Lycra for Garment Fit and Size

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ABSTRACT

Fabrics for apparels are constructed either by weaving or knitting using innovative methods and technology in fiber and fabric manufacture. This research was designed to study physical properties of woven and knitted Lycra blends with different geometry and use them for garment construction to see the garment fit with stretch and recovery property of Lycra and location of seams with larger body sizes. Woven Lycra blends showed additional advantage of allowing sewers to more closely fit a pattern and be very comfortable. It imparted a great level of stretch and dimensional recovery, adding comfort and wrinkle resistance to the garments. Knit Lycra blends were as comfortable and more of dimensionally stable fabrics. The fiber blend and fabric structure have great impact on the fit the garments that impart comfort, aesthetic appeal and flexibility to the wearer of various size groups. Limited range of stretch with woven construction actually needs to have individual garment size developed with marginal ease for comfortable body activities. Knitted garments with higher elastic property can fit the wearers of many larger sizes. Placement of seam in garment construction for body contour as aesthetic parameter and stretch and recovery property as performance parameter would be useful especially when many sizes are expected to fit in one size. On the basis of the study, predictions for standardization of sizes to accommodate range of body sizes could be done for construction of garments even with different styles.

Keywords: Lycra blends, comfort, fabric geometry, elastic recovery, body sizes

INTRODUCTION

The fabric quality has direct association with design development, comfort and aesthetic appearance of the garments with the fiber content, type of yarn, fabric geometry and the form of finish used in each case. Garments made of woven fabrics are strong, firm and dimensionally stable. Knitted garments are stretchable, ready to fit, having good wicking property and gives comfort in various posture of wearer.

India is a country of diversity where one can find a lot of variations in climate, culture and clothing. Indian clothing industry has come a long way with custom made tailoring which seems to dominate the Indian dressing scenario today. The garment industry has increased manifold with millions of garments being produced annually to fit vast population but still we find that in India, 30 million potential customers with good clothing sense are ignored, due to non-availability of proper sizing there by accelerating the need for size classifications of populations (1).

The most important point in judging a garment is its fit. A fit can either flatter or change the contour of human figure. The general standard of a well fitted garment remains the same from year to year as they are based on structural lines of the human figure (5).

Customer's expectations for a particular apparel product depend on garment fit and fabric's wear conditions. The requirements for the fit of apparels may mean the balance of different properties of stretch, drape, smoothness, etc. for different end uses and then get desired comfort as well as aesthetic appeal in the garments. During body movement, the body expands and contracts in the area surrounding it joints, so the garments expansion and contraction should follow the pattern of body movement. Garment should be designed to facilitate body movement both excessive local tightness and looseness are causes of poor garment fit and associated discomfort (4).

Lycra has been introduced into both woven and knitted fabrics for the optimum performance and aesthetics. The influence of Lycra on fabric properties having different geometry, fabric count, mass, thickness, air permeability, shrinkage and stretch and recovery behavior would be useful to create variations in clothing pattern (3).

With respect to body movement end uses of clothing have different requirements in garment design. Therefore, the pattern of the garment should be adjusted to accommodate the body change. Everything concerning pattern making and grading starts with sizes and measurements. Clothing has to be made so that it fits the sizes and the shape of the body as well as possible. The size chart provides vital information which enables manufacturers to select and cater for specific areas of the population. It is obvious that whole population cannot be covered by a single manufacturer (2).

Freedom of movement of the human body is inextricably linked with garment pattern design and construction. The seams that connect major sub-assemblies of a garment are important in the promotion of style and comfort. With the movement of the body, stress and recovery of the garment with body extension and contraction occurs appreciably, which directly affects the fit and comfort of the clothing and can even change the shape of the whole upper garment.

MATERIALS AND METHODS

An experimental study was carried out to understand impact of Lycra on woven and knitted fabrics (cotton/Lycra 97/3%). Two fabrics under each woven and knitted fabric categories were selected to study stretch properties of Lycra with fabric geometry (Table 1).

Table 1: Details of Cotton / Lycra fabric (97 x 3 %) for the study;

Fabric code	Structure Pattern
A	Plain Basket weave(2x2)
B	Twill Weave(2x2)
C	Single Jersey knit
D	Rib knit

In this study, fabric properties were examined for their relationship to shrinkage behavior, strength and recovery properties stretch and fit properties to determine whether incorporation of Lycra had its impact on performance properties of fabrics (Raval H., & Karolia, A. (2017). The tested fabrics were used for construction of the upper garment to study stretch, fit and appearance, and recovery behavior of these fabrics. The basic pattern of garment with specified design details was taken as pilot study and standardized. It was developed on muslin using draping method to check the position of the construction lines and fit of the garment on the dress form. Paper pattern was developed from this draped muslin garment. The design details were princess style from mid arm scye to waist, for both front and back, round neck and sleeveless. The length of the garment was till the waist line (Plate 1).
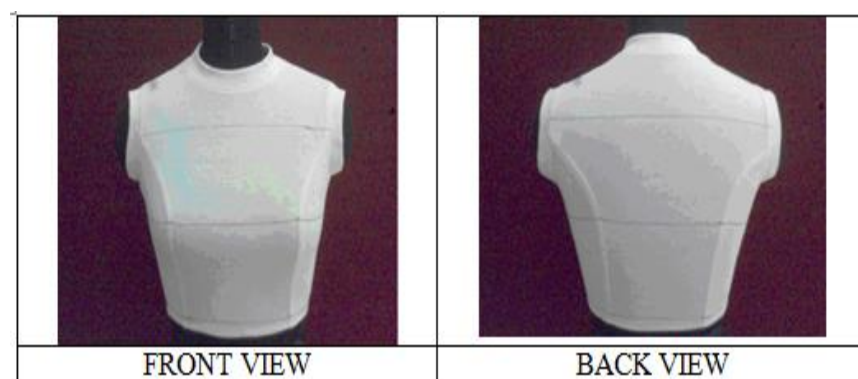

Plate 1: Basic pattern developed for pilot study

The standardized basic bodice block was tried on actual model of the same bust size (81.0 cm). Alteration was done for fit and shape of the garment. The length of the garment was increased by 15 cm making the final length of the garment 55.0 cm (Plate 2-5). As the final garments were to be made from woven and knitted fabric varieties, centre front opening with zip was facilitated for ease of putting the garment on and taking off. Basic set-in sleeve pattern was also developed and constructed. The adapted style was tried on the model and its paper pattern was then finalized for final garment construction.
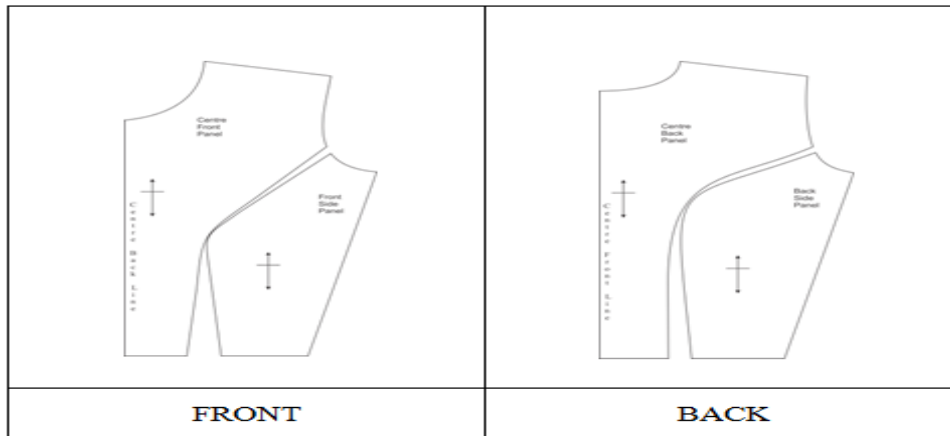

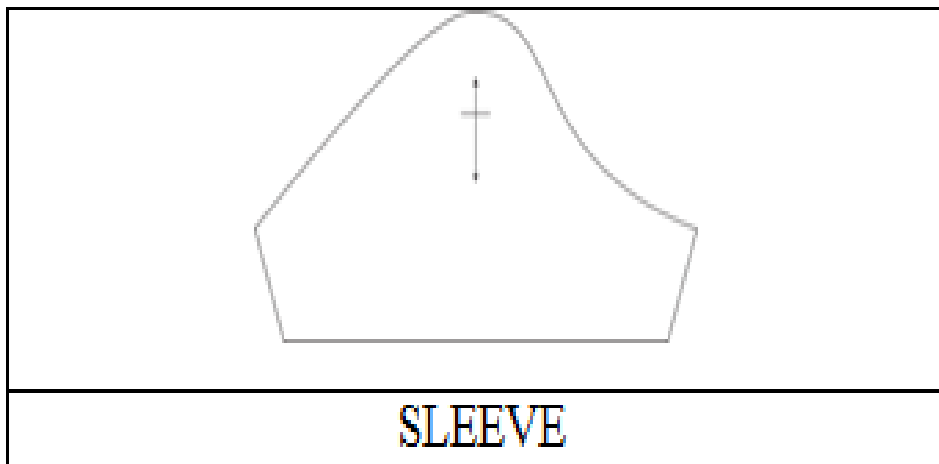Plate 2: Basic patterns developed for the pilot study

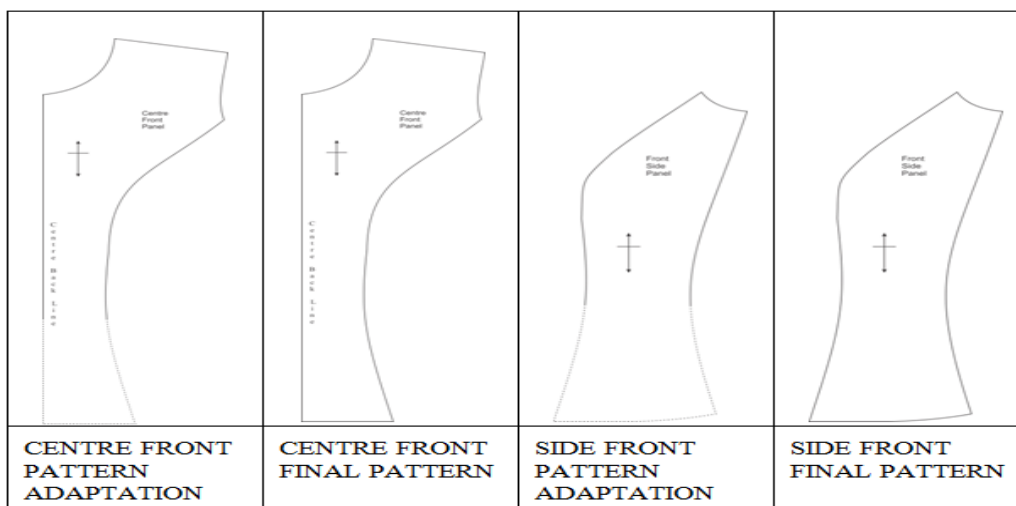Plate 3: Basic sleeve patterns used for final construction

Plate 4: Front pattern adapted for final construction

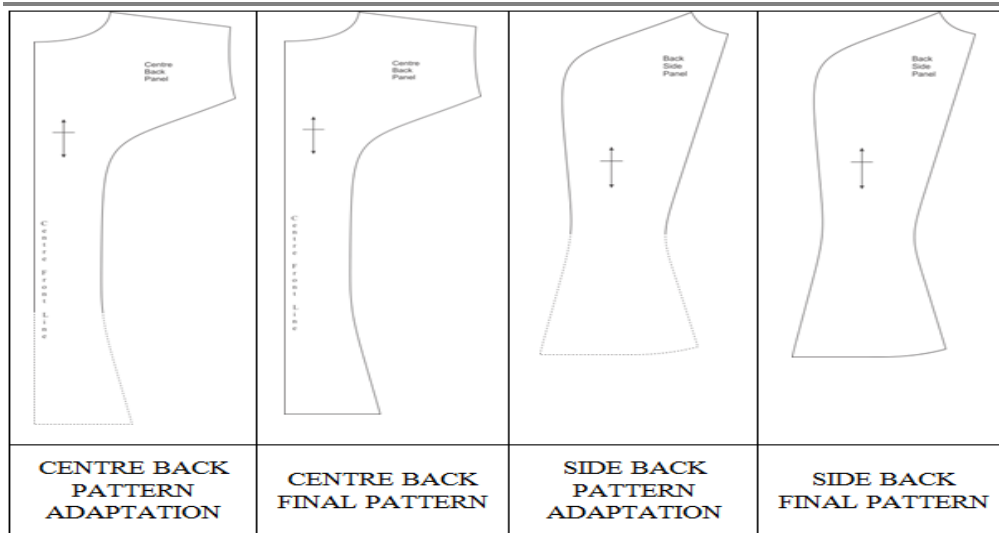| CENTRE BACK PATTERN ADAPTATION	CENTRE BACK FINAL PATTERN	SIDE BACK PATTERN ADAPTATION	SIDE BACK FINAL PATTERN

Plate 5: Back pattern adapted for final construction

The body measurements for female models of different bust size had been represented in Table 2. Development of basic bodice and sleeve block, adaptation in style and construction was done with 81.0 cm bust size as standard. The test fit of the garment was done on the model and necessary alterations were done to fit the arm scye and fit at various girth levels.

Table 2: Measurement chart of subjects for wear trials (in cm)

Bust Round	81.0	86.0	91.0	96.0
Waist Round	66.0	72.0	74.0	86.0
Hip level	86.0	90.0	94.0	100.0
Bust to bust	18.0	18.0	19.0	19.0
Cage round	68.0	74.0	78.0	86.0
Bust length	26.0	26.0	28.0	28.0
Arm Round	35.0	37.0	38.0	44.0
½ Shoulder	16.0	16.0	16.0	16.0
Sleeve girth	25.0	25.0	26.0	35.0
Sleeve Length	16.0	16.0	16.0	16.0
Full length	55.0	55.0	55.0	55.0

The garments constructed with bust size 81.0 cm from the fabrics selected for the research were studied for extension and recovery behavior when worn by larger size figures. Hence the effect of stretch at different areas of the body was noted by measuring body landmarks at various length and girth levels. Table 3 represents the details of measurements.

Table 3: Measurements of front and back body landmarks on standard 81.0 cm bust size garment

	Front (cm)	Back (cm)
a) LENGTH		

i) Full Length	55.0	55.0
ii) Bust Length	26.0	-
iii) Sleeve Length	16.0	-
b) GIRTH		
i) Armpit level	33.0	34.0
ii) Bust level	41.0	40.0
• Centre	18.0	20.0
• Right	11.5	10.0
• Left	11.5	10.0
iii) Waist level	34.0	34.0
• Centre	18.0	18.0
• Right	8.0	8.0
• Left	8.0	8.0
iv) Hip level	42.0	44.0
• Centre	20.0	22.0
• Right	11.0	11.0
• Left	11.0	11.0

The constructed garments were tried on model to assess the garment fit and appearance. Front and back appearance of the garments were recorded photographically. These garments then tried on models of larger bust size of 86.0 cm, 91.0 cm and 96.0 cm. This helped to visualize the stretch ability of Lycra incorporated fabrics on various body sizes. Appropriateness of garment fit or looseness was also noted to relate elastic property with garment design. The constructed garments were marked with benchmarks in lengthwise and widthwise direction at various places measured and noted. The garments were then given to subjects to wear for 8 hours duration for their routine activities. Garments were measured while on subjects. After 8 hours of use, the garments were taken off and measured to immediate elastic recovery. Delayed elastic recovery was measured after 24 hours and percent elastic recovery was calculated. On the basis of the percent elastic recovery, suggestions for garment sizing and styling were drawn.

RESULTS AND DISCUSSION

Visual assessment of garments for overall appearance

The constructed garments were given to the participants for wear trials. The participants were from the age group of 20-24 years, college going students. Their prior consent was taken before the wear trial and photography. It was also clarified that their face will not be revealed in the photographs. Plate 6 shows plain woven garment A of standard size of 81.0 cm bust. The front as well as back of the garment showed very good fit at the upper part of the body. The lower part from the cage level till the end of the garment showed slight looseness due to amount of ease considered while constructing garment out of woven fabrics. This garment was tried by model of one

size larger (86.0 cm bust). The wearer felt the garment was fitted and comfortable due to the stretch effect of Lycra. Sleeveless garment showed creases at underarm with larger body size 86.0 cm. Sleeved garment rectified this defect by giving support to the shape of the arm scye resulting in good fit. Garment A in plain weave with its limitation of woven construction was tried on large bust size 86.0 cm (Plate 7), but further it was not possible to fit it beyond that size. Though there was Lycra yarn in the weft direction, with woven construction it could fit only one size larger than the standard size. Similar results were obtained for garments woven from twill weave fabric B.
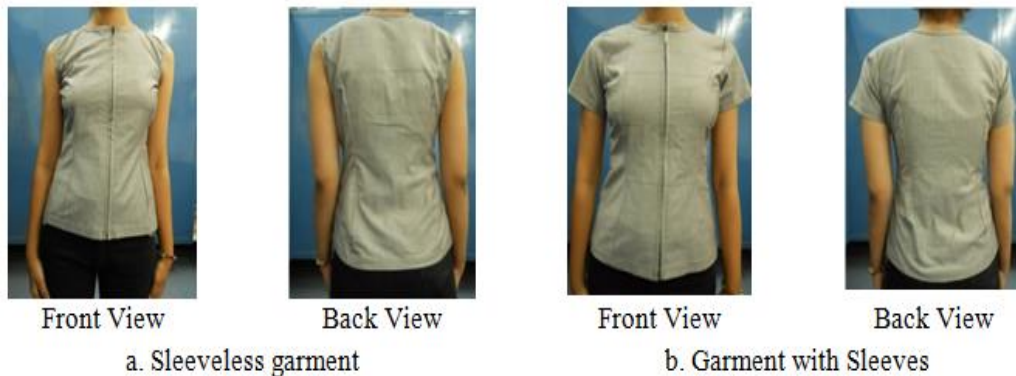

Plate 6: Plain woven garments (A) on 81.0 cm standard size figure
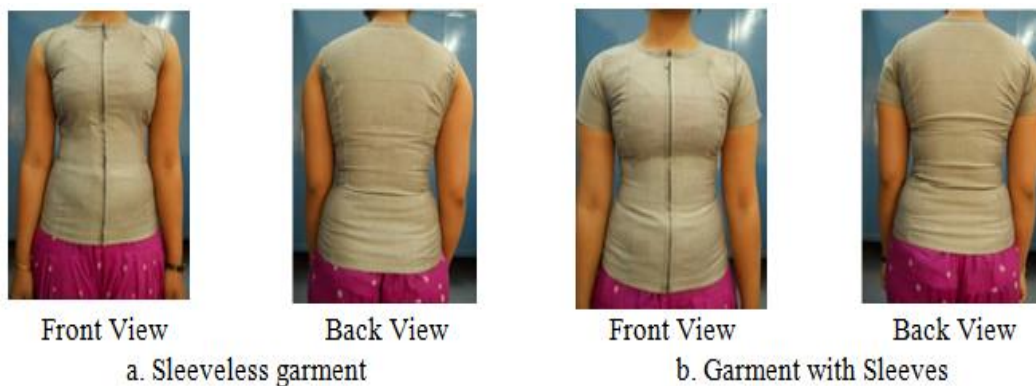
Plate 7: Plain woven garments (A) on 86.0 cm size figure

Knitted garment C was observed with very good fit and appearance without any folds on the garment on standard bust size 81.0 cm. The garment with cotton / Lycra single jersey knit structure emphasized body contour (Plate 8). The wearer of the larger size (86.0 cm bust) felt that the garment was comfortable and well fitted. It was observed that garment C on large bust size (86.0 cm) did not show any folds with tightness at the bust level. Both sleeved and sleeveless garments were very appealing on the figure of larger size (Plate 9).

Plate 8: Single jersey knit garments (C) on 81.0 cm standard size figure

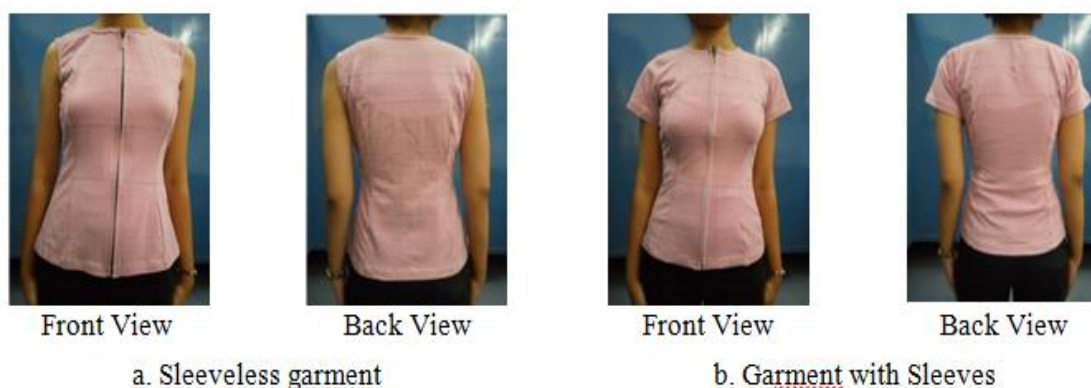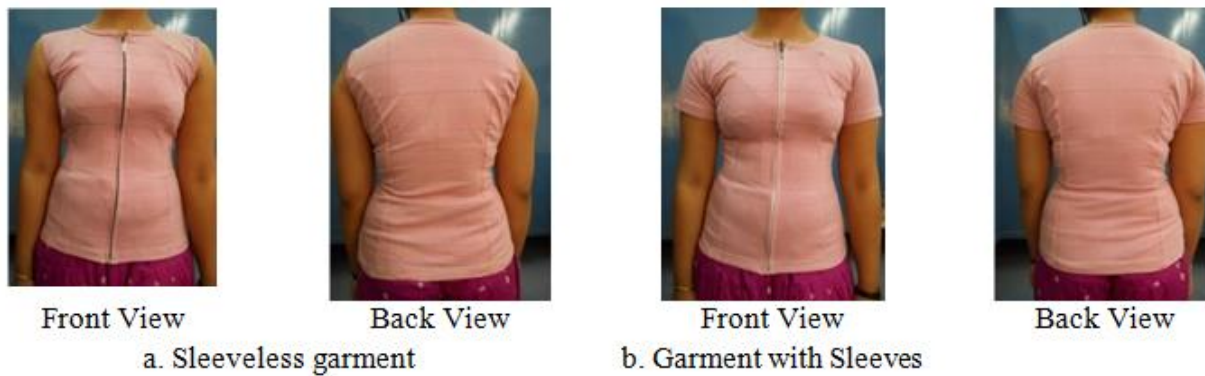Plate 9: Single jersey knit garments (C) on 86.0 cm size figure

The wearer of 91.0 cm bust size (Plate 10) also felt very comfortable with garment C of standard bust size 81.0 cm due to very good elastic property of knitted fabric and Lycra added stretch to it. The fit of the garment observed was very good but princess seam lines showed obvious displacement at the bust level and shifted on the sides making the center panel of the garment appear wider. This effect was observed at the back also. Garment showed only slight shift of princess seam line from cage to hip level as the girth measurements at these areas of the body were smaller than bust area.
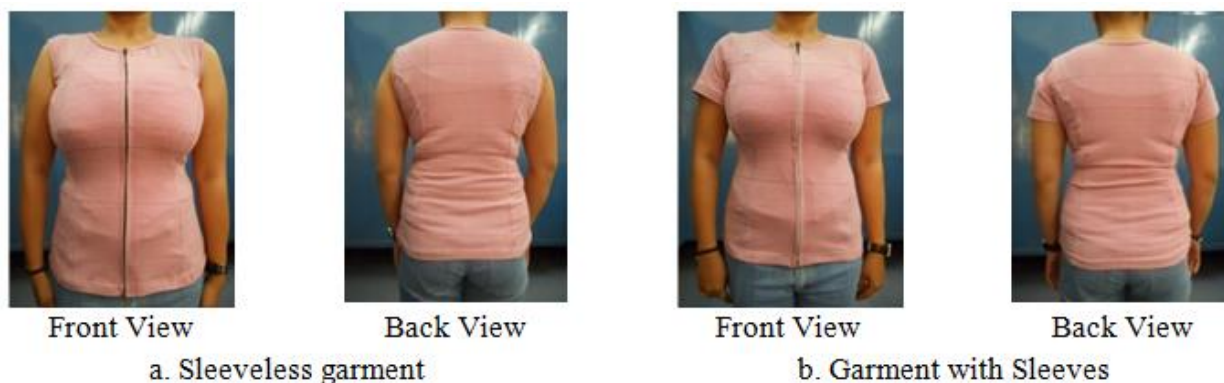
Plate 10: Single jersey knit garments(C) on 91.0 cm size figure
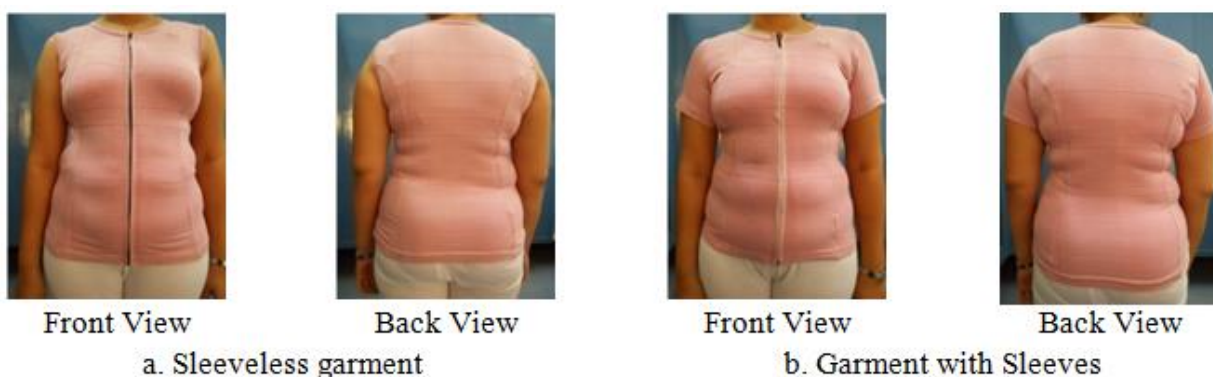
Plate 11: Single jersey knit garments (C) on 96.0 cm size figure

Rib knitted Garment D exhibited very good firm fit with cotton / Lycra in double jersey knit construction of the fabric (Plate 12). From standard bust size 81.0 cm to larger bust size of 96.0 cm showed considerable increase of the body size to fit the garment of 81.0 cm. Rib knit construction with Lycra made it possible to fit without creases or folds were not observed as the garment stretched and fitted to the body with very good elasticity (Plate 15). Like garment C, garment D also showed obvious shift of princess seam line at the bust level with bust sizes 91.0 and 96.0 cm respectively. (Plate 14 & 15)

Front View   Back View   Front View   Back View

a. Sleeveless garment   b. Garment with Sleeves
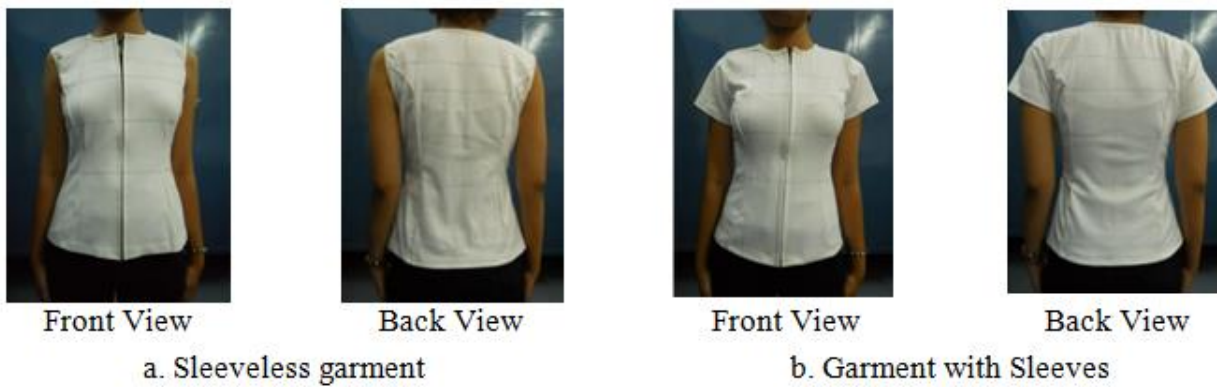
Plate 12: Rib knitted garments (D)on 81.0 cm standard size figure

Front View   Back View   Front View   Back View

a. Sleeveless garment   b. Garment with Sleeves

Plate 13: Rib knitted garments(D) on 86.0 cm size figure

Front View   Back View   Front View   Back View

a. Sleeveless garment   b. Garment with Sleeves
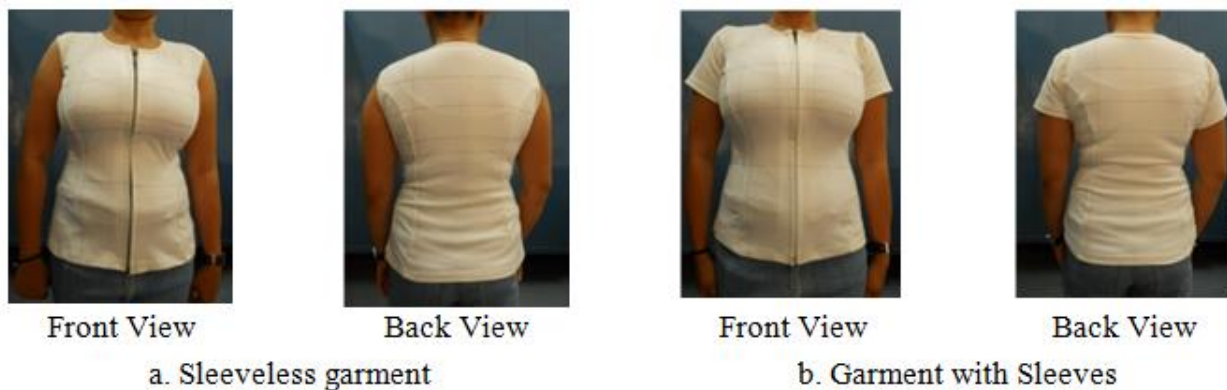
Plate 14: Rib knitted garments(D) on 91.0 cm size figure

Front View   Back View   Front View   Back View

a. Sleeveless garment   b. Garment with Sleeves

Plate 15: Rib knitted garments(D) on 96.0 cm size figure

Assessment of garment recovery property after wear trials

The garments with 81.0 cm bust size were constructed from all four fabrics with specified design details and marked with benchmarks to be measured for stretch and recovery on larger sizes. Table 4 and 5 showed the percent recovery of woven and knitted garments for various sizes respectively.

Table 4: Percent recovery of woven garments

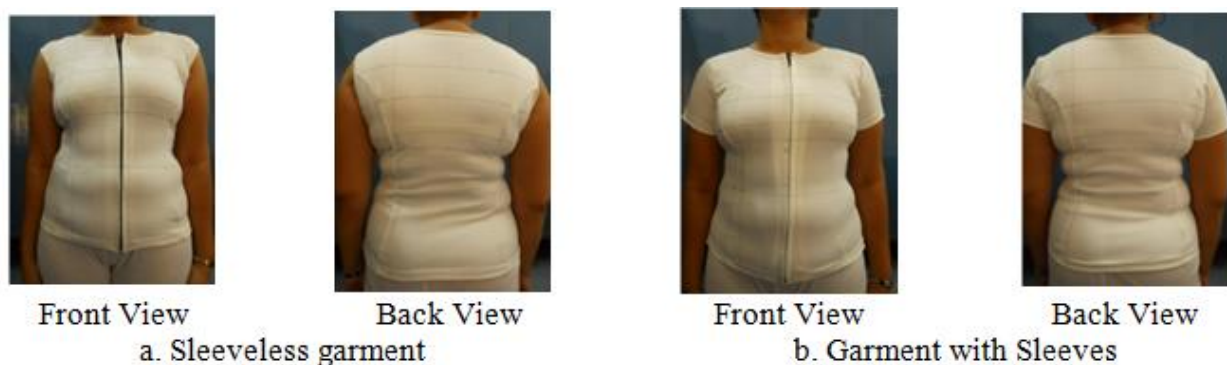| Body Landmarks	FRONT		BACK	
	A	B	A	B
Armpit level	50	100	50	100
Bust level	**10**	**13.33**	**20**	**25**
Centre front	50	100	0	0
Right front	50	100	50	100
Left front	50	100	50	100
Waist level	**15**	**25**	100	100
Centre	50	100	100	100
Right front	100	100	0	0
Left front	100	100	0	0
Hip level	50	100	100	100
Centre	50	0	100	100
Right front	0	0	0	0
Left front	0	0	0	0

Key: A – Plain weave, B – Twill weave

It was observed from Table 4 that woven garment A showed average 50 percent recovery of garment when worn by a larger figure bust size 86.0 cm. The wider areas of bust and waist girth showed 10 and 15 percent recovery respectively with more extension and lower recovery at these areas. Front side panels of the garment exhibited 100 percent recovery. Back of garment A showed recovery only up to 20 percent at bust level. Other areas of the garment showed 50 and 100 percent recovery. Garment B showed 13.33 percent recovery at front bust level and 25 percent recovery at back bust level. Recovery of 25 percent was observed at front waist level also. Other areas of the garment showed total recovery. Fabric B showed better recovery than fabric A with slightly higher elastic property. Though the woven garments with 81.0 cm bust size gave very good and comfortable fit to the larger (86.0 cm) bust size figure, the recovery property was found to be poor so, it could not be worn by the larger size figure.

Table 5: Percent recovery of knit garments

Body Landmarks	FRONT						BACK					
	C			D			C			D		
	86.0	91.0	96.0	86.0	91.0	96.0	86.0	91.0	96.0	86.0	91.0	96.0

Armpit level	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Bust level	100.0	100.0	**60.0**	100.0	100.0	**95.0**	100.0	100.0	100.0	100.0	100.0	100.0
Centre front	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Right front	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Left front	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Waist level	100.0	100.0	**40.0**	100.0	100.0	**60.0**	100.0	100.0	100.0	100.0	100.0	100.0
Centre	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Right front	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Left front	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Hip level	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	**60.0**	100.0	100.0	**95.0**
Centre	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Right front	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Left front	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Key: C – Single jersey knit, D – Rib knit

Garment C and D made of knit structure showed 100 percent recovery from bust size 81.0 to 86.0 and 91.0 cm bust size (Table 5). Only the largest size of 96.0 cm showed 60 percent and 95 percent recovery for garment C and D respectively at the front bust level. Waist level showed 40 percent recovery for garment C and 60 percent for garment D. This was with Lycra in rib knit structure exhibiting more recovery in garment D than garment C. The back of garment C and D gave 100 percent recovery except at hip level. For garment C it was 60 percent and garment D, 95 percent. Here also garment D showed better recovery than garment C. Knitted fabrics fitted very well from standard bust size 81.0 cm to larger bust size of 86.0 and 91.0 cm, also with excellent recovery. 96.0 cm bust size could not give better recovery at wider areas of bust, waist and hip levels. The design of the garment with princess seam line assembled together total seven pattern pieces, four in the front and three at the back, contributed in giving total recovery.

Statistical analysis

The garment extension and recovery measurements were statistically analyzed using paired t-test and one sample t-test. It was calculated for comparison of extension with recovery of the garment. The recovery of each garment was compared with respective Test value (elastic recovery) of the garments.

The analysis of front and back of each garment was done and presented as follows:

Table 6: Mean comparison for front of garment A with regards extension and recovery of fabric N = 13

	Mean	**S.D.**	**t-value**	**p-value ***
Extension	0.93	0.805	2.785	0.015
Recovery	0.364	0.2098		

* If p ≤ 0.05, significant at 5% level of significance

It was observed that t-value (2.785) was found to be significant (p = 0.015), so could be concluded that there exists real difference between extension (Mean 0.93) and recovery (Mean 0.364) with S.D. value 0.805 and 0.2098 respectively (Table 6).

Table 7: Mean comparison for front of garment A with regards to extension and recovery of fabrics with Test value   N = 13

Test value 0.8 (Elastic recovery at yield point)				
	Mean	S.D.	t-value	p-value *
Extension	0.93	0.805	0.597	0.560
Recovery	0.364	0.2098	7.771	0.000

* If p ≤ 0.05, significant at 5% level of significance

The comparison of average extension with Test value, it was found that t-value (0.597) was not significant (p = 0.560) while comparing average extension (Mean 0.93) with Test value (0.8). t-value (7.771) was found to be significant (p = 0.000) while comparing average recovery (Mean 0.364) with Test value (0.8). The garment in plain weave from standard to extended (size 81.0 to 86.0 cm) did not recover completely, showing difference with Test value of 0.8.

Table 8: Mean comparison for back of garment A with regards extension and recovery of fabric N = 13

	Mean	**S.D.**	**t-value**	**p-value ***
Extension	0.69	0.630	3.224	0.007
Recovery	0.300	0.2483		

* If p ≤ 0.05, significant at 5% level of significance

The above Table 8 showed that t-value (3.224) was found to be significant (p = 0.007), so could be concluded that there exists real difference between extension (Mean 0.69) and recovery (Mean 0.300) with S.D. value 0.630 and 0.2483 respectively.

Table 9: Mean comparison for Back of garment A with regards to extension and recovery of fabrics with test value N = 13

Test value 0.8 (Elastic recovery at yield point)				
	Mean	S.D.	t-value	p-value *
Extension	0.69	0.630	-0.616	0.549
Recovery	0.300	0.2483	-7.260	0.000

* If p ≤ 0.05, significant at 5% level of significance

As observed value in Table 9, the comparison of average extension with standard value. From the table it could be interpreted that t-value (0.616) was not found to be significant (p =0.549) while comparing average extension (Mean 0.69) with Test value (0.8). t-value (7.260) was found to be significant (p = 0.000) while comparing average recovery (Mean 0.300) with Test value (0.8). The garment in plain weave also gave similar results with increased size 81.0 to 86.0 cm showing lesser difference in recovery with test value (0.8).

Table 10: Mean comparison for front of garment B with regards extension and recovery of fabric N = 13

	Mean	S.D.	t-value	p-value *
Extension	0.93	0.805	1.414	0.181
Recovery	0.636	0.4162		

* If p ≤ 0.05, significant at 5% level of significance

From the above Table 10 it was found that t-value (1.414) was not significant (p = 0.181), so could be concluded that real difference did not exist between extension (Mean 0.93) and recovery (Mean 0.636) with S.D. value 0.805 and 0.4162 respectively.

Table 11: Mean comparison for front of garment B with regards to extension and recovery of fabrics with Test value N = 13

Test value 1.12 (Elastic recovery at yield point)				
	Mean	S.D.	t-value	p-value *
Extension	0.93	0.805	-0.890	0.390
Recovery	0.636	0.4162	-4.354	0.001

* If p ≤ 0.05, significant at 5% level of significance

While comparing average extension with standard value (Table 11) it could be interpreted that t-value (0.890) was not found to be significant (p = 0.390) while comparing average extension (Mean 0.93) with Test value (1.12). t-value (-4.354) was found to be significant (p = 0.001) while comparing average recovery (Mean 0.636) with Test value (1.12). The garment in twill weave did not show good recovery with extended size (81.0 to 86.0 cm) as the difference in recovery was observed when compared with Test value (1.12).

Table 12: Mean comparison for back of garment B with regards extension and recovery of fabric N = 13

	Mean	S.D.	t-value	p-value *
Extension	0.93	0.805	1.414	0.181
Recovery	0.636	0.4162		

* If p ≤ 0.05, significant at 5% level of significance

Table 12 represented that t-value (1.414) was not found to be significant (p = 0.181), so could be concluded that there was no difference between extension (Mean 0.93) and recovery (Mean 0.636) with S.D. value 0.805 and 0.4162 respectively.

Table 13: Mean comparison for Back of garment B with regards to extension and recovery of fabrics with Test value N = 13

Test value 1.12 (Elastic recovery at yield point)				
	Mean	S.D.	t-value	p-value *

Extension	0.93	0.805	-2.446	0.031
Recovery	0.636	0.4162	-3.967	0.002

* If p ≤ 0.05, significant at 5% level of significance

The comparison of average extension with Test value showed that t-value (2.446) was found to be significant (p =0.031) while comparing average extension (Mean 0.93) with Test value (1.12). t-value (3.967) was also found to be significant (p = 0.002) while comparing average recovery (Mean 0.636) with Test value (1.12) (Table 13). Garment in twill weave showed difference in recovery from size 81.0 to 86.0 cm indicating lower recovery of the garment with the extended size.

Table 14: Mean comparison for front of Garment C with regards to extension and recovery using paired t-test N = 13

		Mean	Std. Deviation	t - value	p – value*
Pair 1	Extension	0.93[a]	0.805	-	-
	Recovery	0.93[a]	0.805		
Pair 2	Extension	1.86[a]	1.550	-	-
	Recovery	1.86[a]	1.550		
Pair 3	Extension	4.36	3.267	1.797	0.096
	Recovery	3.26	1.593		

a. The t-test cannot be computed because the standard error of the difference is 0.

* If p ≤ 0.05, significant at 5% level of significance

The calculations for pair 1 and 2 were not computed as the standard error of the difference was 0. The values for pair 3 showed that t-value (1.797) was not found to be significant (p = 0.096), so could be concluded that there was no difference between extension (Mean 4.36) and recovery (Mean 3.26) with S.D. value 3.267 and 1.593 respectively.

Table 15: Mean comparison for front of garment C with regards to extension and recovery of fabrics with Test value 7.2 N = 13

		Mean	Std. Deviation	t - value	p – value*
Pair 1	Extension	0.93	0.805	-29.142	0.000
	Recovery	1.86	1.550	-12.901	0.000
Pair 2	Extension	4.36	3.267	-3.256	0.006
	Recovery	0.93	0.805	-29.142	0.000
Pair 3	Extension	1.86	1.550	-12.901	0.000
	Recovery	3.26	1.593	-9.247	0.000

* If p ≤ 0.05, significant at 5% level of significance

While comparing average extension with Test value (Table 15), it was found that t-value was significant while comparing average expansion Mean of each pair with Test value (7.2). Garment C from 81.0 to 91.0 cm size showed similar results of expansion and recovery. Extension up to 96.0 cm size showed lower recovery.

Table 16: Mean comparison for back of Garment C with regards to extension and recovery using paired t-test N = 13

		Mean	**Std. Deviation**	**t – value**	**p – value***
Pair 1	Extension	0.69[a]	0.630	-	-
	Recovery	0.69[a]	0.630		
Pair 2	Extension	1.62[a]	1.244	-	-
	Recovery	1.62[a]	1.244		
Pair 3	Extension	3.46	2.332	1.000	0.337
	Recovery	3.22	1.950		

a. The t-test cannot be computed because the standard error of the difference is 0.

* If p ≤ 0.05, significant at 5% level of significance

The calculations for pair 1 and 2 were not computed as the standard error of the difference was 0. The values for pair 3 showed that t-value (1.000) was not found to be significant (p =0.337), so could be concluded that there was no difference between extension (Mean 3.46) and recovery (Mean 3.22) with S.D. value 2.332 and 1.950 respectively.

Table 17: Mean comparison for Back of garment C with regards to extension and recovery of fabrics with Test value 7.2 N = 13

		Mean	**Std. Deviation**	**t - value**	**p – value***
Pair 1	Extension	0.69	0.630	-37.219	0.000
	Recovery	1.62	1.244	-16.183	0.000
Pair 2	Extension	3.46	2.332	-5.781	0.000
	Recovery	0.69	0.630	-37.219	0.000
Pair 3	Extension	1.62	1.244	-16.183	0.000
	Recovery	3.22	1.950	-7.367	0.000

* If p ≤ 0.05, significant at 5% level of significance

While comparing average extension with Test value (Table 17), it was found that t-value was significant while comparing average extension Mean of each pair with Test value (7.2). Garment C from 81.0 to 91.0 cm size showed similar results of extension and recovery. Extension up to 96.0 cm size did not show complete recovery.

Table 18: Mean comparison for front of Garment D with regards to extension and recovery using paired t-test N = 13

		Mean	**Std. Deviation**	**t - value**	**p – value***
Pair 1	Extension	0.93[a]	0.805	-	-
	Recovery	0.93[a]	0.805		
Pair 2	Extension	1.86[a]	1.336	-	-
	Recovery	1.86[a]	1.336		
Pair 3	Extension	4.36	3.267	1.549	0.145
	Recovery	3.73	2.187		

a. The t-test cannot be computed because the standard error of the difference is 0.

* If $p \leq 0.05$, significant at 5% level of significance

The calculations for pair 1 and 2 were not computed as the standard error of the difference was 0. The values for pair 3 showed that t-value (1.549) was not found to be significant (p =0.145), so could be concluded that there was no difference between extension (Mean 4.36) and recovery (Mean 3.73) with S.D. value 3.267 and 2.187 respectively.

Table 19: Mean comparison for front of garment D with regards to extension and recovery of fabrics with Test value 7.79 N = 13

		Mean	**Std. Deviation**	**t - value**	**p – value***
Pair 1	Extension	0.93	0.805	-31.884	0.000
	Recovery	1.86	1.336	-16.612	0.000
Pair 2	Extension	4.36	3.267	-3.932	0.002
	Recovery	0.93	0.805	-31.884	0.000
Pair 3	Extension	1.86	1.336	-16.612	0.000
	Recovery	3.73	2.187	-6.948	0.000

* If $p \leq 0.05$, significant at 5% level of significance

The average extension when compared with Test value (Table 19), it was found that t-value was significant while comparing average extension Mean of each pair with Test value (7.79). Garment D from 81.0 to 91.0 cm size showed similar results of extension and recovery. Extension up to 96.0 cm size also showed better recovery.

Table 20: Mean comparison for back of Garment D with regards to extension and recovery using paired t-test N = 13

		Mean	**Std. Deviation**	**t – value**	**p – value***

Pair 1	Extension	0.69[a]	0.630	-	-
	Recovery	0.69[a]	0.630		
Pair 2	Extension	1.62[a]	1.261	-	-
	Recovery	1.62[a]	1.261		
Pair 3	Extension	3.46	2.332	1.000	0.337
	Recovery	3.43	2.268		

a. The t-test cannot be computed because the standard error of the difference is 0.

* If p ≤ 0.05, significant at 5% level of significance

The calculations for pair 1 and 2 were not computed as the standard error of the difference was 0. The values for pair 3 showed that t-value (1.000) was not found to be significant (p =0.337), so could be concluded that there was no difference between extension (Mean 3.46) and recovery (Mean 3.43) with S.D. value 2.332 and 2.268 respectively.

Table 21: Mean comparison for Back of garment D with regards to extension and recovery of fabrics with Test value 7.79 N = 13

		Mean	**Std. Deviation**	**t - value**	**p – value***
Pair 1	Extension	0.69	0.630	-40.593	0.000
	Recovery	1.62	1.261	-17.657	0.000
Pair 2	Extension	3.46	2.332	-6.694	0.000
	Recovery	0.69	0.630	-40.593	0.000
Pair 3	Extension	1.62	1.261	-17.657	0.000
	Recovery	3.43	2.268	-6.929	0.000

* If p ≤ 0.05, significant at 5% level of significance

The average extension when compared with Test value (Table 21), it was found that t-value was significant while comparing average extension Mean of each pair with Test value (7.79). Garment D from 81.0 to 91.0 cm size showed similar results of extension and recovery. Extension up to 96.0 cm size also showed better recovery.

The above analysis showed that woven fabrics had lower recovery at small extensions whereas knitted fabrics recovered maximum.

CONCLUSION

It could be suggested from the visual analysis that the sleeveless garment could have the arm scye cut slightly lower and allowance for ease can make the wearer of the larger size comfortable. Limited range of stretch with woven construction actually needs to have individual garment size developed with marginal ease for comfortable body activities. Knitted garments with their elastic property exhibited very good fit on many body sizes. The style of the garment with princess seam lines in the front and back projected stress on the garment with increased body size by shift in the placement of princess line towards the sides. This suggested that the placement of seam

line has its importance designing garments with knits especially when many sizes are expected to fit in one size. Knitted garments showed 100 percent recovery from bust size 81.0 to 86.0 and 91.0 cm. Only 96.0 cm bust size showed about 60 percent recovery at the bust and waist levels. Lycra in rib knit structure exhibited more recovery than single jersey. The further research would recommend to study stretch and recovery properties of lower garments constructed with Lycra incorporated in the construction with different geometry.

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Ethical consideration

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REFERENCES

1. Aggarwal, A., (1997).'Grading and sizing', Journal of the Textile Association, 79-81)
2. Cooklin, G. (1994).'Pattern Grading for Women's Outwear', Oxford, Black, Weil Science Ltd., 1-3.
3. Raval H., & Karolia, A. (2017). "Effect of Lycra on Performance of Woven and Knitted Fabrics", Asian Journal of Science and Technology, 6364-6368
4. Robert, S.H., & Fletcher, H.M. (1964). 'Elastic properties of plain and doubleknit cotton fabrics', Textile Research Journal, 649
5. Stephanie, C., (April 24, 2011). 'One Size Fits Nobody: Seeking a Steady 4 or a10', The New York Times.