Tanja Podbevšek
University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Textiles

Comparison Between Measured and Proposed Back Length Distances for Pattern Block Construction

Primerjava izmerjenih in predlaganih hrbtnih dolžin za razvoj osnovnega kroja

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Abstract

The aim of this study was to compare the back length distances (BacLen) from contemporary construction systems with the measured back length distances of the Slovenian young female population to establish which back length presented in different contemporary construction systems fits best to the body dimension of a specific target market group. 160 female students (aged between 19 and 27 years) from the University of Ljubljana (Slovenia) volunteered for the study. The results showed that the measured back length distances differed significantly from those obtained from the tables of contemporary construction systems or calculated as a secondary measure according to these systems. The measured BacLen distances were the same in all size groups and did not increase as did with all analyzed contemporary construction systems. The range of measured BacLen distances inside each size group was substantial (33–43 cm) and the measured BacLen distances were not in correlation with the body height, bust girth and in consequence nor with the calculated BacLen distances. In conclusion, the values for back length distances as proposed by different contemporary construction systems differ significantly from the measured ones in the young Slovenian female population. We thus suggest including back length distance as a directly measured parameter for a pattern block construction when producing made-to-measure clothes.
Keywords: pattern construction, anthropometric measurements, back length, dress, basic pattern block

Izvleček

Namen naše raziskave je bil primerjati hrbtne dolžine sodobnih konstrukcijskih sistemov z izmerjenimi hrbtnimi dolžinami pri mladih Slovenkah, da bi ugotovili, katera hrbtna dolžina iz različnih sodobnih konstrukcijskih sistemov se najbolje ujema s telesnimi merami točno določene ciljne skupine na trgu. Za raziskavo se je prostovoljno javilo 160 študentk (starih 19–27 let), ki študirajo na Univerzi v Ljubljani v Sloveniji. Rezultati raziskave so pokazali, da se izmerjene hrbtne dolžine znatno razlikujejo od tistih, ki so na voljo v preglednicah sodobnih konstrukcijskih sistemov ali ki so izračunane kot sekundarne mere na podlagi teh sistemov. Izmerjene hrbtne dolžine so bile enake v vseh velikostnih skupinah in se niso povečale, kot se je to izkazalo pri vseh analiziranih sodobnih konstrukcijskih sistemih. Razpon izmerjenih hrbtnih dolžin znotraj posamezne skupine je bil precejšen (33–43 cm); izmerjene hrbtne dolžine niso bile v korelaciji s telesno višino, prsnim obsegom in zato tudi ne z izračunanimi hrbtnimi dolžinami. Vrednosti za hrbtne dolžine, kot jih predlagajo različni sodobni konstrukcijski sistemi, se znatno razlikujejo od izmerjenih vrednosti pri mladih Slovenkah. Predlagamo, da se hrbtna dolžina vključi kot neposredno izmerjen parameter za razvoj osnovnega kroja pri izdelavi oblačil po meri.
Ključne besede: konstrukcija kroja, antropometrične meritve, hrbtna dolžina, obleka, osnovni kroj

Corresponding author/*Korespondenčna avtorica:*
dr. Tanja Podbevšek
E-mail: tanja.podbevsek@ntf.uni-lj.si

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1 Introduction

Dresses represent an indispensable piece of apparel in every woman's wardrobe. Because the expectations of today's customers are increasing steadily and are accompanied by an excessive offer of dresses by different producers and retailers, the proper size and fit of the clothes is important since it influences the buying decision of the customers [1]. The fit of the clothes is closely linked with the body dimensions incorporated in the basic pattern blocks of clothes, while every production of garments requires the development of corresponding patterns. Usually measurement tables and basic block patterns in industry are already established and fixed, but they are not necessarily the best reflection of the body dimensions of their target market groups [2, 3].

Back length (BacLen) distance is needed in developing the basic dress pattern block and play an important role in creating the proper fit of the dress on the level of the natural waist girth. If it is shorter from the real one, the dress will be too loose under the natural waist level, if it is longer, the close fitted dress will strand on the hips and cause the balloon of excessive material above the natural waist level. Higher is the difference between the real value of the back length distance and the one incorporated in the basic block pattern of the dress, more distinctive this deviation would be. Influence of the back length on the fit of the dress on the body is often overlooked by contemporary construction systems. In practice, back length distance is usually defined as a secondary measure which can be calculated with an equation from one of the primary measure. Within German Müller system there are two equations proposed based on body height (see equations 1 and 2 in the Methods) [4–7]. In Hungarian so called decimal system [8] they calculate it from the armscye depth, body height and bust girth (see equations 3 in the Methods). Beside this, most of the contemporary construction system includes it in their measurement tables. Values in those tables slightly differentiate from one system to another and increase with the change of the bust girth [5, 6, 9–11].

Differences of BacLen distances from different construction systems set with measurement tables or with equations pose a question, which distance fits best to the natural shapes of different target groups of female bodies. One way to get the answer is to compare these distances with those from the real subjects. There is no common agreement how to measure BacLen distance, while construction systems offer different measurement methodologies [5, 6, 9, 10, 12, 13]. It seems that the most consistent way to select the proper methodology is to follow the nature of dress basic pattern block development. In most of the pattern construction systems, the BacLen distance is applied in the basic pattern block as a vertical distance from the 7th cervical bone to the natural waist line in the middle back of the body [5–7, 9, 11, 14]. The methodology of measurement BacLen distance in the present study was performed in that way.

The aim of this study was to compare BacLen distances from contemporary construction systems with the measured distances of the Slovenian young female population to establish which BacLen distance presented in different contemporary construction systems fits the best to the body dimension of that specific market target group.

2 Methods

2.1 Participants

The anthropometric surveys was carried out on 160 female students (age 19–27 years) from the University of Ljubljana (Slovenia) who volunteered in the study. Subjects were selected to fit into a single body height group as suggested in SIST EN 13402-3 [15] (164–172 cm). A division was made according to their bust girth measure, since it is the most important measure in the basic pattern developing of a dress. Five major groups were formed according to SIST EN 13402-3 [15]. All participants were well informed about the procedures of the experiment. None of them gave birth.

2.2 BacLen distances from the measurement tables

The BacLen distances were obtained from the measurement tables of the following contemporary construction systems: Müller's system [4–6] is presented with two measurement tables (Müller1 and Müller2), Aldrich's system [9], Mors de Castro's system (MdC) [10] and Jansen system [11]. In the study only the values of those systems which followed the same measurement methodology for BacLen distances as the one performed in the study were chosen. The values obtained from the tables

were valid for the female population between 164 and 172 cm body height (here reported as 168 cm) and for selected size groups based on bust girth.

2.3 Calculated BacLen distances

The first calculated *BacLen* distance was based on first Müller's system equation [4–6]:

$$BacLen\_4 = \frac{BH}{4} \quad (1)$$

where *BH* stands for body height.

The second calculated *BacLen* distance was calculated according to the second Müller's system equation (Equation 2) [4–6]:

$$BacLen\_4\_1 = \frac{BH}{4} - 1 \text{ cm} \quad (2)$$

where *BH* stands for body height.

The third calculated *BacLen* distance was calculated according to the equation 3 based on a decimal base pattern design for women's clothes [8]:

$$BacLen\_DPD = armscye\ depth + \frac{BH}{10} \times 1.25 \quad (3)$$

where *armscye* is given in equation 4:

$$armscye\ depth = \frac{BH}{10} \times 1.25 + \frac{bust\ girth}{20} - 2{,}8$$

The *bust girths* and body height of the subjects were measured according to the procedures described in the anthropometric survey.

2.4 Anthropometric survey

During the measurement, the participants were standing on the levelled ground in their natural posture with the feet together and with center of gravity distributed equally on both legs. Their heads were aligned with the Frankfurt's line. During the measurement, they breathed normally with abdomen relaxed with arms hanging down freely along the torso or slightly lifted up but in the way that their posture or body dimensions under consideration did not change. Participants were dressed in underwear and barefoot. Survey was performed in forenoon by the same person and an assistant who recorded the data. The values were always repeated before they were put into the anthropometric form and were round up to a higher value with 0.5 cm accuracy. First, the anthropometric point of the 7th cervical bone was marked with the anthropometric pencil. The point was better determined when the person bent her head forward and the 7th cervical bone exposed more clearly. Following its position, the person returned to her natural posture with her head aligned with the Frankfurt's line, when the anthropometric point of the 7th cervical bone was marked. The plane of natural waist level was selected and marked with 3mm wide elastic band (upper band), which did not compress the soft tissue and therefore affected the values of measurement. The natural waist level was marked between the top of the hip bones and the lower ribs where the girth is the smallest according to ISO 8559 [12] and ISO 3635 [16] (Figure 1). The band was adjusted around the body in a way that the ellipsoid levels of the natural waist girth were perpendicular to the longitudinal axis of the body.

Measured back length distance (BacLen_m) was taken as the distance measured from the marked anthropometric point of the 7th cervical bone to the upper edge of the string on the marked waist line (Figure 1, left).

The bust girth was measured with dimensionally stable tape-measure as the maximum horizontal girth during normal breathing with the subject standing in her natural posture and tape-measure passed across the nipples but adjusted around the body in a way that the ellipsoid level of the bust girth were perpendicular to the longitudinal axis of the body (Figure 1, right).

The measurements of body height (BH) were performed with anthropometer as the vertical distance between the crown of the head and the ground, with the subject standing in their natural posture with the feet together.

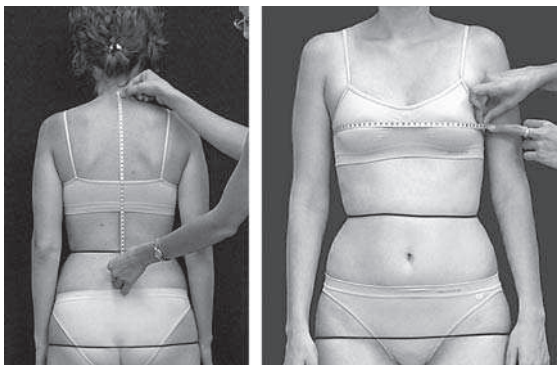

Figure 1. Measurement of the back length (left) and bust girth (right)

2.5 Statistics

The participants with the body height 168 cm (164–172 cm) were arranged into size groups according to their bust girth in the range of 4 cm as it is suggested in SIST EN 13402-3 [15]. Five size groups were formed with the bust girths 80 cm (78.5–82 cm), 84 cm (82.5–86 cm), 88 cm (86.5 to 90 cm), 92 cm (90.5–94 cm) and 96 cm (94.5–98 cm).

For each group, basic statistical parameters of analyzed variables were calculated. Statistical significances of differences among the groups were first tested with ANOVA and then with post-hock T-tests for single pairs of groups (Bonferroni correction). Statistical significances of differences among different BacLen distances (measured and calculated) inside the single size group were tested first with ANOVA and then with post-hock T-tests for single pairs of variables (Bonferroni correction). Pearson correlation coefficients were calculated between measured and calculated BacLens and obtained anthropometrical measurements. Results were statistically processed with the SPSS (version 22, IBM SPSS, New York, USA). Alpha error was set to 5% (two-tailed).

3 Results

Back length distances obtained from different tables of included contemporary construction systems are presented in Table 1. Among the systems, Aldrich system gives the lowest values for smaller size groups while Müller1 gives the lowest values for bigger size groups. Müller2 system provides the greatest values for all size groups. However, the differences among systems are small (less than 1.2 cm). The smallest BacLen distance is 40.2 cm in Aldrich system for women with bust girth 80 cm and the largest 42.0 cm in Müller2 and Mors de Castro's system (MdC) for the women of bust girth 96 cm. Inside the single construction systems, the differences among size groups are again rather small (0.4–1.6 cm).

Table 1. Back length values obtained from different measurement tables of women with different bust girth

Back length (cm)						
Groups (bust girth)	80	84	88	92	96	Max-min
Body height	167.6	167.9	168.3	167.9	168.6	1.0
Müller1	40.9	41.0	41.1	41.2	41.3	0.4
Müller2	41.4	41.4	41.6	41.8	42.0	0.6
Aldrich	40.2	40.6	41.0	41.4	41.8	1.6
MdC	41.2	41.1	41.6	41.8	42.0	0.8
Jansen	-	40.7	41.0	41.3	41.6	0.9
Max-min	1.2	0.8	0.6	0.6	0.7	

Legend: Max-min – difference between maximal and minimal bust girth.

Table 2. Body height and calculated values for BacLen distance as measured on the study's participants

Groups (bust girths, cm)	N	BH (cm)		BacLen_4 (cm)		BacLen_4_1 (cm)		BacLen_DPD (cm)	
		Mean	SDV	Mean	SDV	Mean	SDV	Mean	SDV
80	17	167.6	2.18	41.9	0.54	40.9	0.54	41.4	0.55
84	49	167.9	2.21	42.0	0.55	41.0	0.55	41.7	0.55
88	47	168.3	2.23	42.1	0.56	41.1	0.56	41.9	0.56
92	30	167.9	2.54	42.0	0.64	41.0	0.64	42.1	0.64
96	17	168.6	2.69	42.1	0.67	41.1	0.67	42.4	0.69
Sig.		0.650		0.650		0.650		0.000	

Legend: N – number of measured persons, BH – Body height, BacLen_4 – BacLen distances calculated with equation 1, BacLen_4_1– BacLen distances calculated with equation 2 and BacLen_DPD – BacLen distances calculated with equation 3, Sig. – statistical significance of differences among groups' means, SDV standard deviation.

Table 2 shows that the mean body heights of participants from analyzed size groups did not differ statistically significantly ($p = 0.650$) among the size groups what consequently lead to non-significant differences ($p < 0.650$) in calculated BacLen distances from the body height (BacLen_4 and BacLen_4_1) among the groups. In BacLen_DPD, which calculation was based on the bust girth as well as on the body height, the mean differences among size groups were statistically significant ($p < 0.001$). The mean BacLen_DPD distances were in a range 41.4–42.4 cm. Although the differences among groups were statistically significant, they were small in the absolute values up to 1.0 cm). Differences between BacLen_4 and BacLen_4_1 were fixed according to the formulas 1 and 2 to 1 cm for each size group. Differences between the BacLen_4 and BacLen_DPD 0.5 cm or less, and between BacLen_4_1 and BacLen_DPD less than 1.3 cm.

Results of the BacLen distance as measured in the present study are presented in the Table 3. The largest difference between mean size group values was 0.5 cm. The distances were not aligned according to the size groups nor were differences among groups statistically significant ($p > 0.05$). However, the variability inside size groups was much larger, since standard deviations in size groups were greater than 2 cm, except in the size group 84 cm. The ranges between the smallest and greatest BacLen distance in size groups were 7–9.5 cm. Standard deviations of measured BacLen was approximately 4 times greater than in calculated BacLens.

The difference between calculated BacLen (Table 1) and measured BacLen values (Table 3) are presented in Table 4. The most striking observations were substantial differences regarding BacLen values from the construction systems and the size groups measured. BacLen differences increased as the bust girth increased. The measured BacLen distance was shorter in all cases. The largest difference excided 3 cm, most of them were more than 2 cm which is more than the differences among the size groups inside the systems.

Table 4. Mean differences between BacLen_measured and other BacLen distances (Based on Table 1)

Groups	80	84	88	92	96
Müller1	–1.8	–1.9	–2.0	–2.1	–2.2
Müller2	–1.9	–1.9	–2.1	–2.3	–2.5
Aldrich	–1.0	–1.4	–1.8	–2.2	–2.6
MdC	–1.8	–1.7	–2.2	–2.4	–2.6
Jansen	–	–1.7	–2.0	–2.3	–2.6
BacLen_4	–2.8	–2.5	–2.9	–2.6	–3.2
BacLen_4_1	–1.8	–1.5	–1.9	–1.6	–2.2
BacLen_DPD	–2.3	–2.2	–2.8	–2.7	–3.5

The differences between calculated and measured BacLen are presented in Figure 2. Comparison of the differences between mean measured BacLen distance and mean distances of BacLen_4, BacLen_4_1 and BacLen_DPD showed that the differences were statistically significant in all size groups between all analyzed pairs of variables (Figure 2). Measured BacLen was systematically smaller than calculated BacLen in all size groups. The mean differences between BacLen_m and calculated BacLens were from 1.5 cm

Table 3. BacLen distances as measured on the study's participants

Group (bust girts, cm)	N	Mean	SDV	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
80	17	39.1	2.35	0.57	37.9	40.3	34.5	44.0
84	49	39.5	1.74	0.25	39.0	40.0	36.0	43.0
88	47	39.2	2.11	0.32	38.5	39.8	35.0	43.0
92	30	39.4	2.01	0.37	38.6	40.1	33.5	43.0
96	17	39.0	2.09	0.51	37.9	40.0	33.0	42.0
Sig.		0.881						

Legend: N – number of measured persons, Values in the table are in cm, Sig. – statistical significance of differences among groups' means, SDV – standard deviation.

(BacLen_4_1 size group 84 cm) to 3.4 cm (BacLen_DPD size group 96 cm).

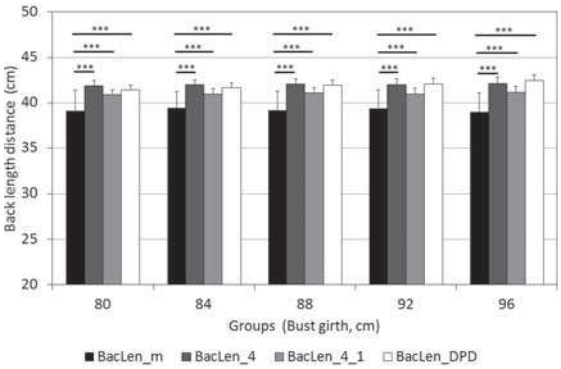

*Figure 2: Comparison between measured and calculated back length distances for single groups. BacLen (measured), BacLen_4 (calculated with equation 1), BacLen_4_1 (calculated with equation 2) and BacLen_DPD (calculated with equation 3), *** - p < 0.001*

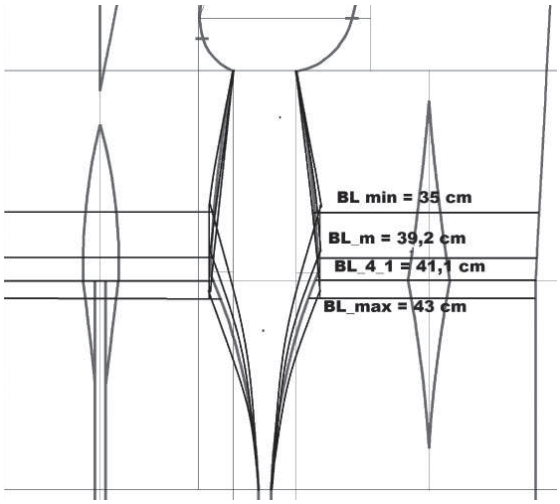

Figure 3. Effect of the different BacLen distances on the shape of the basic dress pattern in the same size group (bust girth 88 cm). BacLen_m – measured (39.2 cm), BacLen_4_1- calculated with Müller's equation 1 (42.1 cm), BacLen_min – measured min (35 cm) and BacLen_max – measured max (43 cm)

Table 5 shows that BacLen_m was not statistically significantly related to any of calculated BacLens ($p > 0.05$). Pearson correlation coefficients between pairs of calculated BacLen were highly significant ($p < 0.001$).

As an example, differently obtained BacLen distances were put into the shape of the basic dress pattern for a single size number to present obtained differences graphically (Figure 3). The differences resulting from different BacLen distances affected the shapes of curved lines of the side seams in the level of the natural waist lines and consequently the fit of the dress on mentioned body level.

4 Discussion

The main findings of this study were that (i) measured back length distances differed significantly from those obtained from the tables of the contemporary construction systems or calculated as a secondary measure according to these systems, (ii) measured BacLen distances were the same in all size groups and did not increase as the size group increased like with all analyzed contemporary construction systems (iii) the range of measured BacLen distances inside each size group was substantial (33–43 cm), and (iv) the measured BacLen distances were not correlated with body height or bust girt and therefore also not to calculated BacLen distances.

The differences in BacLen distances among the analyzed systems as well as among the size groups inside those systems were rather small, mostly less than 1 cm and the BacLen distances increased as the size group increased. It seems that different contemporary constructing systems follow similar approach in setting their BacLen distances. In contrast to them, the measured BacLen did not follow any trend and its mean distances did not significantly differ among the size groups nor they show

Table 5. Pearson correlation coefficients

	BacLen_m	BacLen_4	BacLen_4_1	BacLen_DPD
BacLen_m	1	0.147	0.147	0.111
BacLen_4	0.147	1	1.000**	0.933**
BacLen_4_1	0.147	1.000**	1	0.933**
BacLen_DPD	0.111	0.933**	0.933**	1

* - p < 0.05, ** - p < 0.01, *** - p < 0.001.

any tendency of increasing or decreasing as the size group increased. Additionally, measured BacLen distances were much smaller than those from the systems, what points to important discrepancies between proposed and actual BacLen values and put a question of suitability of the BacLen values in contemporary construction systems' tables to the observed population of young Slovenian females. Differences in values strongly affect the fit of the dress around the natural waist level (Figure 3). The range inside the size groups in measured BacLen values were much larger, from 7 cm in the group with 84 cm bust girth up to 9.5 cm in the groups with 80 and 96 cm bust girth than in measurement tables which raises a question of introducing the sub-sizes upon BacLen values.

Calculated BacLen distances should better fit to individual characteristics of the subjects since they are based on their known dimensions, e.g. body height or bust girth. However, in the present study measured BacLen and calculated BacLens were not correlated. Additionally, the mean differences between calculated BacLens and measured BacLen were significant and large enough to affect the fit of the clothes. This means that the calculated BacLens did not reflect the actual body dimension of young Slovenian females. Differences in BacLen distance will affect the shape of the basic dress block around the natural waist level as presented in Figure 3. The BacLen distance is not only important in the process of developing basic dress pattern blocks in the sense of proper fit. It is also important for every garment that covers the part of the body over the natural waist level like blouses, t-shirts, coats, overalls etc. Smaller is the ease of the clothes incorporated in the basic pattern cut (in other words, the fitter the clothes are), the more important becomes the right value of BacLen distance.

The importance of selecting the real values of BacLen distance is even more important in the made-to-measure business. Values of BacLen distances of the participants in the survey vary 33–44 cm, which mean 11 cm differences in between. If we for example developed the basic dress pattern block for women with much smaller value of BacLen distance, ignoring this data and using the one from the measurement tables or calculated one, the dress would strand on the hips and cause the balloon of excessive material above the natural waist level. Alterations would not be possible because of the lack of the textile material on the side seam above the waist level. This problem would be smaller if the real value of BacLen distance is larger from the one incorporated in the basic block pattern since it would cause only very poor fit of the garment. Alterations would still be possible and necessary. Anyways time and energy put in those alterations means lost money and raising the prices of the product, which cannot help businesses to maintain competitive advantage on the market. This is another reason to include BacLen distance into the anthropometric surveys as one of the important measures that influence the shape of the pattern cut and consequently the fit of the clothes.

In the past, there was a tendency towards reducing the numbers of primary measures, because manual anthropometric surveys are time consuming and costly. However, in the last decade, with the use of 3D body scanners, this is changing dramatically. Today the information about body dimensions can be obtained faster and more users friendly. This gives possibility to obtain significantly more measures directly from the bodies, among which back length distance should be included [17, 18]. Additionally, large data bases of clothing 'customers' can be created and clothing companies would have possibilities to extract from databases only those 'customers' important for their business. In that way the information of their real values would give them competitive advantage on the market and in the same time give consumers better satisfaction in a sense of proper fit of the garments on their bodies.

5 Conclusions

In conclusion, the values for back length distances as proposed by different contemporary construction systems differ significantly from the ones measured in young Slovenian female population. The main differences were observed in obtained range of measured BacLen distances in comparison to other systems and no relationship between measured and calculated BacLens. It is suggested to include back length distance as a directly measured parameter for pattern block construction when producing made-to-measure clothes.

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