

# DETERMINATION OF STANDARD MEASUREMENTS OF T-SHIRT FOR YOUNG ADULTS OF BANGLADESHI ORIGIN

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**Abstract:** Ready-made garments are popular because of readily availability in the retail shops. Ready-made garments production requires standard measurement for each age group which depends on anthropometry. Measurement of ready-made garments varies on the anthropometry of a nation. The goal of the study was to develop a measurement chart and identify the size ratio and color preferences of both male and female young adults of Bangladeshi origin which is not in literature. A different point of measurement along with their heights of 409 males' and 356 females' young adult for the T-shirt was taken. Based on height, the male and female young adults were categorized into five sizes (S, M, L, XL, and XXL). It is found that the size ratio was around S: M: L: XL: XXL = 6: 32: 37: 18: 7 and 17: 30: 34: 13: 6 for male and female respectively. Proposed standard measurement of Length from highest point of shoulder, Centre front length, Armhole, Sleeve length, Neck width, Across shoulder, Half chest and Hem Width for size L for male is 68 cm, 63 cm, 23 cm, 19.5 cm, 21 cm, 44 cm, 49 cm and 49 cm for respectively. Preferences of color are quite wide of both male and female, most preferred color is blue among the male and black among the female. Two-third female adults preferred short sleeve t-shirt. Brands that are targeting to retail their T-shirt in the market of Bangladesh can use developed measurement sheets for the bulk production of T-shirt.

**Keywords:** Measurement chart; Young adults; T-shirt; Bangladesh

## 1. INTRODUCTION

Much has been written about the equality of humans, all humans are equal, and maybe equal in the eyes of laws, however not in physic as physical structure depends on the anthropometry of individuals. And it is also been widely told that size does not matter, size may not matter for doing a specific job but the size of garments a matter for coziness of the wearer. Appropriate measurement ensures proper fitting of the garments that confirm the satisfaction of the user. If a garment does not show any stress, wrinkle or unnecessary fluffiness may be identified as properly fitted garments. Maintaining proportionate measurement is one of the key elements for a properly fitted garment. However, fitting is more important for

tightly fitted garments as the smallest of misfit is noticeable whereas smaller deviations may not be visible for loosely fitted garments.

Fitting of any garment is a very important consideration of the end-users of any garment. Among the age groups, both male and female young adults are more concerned about the fitting of the garments they wear [1]. It has been discovered in the study that there is a huge scope to improve the fitting of the garments [2]. The fitting has a strong impact on young adults buying decisions as well. Although the price and quality of garments are important, other important factors that influence the buying decision is the exact fitting of one's garments and its color [3-5]. There is no universal standard measurement for any garments of any age group as the anthropometry of the different nations is not the same. Most countries and retailer of brands usually possess their official garment size systems, which differ in many aspects from one to another [6]. Letter grade (XS, S, M, L, XL, XXL) sizing systems is popular in Bangladesh for top i.e., T-shirts of both male and female and differences between one size to next size is not fixed as well, however Sizing systems in the U.S. apparel industry is developed from rules that set fixed increments between sizes [7].

However higher numbers of sizes ensure a better comfortable fit for users [8]. One of the greatest challenges for the apparel industry is to produce garments that fit customers properly [9]. It is more difficult to satisfy youngsters as Children and teenagers experience rapid physical growth and alterations in body shape as they develop-changes that pose significant challenges in creating apparel sizing systems [10]. As the Anthropometry of different ethnic origin is different, there is no universal size chart that satisfies every ethnic group. The standard size chart has been developed in a different country by brands based on their experience and customer feedback [11]. Anthropometric study has been conducted in different countries to develop a measurement chart, standard measurement chart has been developed for Indian young men [12], suit sizing

system developed for Iranian male [13], size chart developed for Taiwanese adult female [14].

The standard size of the T-shirt of Bangladeshi young male and female is not determined yet. When someone goes to produce a T-shirt for Bangladeshi young's, they do not get any size specification sheet that properly represents the exact size of the Bangladeshi young adults. Moreover, the proportion of the size of the population is yet to determine as well. Hence producing garments in different sizes by the proportion of the population is difficult. There is an increasing trend to buy ready-made garments, especially knitted items like a T-shirt for both male and female young adults in Bangladesh. The need to developing a standard size chart for the mentioned age group is understandable. This study was conducted to obtain a standardized measurement chart of T-shirt and preference on colors of Bangladeshi young adults. The specific objectives of the study are to find out the standard measurement of each size, to identify the proportion of size, to rank the color in accordance with the preference and to find out the preference of young Bangladeshi females on sleeve length of T-shirt.

## 2. METHODOLOGY

### A. Data Collection

Students who were doing under graduation were trained to measure the T-shirt of young adults. Female students were assigned to measure the female young adults and male students were assigned to male young adults. Besides, the measure of T-shirt color preference was also asked, individuals. Participants of the study also the students of undergraduate level and they were selected randomly. A number of 409 males and 356 females have participated in the survey.

### B. Terminology for this Study

Figure 1 presents the outline of a T-shirt and its terminology is described as follow -

<b>Young Adult:</b>	A person who is in the age of late teen to early twenties, to be specific we considered 18 to 24 years
<b>Length from HPS<sup>1</sup>:</b>	Measure at front, from the highest points of shoulder (HPS) of shoulder seam straight down to the bottom of the garment
<b>Center Front Length<sup>2</sup>:</b>	Measure length from center of front neck to bottom hem
<b>Arm Hole<sup>3</sup>:</b>	Curvy measurement from top of armhole (shoulder seam or natural fold) to bottom of armhole

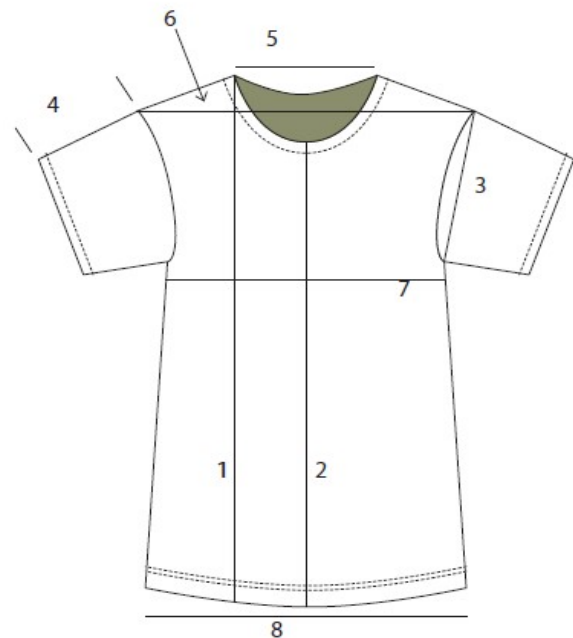


Figure 1. Outline of a T-shirt

<b>Sleeve Length<sup>4</sup>:</b>	From the shoulder seam to the bottom edge of sleeve opening
<b>Neck Width<sup>5</sup>:</b>	Measure from inside of neck rib of one side to another side
<b>Across Shoulder<sup>6</sup>:</b>	Straight across from shoulder point to shoulder point
<b>Half Chest<sup>7</sup>:</b>	Measure around the fullest part of the chest
<b>Hem Width<sup>8</sup>:</b>	Measure with closed garment, measure straight across from side to side

### C. Target Population and Inclusion Criteria

All male and female young adults of Bangladesh were the target population. Inclusion criteria was all the male and female who was aged between 18–24 years.

### D. Analytical Tools

Collected data were cleaned to exclude the missing values and extreme values. The descriptive statistics were calculated to know the distribution of size and prepare a measurement chart. Statistical Package for Social Sciences (SPSS) was used for analysis.

## 3. RESULTS AND DISCUSSION

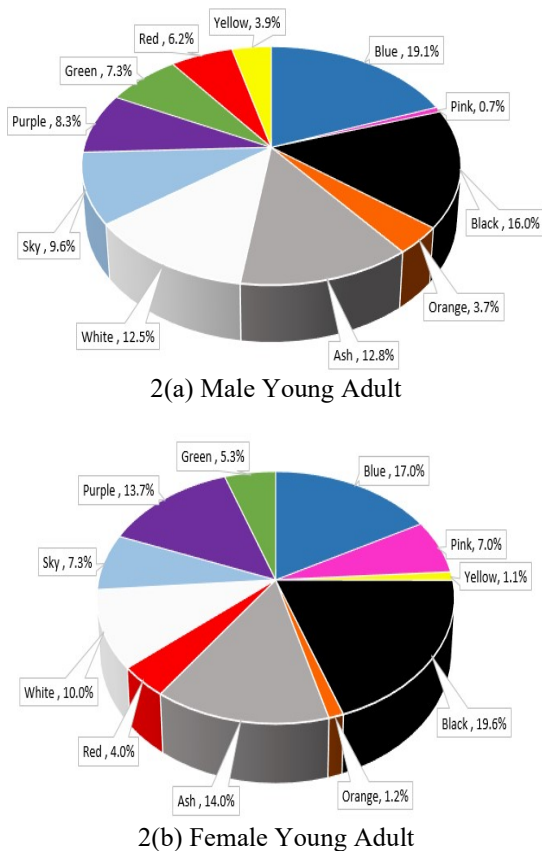
### A. Preference in T Shirt of Young Adults

Figure 2 presents the color preferences of young adults for a T-shirt. It is found that Blue (19.1%), Black (16.0%), Ash (12.8%) and White (12.5%) have the highest preference which was followed by Sky

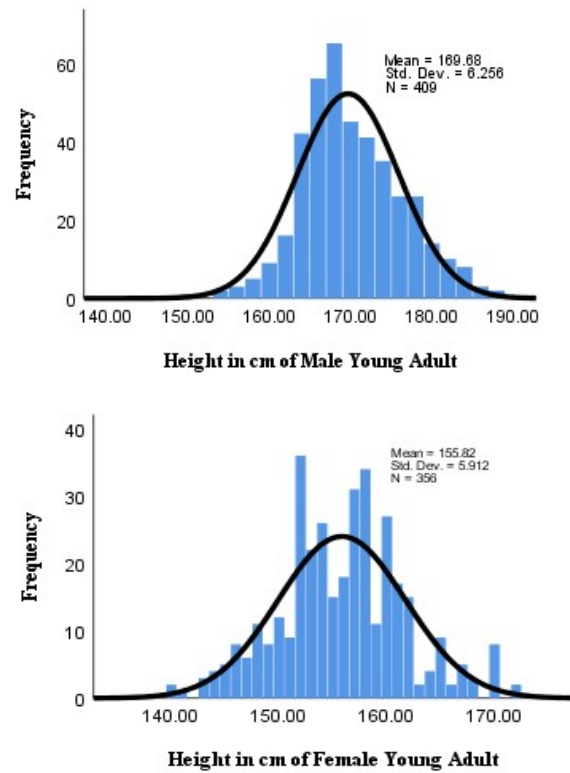
(9.6%), Purple (8.3%), Green (7.3%) and Red (6.2%) among the male young adults (Figure: 2 (a)).

Among the female young adults, the most preferred three colors were Black (19.6%), Blue (17.0%) and Ash (14.0%) which were followed by Purple (13.7%), White (10.0%), Sky (7.3%), Pink (7.0%), and Green (5.3%) (Figure: 2(b)). The least preferred colors by male were Yellow (3.9%), Orange (3.7%) and Pink (0.7%) whereas Red (4.0%), Orange (1.2%) and Yellow (1.1%) by female young adults. In the case of color preference, Blue, Black and Ash were the first three preferred colors for both male and female young adults. Female young adults have higher preferences on Purple and Pink color in comparison to the males. Color preferences on White, Sky, Green, Red, Yellow and Orange were almost similar in both genders.

Distribution of height of young adults of Bangladeshi is shown in Figure 3. The average height of male and female young adults are 169.98 cm with standard deviation 6.25 cm and 155.82 cm with standard deviation 5.91 cm respectively. The normal curve of height of both male and female are almost symmetric thus, the distribution of data tends to be normal.



**Figure 2.** Color Preference in percentage (a) Male and (b) Female young adults



**Figure 3.** Height distribution of Young adults of Bangladeshi

Table I presents size distribution for T shirt of the male and female young adults of Bangladesh. Among the male young adults, about 6% were in the small category (height up to 161 cm). About 32%, 37% and 18% young male adults were in Medium (162 to 167 cm), Large (168 to 173 cm) and Extra Large (174 to 179 cm) respectively. However, only 7% were in Extra-Extra Large (more than 179 cm) category.

Among the female young adults, about 16.9% were in the small category (height up to 150 cm). About 30.3%, 34.0% and 13.2% young female adults were in Medium (151 to 155 cm), Large (156 to 160 cm) and Extra Large (161 to 165 cm) respectively. However, only 5.6% were in Extra-Extra Large (more than 165 cm) category.

It is revealed from the results that more than 64% of the respondents from male and female were in medium and large groups.

### B. Young Male Adult

Standard measurements of Young Male Adult are presented in Table A1 (Appendix). Average length from HPS was  $65.30 \pm 3.36$  cm,  $67.25 \pm 3.47$  cm,  $68.39 \pm 3.74$  cm,  $69.89 \pm 3.34$  cm and  $71.31 \pm 3.38$  cm for size S, M, L, XL and XXL respectively.

**TABLE I: SIZE DISTRIBUTION AMONG MALE AND FEMALE YOUNG ADULTS OF BANGLADESH**

Size	Male (n = 409)			Female (n = 356)		
	Height (in cm)	Frequency	Percent	Height (in cm)	Frequency	Percent
Small (S)	Up to 161	23	5.6	Up to 150	60	16.9
Medium (M)	162 – 167	132	32.3	151 – 155	108	30.3
Large (L)	168 – 173	152	37.2	156 – 160	121	34.0
Extra Large (XL)	174 – 179	73	17.8	161 – 165	47	13.2
Extra-Extra Large (XXL)	Above 179	29	7.1	Above 165	20	5.6

**TABLE II: WORKABLE MEASUREMENT CHART FOR T-SHIRT (IN CM) OF YOUNG MALE ADULTS OF BANGLADESHI ORIGIN**

Description	Tolerance+/-	S	M	L	XL	XXL
Length from HPS	1.5	65.0	67.0	68.0	70.0	72.0
Centre front length	1.5	60.0	62.0	63.0	65.0	67.0
Armhole	0.5	21.0	22.0	23.0	24.0	25.0
Sleeve length	0.5	18.5	19.0	19.5	20.0	20.5
Neck width	0.5	19.0	20.0	21.0	21.0	22.0
Across shoulder	1.0	42.0	43.0	44.0	45.0	46.0
Half chest	1.0	46.0	48.0	49.0	50.0	51.0
Hem Width	1.0	46.0	48.0	49.0	50.0	51.0

In 95% cases, the average value of size S would be lies in between 63.85 to 66.76 cm. Minimum and maximum length from HPS for size S was 57 cm and 71 cm respectively. For Half-chest, the average value was 46.26±3.22 cm, 48.20±3.84 cm, 48.11±4.77 cm, 50.38±4.48 cm, and 50.48±4.08 cm. for the Size S, M, L, XL and XXL respectively.

Average armhole size of male young adults was 21.83±1.77 cm, 22.52±1.86 cm, 23.37±1.94 cm, 23.62±2.44 cm and 24.24±2.34 cm for size S, M, L, XL and XXL respectively.

Average measurement of Centre Front Length, Sleeve Length, Across Shoulder, Neck Width and Hem Width are also available in Table A1. Based on the average measurement a workable measurement for young male of Bangladesh is presented in Table II.

### C. Female Young Adult

Among the female young adults (Table IV), 67.4% were preferred short sleeve length and remaining 32.6% were interested for long sleeve T shirt (Table III).

From Table A2 (Appendix), average length from HPS was 57.30±5.09 cm, 59.72±4.52 cm, 60.77±4.43 cm, 64.04±3.82 cm and 68.60±3.50 cm for size S, M, L, XL, and XXL respectively.

In 95% cases, the average value of size S would be lies in between 55.98 to 58.62 cm. The Minimum and maximum length from HPS for size S was 40 cm and 68 cm respectively. For Half-bust, the average value was 43.93±4.45 cm, 44.90±5.20 cm, 45.56±4.86 cm, 46.68±5.66 cm, and 47.30±5.29 cm for Size S, M, L, XL, and XXL respectively. Average armhole size of a female young adults was 21.53±2.28 cm, 21.97±2.48 cm, 22.40±2.01 cm, 22.83±2.44 cm and 23.75±2.05 cm for size S, M, L, XL, and XXL respectively.

Table A2 describes also the average measurement of the Centre Front Length, Sleeve Length (both Short and Long), Across Shoulder, Neck Width and Hem Width. Based on the average measurement, a workable measurement for a young female of Bangladesh is presented in Table IV.

**TABLE III: PREFERRED TYPE OF SLEEVE LENGTH OF FEMALE YOUNG ADULTS**

Long sleeve T shirt	Short sleeve T shirt
32.6%	67.4%

**TABLE IV: WORKABLE MEASUREMENT CHART FOR T-SHIRT (IN CM) OF YOUNG FEMALE ADULTS OF BANGLADESHI ORIGIN**

Description	Tolerance+/-	S	M	L	XL	XXL
Length from HPS	1.5	57	59	61	64	68
Centre front length	1.5	50	52	54	57	60
Armhole	0.5	21	21.5	22	23	24
Sleeve length - short	0.5	15	16	16.5	16.5	17
Sleeve length - long	1	51	53	55	57	60
Neck width	0.5	22	23	24	24.5	25
Across shoulder	1	39	40	41	42	43
Half bust	1	43	45	46	47	48
Hem Width	1	48	49	49.5	50	51

#### 4. CONCLUSION

Developing a standard measurement for any age group is essential for the mass production of garments. Tailor-made garments are eroding day by day in Bangladesh as ready-made garments are available in the market which is easy to access. The absence of standard measurement may produce unfit garments and production may be unsold if the size ratio is not maintained. This study identifies the size ratio of males and females as well as offered a standard measurement sheet. This newly developed measurement sheet will remain continually beneficial for both production planning and better fitting.

##### A. Research Limitation/Implications

The findings presented are obtained from the students of a university of Bangladesh. Future research could be done on different types of garments on all age groups. These newly developed size charts will be helpful for both production planning and reducing inventory costs.

#### REFERENCES

- [1] S. Akter, and S. Ahammed, "Analysis on Garments Buying Behavior of Textile Engineering Students-A Study in Bangladesh", *Elixir International Journal*, 2018, 49675-49678, 2018.
- [2] R. Howarton, and B. Lee, "Market analysis of fit preferences of female boomers". *Journal of Fashion Marketing and Management: An International Journal*, 14(2), 219-229, 2010.
- [3] H. Kim, and M. L. Damhorst, "Gauging concerns with fit and size of garments among young consumers in online shopping". *Journal of Textile and apparel, Technology and Management*, 8(3), 2013.
- [4] O. Rahman, B. C. Fung, Z. Chen, and X. Gao, "A cross-national study of apparel consumer preferences and the role of product-evaluative cues," *Asia Pacific Journal of Marketing and Logistics*, 29(4), 796-812, 2017.
- [5] M. Koszewska, O. Rahman, and B. Dyczewski, "Polish Apparel Consumer Purchase Criteria: Driver or Inhibitor for Circular Economy?" in Proc. of the 18th AUTEX World Textile Conference, June 20-22, 2018, Istanbul, Turkey
- [6] D. Ujević, L. Szivovicza, and I. Karabegović, "Anthropometry and the comparison of garment size systems in some European countries," *Collegium antropologicum*, 29(1), 71-78, 2005.
- [7] C. E. McCulloch, B. Paal, and S. P. Ashdown, "An optimisation approach to apparel sizing," *Journal of the Operational Research Society*, 49(5), 492-499, 1998.
- [8] B. Pemberton, "The size of IT Primark has expanded its clothing sizes for a 'more comfortable fit' – and the range now goes from a size four to 24," *thesun.co.uk* 30 June 2018. Available: <https://www.thesun.co.uk/fabulous/6663003/primark-expanded-clothing-sizes-comfortable-fit-size-four-24/>.
- [9] N. Zakaria and D. Gupta, "Apparel sizing: existing sizing systems and the development of new sizing systems" in *Anthropometry, Apparel Sizing and Design*: Woodhead Publishing, 2014, pp. 3 - 33.
- [10] N. Zakaria, "Clothing for Children and Teenagers: Anthropometry, Sizing and Fit: Woodhead Publishing, 2016.
- [11] L. M. Boorady, "Functional clothing—Principles of fit" *Indian Journal of Fibre & Textile Research*, 36, 344-347, 2011.
- [12] D. Gupta, "Anthropometric study of young indian men for garment sizing," *Research Journal of Textile and Apparel*, 14(1), 82-89, 2010.
- [13] M. S. Esfandarani, and J. Shahrabi, "Developing a new suit sizing system using data optimization techniques," *International Journal of Clothing Science and Technology*, 24(1), 27-35, 2012.
- [14] C. H. Hsu, H. F. Lin, and M. J. Wang, M. J. "Developing female size charts for facilitating garment production by using data mining," *Journal of the Chinese Institute of Industrial Engineers*, 24(3), 245-251, 2017.

APPENDIX

**TABLE A1: STANDARD MEASURES OF POINT OF MEASUREMENTS (IN CM) FOR YOUNG MALE ADULTS, BANGLADESH**

POM	Size	Mean	Standard Deviation	95% Confidence Interval		Minimum	Maximum
				Lower Bound	Upper Bound		
Length from HPS	S	65.3	3.4	63.9	66.8	57.0	71.0
	M	67.3	3.5	66.7	67.9	53.0	75.0
	L	68.4	3.7	67.8	69.0	56.0	77.0
	XL	69.9	3.3	69.1	70.7	58.0	76.0
	XXL	71.3	3.4	70.0	72.6	65.0	82.0
Center Front Length	S	60.7	4.1	58.9	62.5	52.0	69.0
	M	62.1	2.8	61.6	62.6	52.0	70.0
	L	63.1	3.7	62.5	63.7	51.0	72.0
	XL	63.9	3.5	63.1	64.7	51.0	70.0
	XXL	66.1	3.0	65.0	67.2	61.0	72.0
Armhole	S	21.8	1.8	21.1	22.6	17.0	25.0
	M	22.5	1.9	22.2	22.8	18.0	28.0
	L	23.4	1.9	23.1	23.7	18.0	30.0
	XL	23.6	2.4	23.1	24.2	14.0	30.0
	XXL	24.2	2.3	23.4	25.1	20.0	29.0
Sleeve Length	S	18.5	1.9	17.7	19.3	15.0	21.0
	M	18.7	1.7	18.1	18.7	14.0	23.0
	L	18.9	1.6	18.6	19.2	15.0	23.0
	XL	19.4	1.8	19.0	19.8	15.0	25.0
	XXL	20.5	1.8	19.8	21.2	17.0	25.0
Neck Width	S	20.4	1.7	19.7	21.2	17.0	25.0
	M	20.7	1.8	20.4	21.0	17.0	26.0
	L	21.0	1.8	20.7	21.3	16.0	28.0
	XL	21.4	2.1	20.9	21.9	17.0	25.0
	XXL	21.5	2.0	20.7	22.2	18.0	26.0
Across Shoulder	S	42.9	1.8	42.1	43.7	39.0	45.0
	M	43.8	2.2	43.4	44.2	39.0	52.0
	L	44.1	2.2	43.8	44.5	37.0	51.0
	XL	45.2	2.2	44.7	45.7	40.0	52.0
	XXL	46.1	3.0	44.9	47.2	42.0	53.0
Half Chest	S	46.3	3.2	44.9	47.7	39.0	51.0
	M	48.2	3.8	47.5	48.9	42.0	62.0
	L	48.1	4.8	47.3	48.9	19.0	56.0
	XL	50.4	4.5	49.3	51.4	41.0	64.0
	XXL	50.5	4.1	48.9	52.0	45.0	59.0
Hem Width	S	46.6	3.0	45.3	47.9	40.0	50.0
	M	47.9	3.4	47.3	48.5	41.0	57.0
	L	48.4	3.1	47.9	48.9	40.0	56.0
	XL	49.5	4.6	48.4	50.6	32.0	64.0
	XXL	50.9	4.1	49.3	52.5	45.0	60.0

**TABLE A2: STANDARD MEASURES OF POINT OF MEASUREMENTS (IN CM) FOR YOUNG FEMALE ADULTS, BANGLADESH**

Point of Measurement	Size	Mean	Std. Deviation	Std. Error	95% Confidence Interval		Minimum	Maximum
					Lower Bound	Upper Bound		
Length from HPS	S	57.3	5.1	0.7	56.0	58.6	40.0	68.0
	M	59.7	4.5	0.4	58.9	60.6	48.0	71.0
	L	60.8	4.4	0.4	60.0	61.6	49.0	69.0
	XL	64.0	3.8	0.6	62.9	65.2	53.0	70.0
	XXL	68.6	3.5	0.8	67.0	70.2	63.0	73.0
Center Front Length	S	50.3	4.8	0.6	49.1	51.5	36.0	60.0
	M	52.1	4.6	0.5	51.2	53.0	42.0	65.0
	L	53.2	4.4	0.4	52.4	53.9	41.0	64.0
	XL	57.1	4.4	0.6	55.8	58.3	46.0	66.0
	XXL	59.3	2.6	0.6	58.1	60.5	54.0	63.0
Armhole	S	21.5	2.3	0.3	22.4	23.6	17.0	27.0
	M	22.0	2.5	0.2	21.6	22.5	17.0	27.0
	L	22.4	4.0	0.4	22.7	24.1	15.0	43.0
	XL	22.8	4.5	0.7	21.5	24.2	18.0	44.0
	XXL	23.8	4.1	0.9	21.9	25.7	18.0	34.0
Sleeve Length-Short	S	15.3	2.3	0.4	14.6	16.0	11.0	18.0
	M	16.3	3.3	0.4	15.5	17.0	10.0	19.0
	L	16.1	2.3	0.3	15.6	16.7	10.0	20.0
	XL	15.5	3.1	0.6	14.3	16.7	10.0	20.0
	XXL	16.9	2.2	0.6	15.7	18.2	10.0	19.0
Sleeve Length-Long	S	51.5	2.6	0.7	50.1	52.9	43.0	54.0
	M	52.8	6.8	1.2	50.3	55.3	44.0	58.0
	L	54.7	4.6	0.7	53.3	56.1	45.0	64.0
	XL	55.4	6.1	1.4	52.5	58.3	45.0	61.0
	XXL	60.8	1.2	0.5	59.6	62.1	60.0	63.0
Neck Width	S	22.3	2.7	0.3	23.6	24.9	19.0	31.0
	M	23.3	3.0	0.3	22.8	23.9	16.0	31.0
	L	23.6	3.5	0.3	22.9	24.2	16.0	32.0
	XL	23.9	4.0	0.6	21.7	24.1	17.0	29.0
	XXL	24.4	2.6	0.6	22.7	25.1	18.0	29.0
Across Shoulder	S	39.6	3.8	0.5	39.6	41.6	34.0	54.0
	M	40.2	3.6	0.4	38.5	40.8	32.0	55.0
	L	41.3	4.4	0.4	40.5	42.1	32.0	57.0
	XL	41.8	7.3	1.1	39.7	42.9	30.0	57.0
	XXL	42.4	2.9	0.7	40.0	43.8	36.0	58.0
Half Bust	S	43.9	4.5	0.6	43.8	45.6	38.0	56.0
	M	44.9	5.2	0.5	43.9	45.9	36.0	65.0
	L	45.6	4.9	0.4	44.7	46.4	35.0	66.0
	XL	46.7	5.7	0.8	43.0	47.3	32.0	66.0
	XXL	47.3	5.3	1.2	42.8	48.8	38.0	68.0
Hem Width	S	48.2	4.7	0.6	47.0	49.4	40.0	57.0
	M	48.3	5.9	0.6	47.2	49.4	38.0	71.0
	L	49.4	5.6	0.5	48.4	50.4	38.0	66.0
	XL	49.7	6.2	0.9	47.9	51.6	38.0	67.0
	XXL	50.3	6.0	1.3	47.5	53.1	40.0	60.0