WC≥80 cm or round up 31inches and above) for Asian/Indian females was compared with brand's initial waist circumferences as highlighted with 'Italic font' in table 3. It was observed that entire lot of brand's initial WC were satisfying the waist circumference criteria of central obesity. In order to define WC cut-off for plus-size, a range of waist circumference starting from 31 inches (central obesity WC cut-off) and ending with 41inches (maximum WC value among brand's initial waist circumferences) with class interval of 2 inches (standard grade) was taken as demonstrated in table 6.

The median value of a class interval with highest class frequency (34) was taken as the plus-size WC cutoff. Hence the current study defines Indian female plus size as waist 34inches and above.

Analysis of Brand's Plus-Size Charts

Literature established that standard size labelling varies from retailer to retailer globally. Table 3 validates the same. If the analogy of brand A to C was observed; although their initial cut-off waist measurement (32 inches) exactly same but the size labelling diverges from XXS to XL sizes. Analogous with the waist measurement of 34 inches, the brands lay under these criteria also ranges from XS to XL sizes. Moreover, an observation was evidence for varying other two key measurements with same WC. For instance; common size designation of WC 44 inches for brands I, J, K having different Bust and hip circumferences. Similar trends can be observed in terms of common bust and hip groups. Although the size designation and the anthropometric measurements among brands vary but some similarities do exist. It was observed that majority of brands synonymously falls within around a set of 16 to 18inches range for all three key measurements with a standard grade rule of 2 inches. Validity of the argument can observe through subtracting the starting and ending mode values of BC (56-40=16), WC (52-34=18), and HC (62-44=18) which covered most of the sizes of the brands. Hence it is evident that although there is disparity in size label and anthropometric measurements among size charts but follows similar range of anthropometric measurements. The analysis of brand's size charts found the need of 'Standardized Size Chart' and leads researcher to create a new one which can be derived from estimated range of key measurements.

Body Shape Analysis

The shape analysis was carried out on the basis of available three key measurements using FFIT mathematical equations as illustrated in table 2. As per literature; there are 9 shapes identified using FFIT with chronology of Hourglass, Spoon, Diamond, Bottom Hourglass, Top Hourglass, Oval, Inverted triangle, Triangle and Rectangle with the first shape with all requirements met being the identifier [27]. A total of five shapes: Hourglass, Top Hourglass, Inverted Triangle, Triangle and Rectangle shapes were identified for brands and remaining four shapes were omitted due to data limitation for this study. The shape analysis typically evaluates for various brands size charts and the kind of shapes adopted by these were shown in figure 1.

Unexpectedly, any of the plus-size brands was not following hourglass shape, which is considered the most popular shape among clothing manufacturers. 'Top Hourglass' and 'Inverted Triangle' shapes also not showed their presence. Figure 1 indicates that 50% of the brands were following 'Rectangle shape,' 10% of the brands were followed 'Triangle shape' and 40% of the brands were lies under 'No Specific Shape.' 'No Specific shape' was the accumulation of brands which did not follow any of the chosen shape criteria. The most adopted 'Rectangle' shape has symmetry with 'ASTM D6960/D6960M-16e1 Straight (a standard Tables for Body Measurements for Plus Women's Figure type),' which is also rectangle shaped [27].

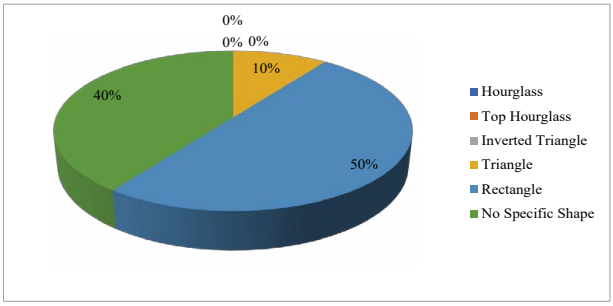

Figure 1: Percentages of the type of female body shapes acquired by Plus-Size brand's size charts.

doi: 10.37532/jftte.2020.8(4).194

Table 7: WHR (Waist-to-hip Ratio) values of various plus-size brand's size charts and their corresponding shapes acquired using FFIT software mathematical equations.

Brand	XS	S	M	L	XL	2XL	3XL	4XL	5XL	6XL	7XL	8XL	9XL	Shapes
B	0.89	0.89	0.90	0.90	0.91	0.91	0.92	0.92	0.92	0.93				Rectangle
E					0.81	0.82	0.83	0.83	0.84	0.85				
H				0.80	0.81	0.82	0.82	0.83	0.84	0.84	0.85	0.85		
M							0.93	0.93	0.98	0.98	0.94	0.98	0.98	
N				0.89	0.90	0.90	0.91	0.91	0.92	0.92	0.93			
J				0.86	0.87	0.88	0.88	0.88	0.89	0.89	0.90	0.90	0.90	Triangle
C					0.76	0.77	0.78	0.79						No Specific Shape
G					0.75	0.79	0.80	0.82	0.83	0.84	0.86			
I				0.78	0.80	0.80	0.81	0.82	0.83	0.84				
A	0.77	0.78	0.79	0.80	0.81	0.81								

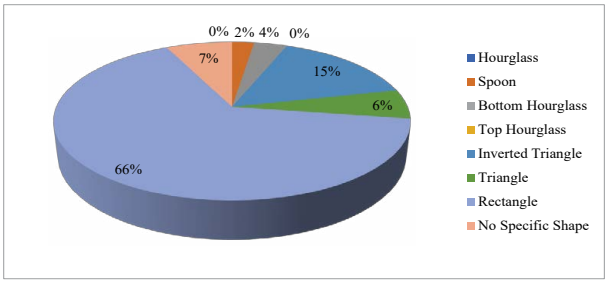

Figure 2: Percentages of the type of female body shapes acquired by selected 84 Plus-Size female Subjects.

In order to gather further clarification about the shapes; 84 plus size women were measured and analyzed for 7 shapes out of total 9 shapes designed; as shown in figure 2.

Here, the figure 2 signified the 'Rectangle' shaped subjects are in majority with their 66% presence. Other shapes were also showed their occurrence likewise Inverted triangle, as second highest majority with 15% presence, 7% Triangle shaped subjects occur and the least identified Spoon shape with 2% availability. 'Hourglass,' 'Top Hourglass' do not show their presence here as well. 7% of plus size subjects didn't follow any of the shape criteria. These subjects might come in two omitted shapes 'Diamond' and 'Oval' due to lack of abdomen, stomach measurements which were essential to derive these shapes. Consequently, the data analysis and literature signify that the rectangle shape was the most popular and prevalent.

Influence of Obesity

Literature revealed various determinants of obesity, but the current study restricted to analyze using WC and WHR. BMI was omitted due lack of weight and height measurements. As per WHO norms, WC and WHR cut-off values were 80 cm, 0.80 respectively which applies to Asian females. From literature the central obesity defined with cut off value for WHR≥0.80 for Indian females [16]. In context to WC; all brands start their plus size range with 32 inches or above; which surpasses the obesity rule of 80cm and above cut-off as refereed from table 3. Another important aspect was WHR; various brand's WHR values and corresponding shapes attained demonstrated in Table 7:

Here in Table 7, the values highlighted with 'bold Italic font' were not following the WHR cut-off. It was observed that the brands following rectangle and triangle shapes are the ones which are clearly following the WHR cut-off 0.80. But in case of the brands which were not falling any of the shape category (No specific shape) were not following WHR cut-off for some of their initial waist measurements. Primary data was also synthesized against WHR cut-off; the analogous trend was followed as adopted by brands. 'Rectangle,' 'Triangle' and 'Inverted triangle,' shaped figures were following WHR cut-off. But Spoon, Bottom Hourglass and the subjects with 'No specific shape' were not following the WHR cut-off. Since in both brands and primary data established that Rectangle and Triangle shapes following cut-off of WHR. Here it's important to mention that for current study the plus sized (WC≥34 inches) rectangle and triangle shaped brands and subjects were following WHR cut-off, but if the extreme values of mathematical indicators of shapes were taken (refer table 2) then it was observed that for WC≥40 inches and WC≥36 inches will always follow the WHR cut-off in case of Rectangle and Triangle shapes respectively. Therefore, it's recommended that, to correlate body shapes with WHR; needs further extensive research with a larger sampling frame. But for current study, it's been identified that Rectangle and Triangle shaped brands, plus-size subjects were following standard WHR cut-off.

Development of Sizing System

The idea of creating a new sizing system generated after locating the shared anthropometric range of measurements of three key determinants of brand's size charts. The shape analysis also shows that 'Rectangle' shape is the most prevalent among brands throughout the sample. The measurements of all Rectangle shaped brands were used to create a new sizing system. The waist used as key determinant to decide the size range of the sizing system. The lower value of WC for sizing system was 34 inches (plus-size cut-off) and the top of the scale was calculated through averaging of ending WC values of rectangle shaped brand's size charts i.e. (50+46+52+55+62)/5=53 inches. The other two measurements Bust and Hip were determined by statistically analysis of the data corresponding to predefined waist range. Staton created sizing system by doing shape analysis of SizeUSA data for plus size female subjects. The author designate waist circumference as key determinant and the mean values of bust, hip measurements were taken; which were grouped with respect to predefined range of waist circumference corresponding to the most prevalent shaped occurred 'Rectangle' and 'Spoon' [27].

Rectangle shaped brand's (B, E, H, M, and N) bust and hip measurements were taken to create the rectangle sizing system. The mean values of BC, HC were calculated within the predefined group of waist measurement. For instance, the mean of BC, HC were calculated as 38, 40 inches respectively with respect to WC grouped from 34-35 inches. An average value of interval of WC was taken to allocate waist in the sizing system. For example, a group of WCs 34-35 was taken as 34.5 inches. The grade intervals between averages of (BC) and (HC) values were calculated by subtracting two consecutive measurements as demonstrated in example (Ex.) in table 8. It was

doi: 10.37532/jftte.2020.8(4).194

observed that the grade intervals values were too random and low; not to practically feasible for grading of ready-to-wear. For instance; difference between the two consecutive mean values of the measurements comes out to be less than an inch; as demonstrated in table 8 with italic red font. Proportional grading, increasing the pattern proportionally in height and width, has been the standard method of grading in the apparel industry for decades [43,44]. Therefore, a method was devised to find out grade rule for development of sizing chart. In order to serve the purpose, the calculated grade intervals were divided into 2 groups: a) grade interval value<2 inches (standard grade) b) grade interval value≥2 inches. The groups of grade intervals were shown in table 8 using curly brackets (}). Later the mean of these grade interval groups was calculated and taken as grade rule to designate sizes. These mean values of grade interval groups are shown in table 8 with bold font; as demonstrated below:

The rectangle shape-based sizing system was developed using predefined WC ranges from 34-53 inches with standard grade of 2 inches as illustrated in table 9. The bust and hip measurements were calculated using newly designed grade rule mentioned in table 8. The alphanumeric (L to 9XL) size labelling was used; which usually familiar to consumers as well retailers in India.

By refereeing table 9, it's confirmed that size chart follows non-proportional grading. The different sizing system used by fashion retailers, nevertheless, almost all is based on myth that humans have mathematically proportional bodies with reference to ideal shape and grow in proportional ways [11]. Boorady elaborated on linear grading in plus-size via comments of three interviewees, which are well known faces in plus-size garment sector. The experts commented on plus-size grading as 'Standard, proportional grading not happening anymore in plus-size.' Another interviewee with more than 25 years of experience in plus-size apparels stated: 'We implemented our own grading and used customer feedback to tweak it and make it work.' [45]. Numerous other studies also revealed inaccuracies of proportional grading [43,44]. Subsequently, the Rectangle shape analysis and WHR were carried out for newly developed sizing system as demonstrated in table 10.

Table 8: Calculation of grade rule to develop a rectangle shaped sizing chart for Indian plus-size females.

Average (BC) values	Grade interval between average (BC)	Average of (WC) range	Average (HC) values	Grade interval between average (HC)
38	N/A	Ex. 34+35/2= 34.5	40	N/A
41	Ex. (41-38) = 3	36.5	43	Ex. (43-40) =3
43	2 — Mean = **2.5**	38.5	45	2 — Mean= **2.5**
43.8	0.8	40.5	46.75	1.75
46	2.2 → (Excluded due to exceeding 2 inches)	42.5	47	0.25
47.6	1.6 — Mean=1.45 or (approx.) =**1.5**	44.5	47.75	0.75 — Mean= 1.3 or (approx.) **1.5**
49.25	1.65	46.5	49.6	1.85
51	1.75	48.5	51.25	1.65
53	2	50.5	55	3.75
55.7	2.7 — Mean=2.35 or (approx.) **2.5**	52.5	57.67	2.67 — Mean= 3.2 (approx.) **3**

Table 9: Newly developed Rectangle Shaped Sizing System for plus-size females.

Size Category	Bust Circumference	Waist Circumference	Hip Circumference
Grade Rule	(2.5)	(2)	(2.5)
L	38	34.5	40
XL	40.5	36.5	42.5
2XL	43	38.5	45
Grade Rule	(1.5)	(2)	(1.5)
3XL	44.5	40.5	46.5
4XL	46	42.5	48.0
5XL	47.5	44.5	49.5
6XL	49.0	46.5	51.0
7XL	50.5	48.5	52.5
Grade Rule	(2.5)	(2)	(3)
8XL	53.0	50.5	55.5
9XL	55.5	52.5	58.5

Table 10: Shape analysis and WHR (Waist-to-hip ratio) of newly developed Rectangle Sizing Chart.

Rectangle Sizing System				Mathematical Indicators of Rectangle Shape				WHR
Size Category	BC	WC	HC	(hip-bust) < 3.6	(bust-hip) <3.6	(bust-waist) <9	(hip-waist) <10	
L	38	34.5	40	2	-2	3.5	5.5	0.86
XL	40.5	36.5	42.5	2	-2	4	6	0.86
2XL	43	38.5	45	2	-2	4.5	6.5	0.86
3XL	44.5	40.5	46.5	2	-2	4	6	0.87
4XL	46	42.5	48	2	-2	3.5	5.5	0.89
5XL	47.5	44.5	49.5	2	-2	3	5	0.90
6XL	49	46.5	51	2	-2	2.5	4.5	0.91
7XL	50.5	48.5	52.5	2	-2	2	4	0.92
8XL	53	50.5	55.5	2.5	-2.5	2.5	5	0.91
9XL	55.5	52.5	58.5	3	-3	3	6	0.90

doi: 10.37532/jftte.2020.8(4).194

The analysis confirmed that the newly developed sizing system follows all four criterions of 'Rectangle' shape and standard WHR cut-off. The chart can address the immediate need of 'Standardization' and can be a useful tool for plus-size pattern drafting.

Conclusion

The need of standardization of plus size in Indian context will be the pathway to develop separate standards for plus-size females. To initiate the process, Brand's sizing chart were selected and three key determinants bust, waist and hip circumferences were placed corresponding to their size labels. It was observed that there was disparity in size labels and respective anthropometric measurements but interestingly majority of brands synonymously falls within around a set of 16 to 18 inches of range for all three key measurements with a standard grade rule of 2 inches. Defining plus size was the biggest challenge due to unavailability of any standards to define it for Indian context. Waist circumference 34 inches or above was decided as the key determinant of plus-size. Shape analysis for all chosen brands was done using mathematical equations designed for FFIT using Microsoft excel. The shape analysis was based on 5 selected shapes those were 'Hourglass,' 'Top Hourglass,' 'Inverted Triangle,' 'Triangle,' 'Rectangle' for brands size charts and in addition to 2 more shapes 'Spoon' and 'Bottom Hourglass' for 84 Indian plus-size female subjects. The shape analysis resulted that 'Rectangle' shape was most prevalent and adopted body shape. A correlation also tried to search between plus-size and obesity through WHR and female body shapes. The Rectangle, Triangle shapes follows the WHR cut-off from all chosen shapes. Accumulating the whole brand's size-chart analysis; a new rectangle shaped sizing system was designed to cater the immediate need of Indian retailers and consumers.

Limitations

The study was solely based on online available data of Indian plus-size brands. Research also limits itself within 3 key anthropometric measurements which further limit the shape analysis within 5 to 7 shapes. The newly developed size chart caters preferably 'Rectangle' shaped population.

Suggestions for Future Research

In future, the current study can be extended by doing real time survey of Indian plus-size female to develop standardized size chart. The extensive data collection can lead to measure abdomen, stomach measurements which are the base for Oval and diamond shapes which might be leading shapes in this category. Large sample size will also be led to correlate Plus-Size, obesity and female body shapes to define plus-size universally. An accurate, updated new sizing system can also be developed which cumulatively be used by Indian retailers.

References

1. Rao BG (2016) "Of Size and Suitability
2. Credence Research (2018) "Plus Size Women's Clothing Market Size, Share and Forecast To 2026.
3. Rao N (2017) "Fashion for plus-size people turned into big business now - The Financial Express."
4. Meharda B, Sharma SK, Singhal G, Kumar LD (2017) Overweight and obesity: a rising problem in India. Int. J Community Med Public Heal. 4:4548.
5. Otieno R, Harrow C, Lea-Greenwood G (2005) The unhappy shopper, a retail experience: Exploring fashion, fit and affordability. Int. J. Retail Distrib. Manag. 33:298-309.
6. Leslie DB, Kathy K, Mullet NOB (2011) The Business of Fashion: Designing, Manufacturing and Marketing: Leslie Davis Burns: Fairchild Books. New York: Fairchild Books. 4th ed.
7. Anand N (2016) "Tech Exchange Size Matters – National Sizing Survey of India Dec2011."
8. Gill S, Brownbridge K (2013) The myth of standard size. Beauty 3 Confpp. 1-14.
9. Dunn SC (2016) Women's Plus-Size Apparel: Assessment of Clothing Size Charts among National Retail Federation's 2015 Top 100 US Retailers. Washington State University.
10. Baczek M (2013) "Analysis of the contemporary problem of garment sizes," in the 7th Textile Science 2013 conference, Sep. 2011, 1-8.
11. Simmons K, Istook CL, Devarajan P (2004) Female Figure Identification Technique (FFIT) for apparel part I: Describing female shapes. J. Text. Apparel, Technol. Manag. 4.
12. Alexander M, Pisut GR, Ivanescu A (2012) Investigating women's plus-size body measurements and hip shape variation based on SizeUSA data. Int. J. Fash. Des. Technol. Educ 5:3-12.
13. ASTM International ASTM International, "ASTM D6960 / D6960M-16e1 (2016) Standard Tables for Body Measurements for Plus Women's Figure Type, Size Range 14W – 40W," West Conshohocken, 2016.
14. Romeo LD (2013) Exploration of plus-size female teens' apparel fit and sizing in the United States. Iowa State University.
15. Singh G (2012) Determination of Cutoff Score for a Diagnostic Test. Internet J. Lab. Med. 2:1-4.
16. Reddy KS, Prabhakaran D, Shah P, Shah B (2002) Differences in body mass index and waist: Hip ratios in North Indian rural and urban populations. Obes. Rev. 3:197-202.
17. WHO (2004) Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies: Report of a WHO Expert consultation
18. World Health Organization (2008) Waist Circumference and Waist-Hip Ratio. Rep. a WHO Expert Consult.
19. Lean MEJ, Han TS, Morrison CE (1995) Waist circumference as a measure for indicating need for weight management. Bmj. 311:158.
20. Gupta R, Rastogi P, Sarna M, Gupta VP, Sharma SK, et al. (2007) Body-mass index, waist-size, waist-hip ratio and cardiovascular risk factors in urban subjects. J. Assoc. Physicians India. 55:621–27.
21. Bajaj HS, Pereira MA, Anjana RM, Deepa R, Mohan V, et al. (2014) Comparison of relative waist circumference between Asian Indian and US adults. J. Obes.
22. Lear SA, James PT, Ko GT, Kumanyika S (2010) "Appropriateness of waist circumference and waist-to-hip ratio cutoffs for different ethnic groups," European Journal of Clinical Nutrition 64:42-61.
23. Snehalatha C, Viswanathan V, Ramachandran A (2003) Cutoff values for normal anthropometric variables in Asian Indian adults. Diabetes Care. 26:1380 -84.
24. Derby CA, Zilber S, Brambilla D, Morales KH, McKinlay JB (2006) Body mass index, waist circumference and waist to hip ratio and change in sex steroid hormones: The Massachusetts Male Ageing Study. Clin. Endocrinol. (Oxf). 65:125-31.
25. Cambridge. PLUS SIZE | meaning in the Cambridge English Dictionary.
26. Chun J (2012) Men's and women's body types in the global garment sizing systems. Res. J Costume Cult. 20:923-36.
27. Staton S (2019) Analysis of Body Shapes & Fit in Plus-Size Women using SizeUSA Data. North Carolina State University.
28. Chowdhary U,Beale NV (1988) "Plus-Size Women's Clothing Interest, Satisfactions and Dissatisfactions with Ready-to-Wear Apparel," Percept. Mot. Skills, 66:783 -788.
29. Kind K O,Hathcote J M (2000) "Speciality-size college females: Satisfaction with retail outlets and apparel fit," J. Fash. Mark. Manag., 4:315-324.
30. Hu FB (2003) Overweight and obesity in women: Health risks and consequences. Journal of Women's Health, 12: 163–172.

31. Young M (2005) "One size fits all: Disrupting the comsumerized, pathologized, fat female form," Feminist Media Studies.
32. Connell LJ, Ulrich PV., Brannon EL, Alexander M, Presley AB (2006) Body shape assessment scale: Instrument development for analyzing female figures. Cloth. Text. Res. J. 24:80-95.
33. Lee JY, Istook CL, Nam YJ, Park SM (2007) Comparison of body shape between USA and Korean women. Int. J. Cloth. Sci. Technol. 19:374 - 91.
34. Strydom M, De Klerk H (2010) Key to good fit: body measurement problems specific to key dimensions. J. Fam. Ecol. Consum. Sci./Tydskrif vir Gesinsekologie en Verbruikerswetenskappe. 38.
35. Labat KL, Delong MR (1990) "Body Cathexis and Satisfaction with Fit of Apparel," Cloth. Text. Res. J., 8: 43- 48.
36. Chun-Yoon J, Jasper CR (1996) "Key dimensions of women's ready-to-wear apparel: Developing a consumer size-labeling system," Cloth. Text. Res. J. 14: 89 - 95.
37. Otieno RB, Fairhurst C (2000) The Development of New Clothing Size Charts for Female Kenyan Children. Part I: Using Anthropometric Data to Create Size Charts. J. Text. Inst. 91:143 -52.
38. Winks JM (1997) Clothing Sizes : International Standardization. Manchester: Textile Institute.
39. Gupta D, Zakaria N (2014) Anthropometry, Apparel Sizing and Design. (2nd Edition) Woodhead Publishing.
40. Gordon CC (1986)Anthropometric Sizing and Fit Testing of a Single Battledress Uniform for US Army Men and Women. Philadelphia: ASTM special technical publication.
41. Ashdown SP (1998) "An investigation of the structure of sizing systems. A comparison of three multidimensional optimized sizing systems generated from anthropometric data with the ASTM standard D5585-94," Int. J. Cloth. Sci. Technol., 10: 324-341.
42. Gupta D, Gangadhar BR (2004) "A statistical model for developing body size charts for garments," Int. J. Cloth. Sci. Technol., 16:458- 469.
43. Schofield NA, LaBat KL (2005) "Exploring the relationships of grading, sizing, and anthropometric data," Cloth. Text. Res. J., 23:13-27.
44. Petrova A, Ashdown SP (2008) Three-dimensional body scan data analysis: Body size and shape dependence of ease values for pants' fit. Cloth. Text. Res. J. 26:227-52.
45. Boorady LM (2014) Overweight and obese consumers: shape and sizing to design apparel that fits this specific market. In Designing Apparel for Consumers, Edited by Marie-Eve Faust and Serge Carrier, Woodhead Publishing 153-68.

Author Affiliations Top

Fashion Technology department in National Institute of Fashion Technology, Delhi, India