Middle-East Journal of Scientific Research 15 (3): 372-376, 2013
ISSN 1990-9233

DOI: 10.5829/idosi.mejsr.2013.15.3.001

Optimizing Muller Body Measurement System for Given Iranian Population

[1]Abolfazl Davodi Roknabadi, [2]Masoud Latifi, [2]Siamak Saharkhiz,
[3]Hamed Aboltakhty and [4]AmirShahin Sharifi

[1]Department of Textile Engineering, Science and Research branch,
Islamic Azad University, Tehran, Iran
[2]Department of Textile Engineering, Textile Research and Excellence Centers,
Amirkabir University of Technology, Tehran, Iran
[3]Young Researchers and Elites club, Science and Research Branch,
Islamic Azad University, Tehran, Iran
[4]Department of Textile Engineering, Islamic Azad University, Yazd Branch, Yazd, Iran

Abstract: The origins of measurement standards can be traced back to the middle Ages and many researches and development had occurred in different country. Muller system one of the main systems in Iranian apparel industry but this system produced base on non-Iranian people thus it has not goof fitness. The purpose of this study optimizing Muller formula based on Iranian population. However according to Muller definitions, measuring 65 persons and then with linear regression optimize Muller formula. Root Mean Square value and visual comparison used for compared two methods, Muller Method and Proposed Method. These methods proved proposed method can better predicted measurements.

Key words: Body measurement systems · Muller sizing system · Statistical method

INTRODUCTION

The origins of measurement standards traced back to the Middle Ages and also to the enlightenment of the eighteenth century and the great interest in all fields of science [1,2]. In those days sizing system and body measurement for apparel industry started to develop. Benjamin Read in 1815 published one of the earliest size tables, *The Proportionate and Universal Table*; he used inches and listed ten proportionate measurements. Cook and Golding, also in 1815, devised a combination system, the divisions being based on theories of proportion. They set up a '*School of Instruction in the Art of Cutting upon True Scientific Principles*'. They declared that 'The use of the inch measure has become so general, that we need not attempt a description of its superiority of the exploded method of measuring by slips of parchment'. They listed eight measurements in inches for a man's coat and breeches and included tables of proportion for men from 6 feet 2 inches to 4 feet 10 inches and also cloth quantities. Bailey's list of garment measurements in 1815 extended to 13; he constructed a direct measurement draft which required more measurements [1,2,5,6,8,9,10].

Nowadays many researchers study on body measurement and sizing systems. Ochae Kwon et al study on glove sizing system and they suggested new key dimension and relationships between hand dimensions [11]. Meng-Jung Chung et al developed a sizing systems for high school student [7]. They used statistical method like a two-stage cluster analysis. The size charts were developed based on the morphological characteristics of each figure type. Twelve sizing systems were established systematically by age group, gender and garment. The coverage rate of the developed sizing systems was over 85%. Bagherzadeh et al also used statistical methods like factor analysis and cluster analysis to developed sizing system. In addition to statistical methods, methods like self-organization were also used [3,4].

Corresponding Author: Abolfazl Davodi Roknabadi, Department of Textile Engineering, Science and Research branch, Islamic Azad University, Tehran, Iran.

As mentioned above, Sizing systems have been widely used for large scale clothing industries. There are different methods for body measurement in Iranian industry like Muller, Metric and so on [5,12-14]. Among these methods, Muller is the most applicable in Iran [5]. This sizing system produces according to non-Iranian population and has no good fitness with Iranian body measurement. The aim of this study is improving and optimizing Muller sizing system based on statistical methods. In this study, we used very simple statistical method like linear regression to optimize Muller formulas.

MATERIALS AND METHODS

Data Preparation: Anthropometric data of 65 Iranian male students from Islamic Azad University of Yazd Branch were obtained. Also 10 Iranian male students were measured to compare the results. We used common tools for body measurement like meter tape, ruler and etc. 16 dimensions was obtained from each person according to Muller measurement definition. Table 1 shows these dimensions.

As mentioned above, according to statistical analysis, samples d ivided to 2 groups, group one include 65 persons and another one include 10 persons. Linear regression performed on group 1 and results extracted, in fact this results were optimizing Muller's formulas. Group 2 was used for showing accuracy in results.

Linear Regression: There are a lot of methods in statistic for declaring relationship between two variables, one of these methods is regression. According to Muller's formulas, each formula has two variable, dependent and independent variable. Each variable in Muller's formula was a dependent variable, in suggested formula set as a dependent variable and vice versa. Therefore here was used a linear regression. We used One-Sample Kolmogorov-Smirnov test to determine normalized distribution of dependent variable.

Root Mean Square: Root mean square (RMS) was used after optimizing by linear regression. RMS Value was determined for both groups (1 and 2) by equation 1:

$$RMS = \frac{1}{N}\sum (Y_1 - \hat{Y})^2 \quad (1)$$

RESULT AND DISCUSSION

Normalized Distribution: Normalized distribution of dependent variable is an important condition in regression, we used One-Sample Kolmogorov-Smirnov test in significance level of 0.05. As shown in Table 2, all dependent variables have normalized distribution except of Height Cloth. According to normal P-P plot of this variable, this variable has a normalized distribution (Figure 1).

Proposed Model: Table 3 shown statistical results. Dependent and independent variables selected based on Muller's formula.

According to Table 3 had extracted new equations. First row shows the relationship between stature and back waist length. Pearson correlation is suitable for applying linear regression. Two last columns show regression values and Beta. According to these values we can propose equation 2:

$$\text{Back waist L} = (\text{Stature} \times 0.231) - 0.118 \quad (2)$$

Here Beta value is 0.58 shows independent variable has effective role in predictive regression model. However we can extract new formula. These formulas were show in Table 4 as a proposed model (PM). In another column Muller's formulas were shown. Beta value in all regression model is bigger than 0.5, except in two models. Means that these variables have a regression model but may be not a linear or may be need new variables. All statistical analysis was performed in SPSS 19.

Comparison: Proposed model and Muller's formula were compared with tow method, at first RMS values calculated for 65 persons that use in regression model and then 10 persons measured again and RMS values calculated for them. Table 5 shows these results. As seen in table 5, all RMS values for proposed model lower than Muller's formula, means that all calculated dependent variables in proposed model have lowest differences with actual dimensions.

As a visual comparison, sewed a basic cloth based on proposed model and Muller's Method. These clothes were shown in Figure 2. Completely clear that proposed model has good fitness with person and here Muller method presents a tight cloth.

Table 1: Human body dimensions

No	Dimensions	No	Dimensions
1	Neck girth	9	Wrist girth
2	Chest girth	10	Waist to foot length
3	Waist girth	11	Sleeve length
4	Hip girth	12	Cloth length
5	Stature	13	Crotch length
6	Back width	14	Scye depth
7	Lower Waist girth	15	Chest width
8	Inseam	16	back waist length

Table 2: One-Sample Kolmogorov-Smirnov Test

		Doresine	Ghad	Karolposht	Ghadlebas	Halgheastin	Pishsine	Balataneposht
N		65	65	65	65	65	65	65
Normal Parameters	Mean	97.302	175.354	38.495	69.072	24.835	21.549	40.380
	Std. Dev	9.1787	6.7925	3.8749	2.5804	2.6948	1.8626	2.6687
Most Extreme Differences	Absolute	.078	.098	.130	.256	.138	.095	.103
	Positive	.078	.059	.130	.221	.138	.095	.065
	Negative	-.035	-.098	-.066	-.256	-.116	-.055	-.103
Kolmogorov-Smirnov Z		.629	.788	1.047	2.062	1.117	.765	.827
Asymp. Sig. (2-tailed)		.824	.564	.223	.000	.165	.601	.501

Table 3: Statistical Results

						Unstandardized Coefficients		Standardized Coefficients
				Pearson Correlation		----------		----------
		Mean	Std. Dev	Sig. (1-tailed)	Regression	B	Std. Err	Beta
1	Stature	175.354	6.7925	.000	Constant	-.118	7.027	
	Back waist L	40.380	2.6687		Stature	.231	.040	.588
2	Chest width	21.549	1.8626	.000	Constant	6.337	1.593	
	Chest girth	97.302	9.1787		Chest girth	.156	.016	.770
3	Back width	38.495	3.8749	.001	Constant	23.346	4.831	
	Chest girth	97.302	9.1787		Chest girth	.156	.049	.369
4	Scye depth	24.835	2.6948	.001	Constant	13.650	3.326	
	Chest girth	97.302	9.1787		Chest girth	.115	.034	.392
5	Cloth length	69.072	2.5804	.000	Constant	32.329	7.006	
	Stature	175.354	6.7925		Stature	.210	.040	.552

Table 4: Proposed and Muller formula

Proposed Model (PM)	Muller's formula (MF)
Cloth length = (Stature × 0.210) + 32.329	Scye depth = (Chest girth × 0.115) + 13.650
Back width = (Chest girth×0.156) + 23.346	Chest width = (Chest girth×0.156) – 6.337
Back waist L = (Stature × 0.231) - 0.118	Cloth length = (Stature × 0.5) – (13 to 15)
Scye depth = (Chest girth × 0.1) + 12	Back width = (Chest girth×0.2) – 1
Chest width = (Chest girth×0.2) – 1	Back waist L = Stature × 0.25

Table 5: Actual Dimension (AD) Muller's formula (MF) and Proposed Model (PM)

Cloth length	MF	PM	Scye depth	MF	PM	Back width	MF	PM	Chest width	MF	PM	Back waist L	MF	PM
70	75.50	69.92	28.3	21.90	25.04	44.2	37.60	38.79	22.1	26.00	21.78	45	44.75	41.23
69.1	72.00	68.45	26.5	22.00	25.15	46	38.00	38.95	25	25.64	21.94	41.2	43.00	39.61
68.4	77.00	70.55	29.6	22.02	25.17	37	38.08	38.98	20.2	25.36	21.97	40.4	45.50	41.92
68.3	74.50	69.50	25.7	21.12	24.14	41.6	34.48	37.57	20.5	25.32	20.56	43.2	44.25	40.77
69	75.00	69.71	25.1	22.01	25.16	38.4	38.04	38.96	22.1	25.60	21.95	41.2	44.50	41.00
70	77.50	70.76	28.2	23.10	26.42	42	42.40	40.66	25	26.00	23.65	41.2	45.75	42.16
69	75.00	69.71	24.4	20.78	23.75	46	33.12	37.04	20.5	25.60	20.03	40.4	44.50	41.00
68.1	69.50	67.40	26.1	20.72	23.68	39.1	32.88	36.95	21	25.24	19.94	38.5	41.75	38.46
70	75.00	69.71	22	21.72	24.83	40.1	36.88	38.51	20	26.00	21.50	43	44.50	41.00
67	70.00	67.61	25.1	21.90	25.04	45	37.60	38.79	21.9	24.80	21.78	42.2	42.00	38.69
RMS	4.85	0.14		3.50	0.80		6.61	3.50	RMS	2.57	0.28		1.41	0.66

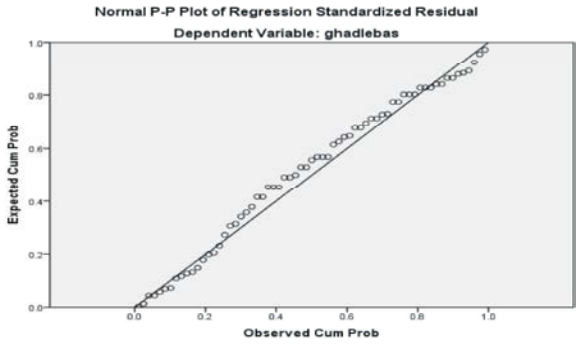

Fig. 1: Normal P-P Plot of regression

(a) (b)

Fig. 2: Cloth based on (a) Muller method and (b) Proposed method

Both root mean square and visual comparison proved that proposed model can improve and optimize Muller methods in selected population.

CONCLUSION

As mentioned before, there are several methods for body measurements, but Muller method is an important and useful method in Iranian apparel industry. This method has no good fitness with Iranian population and we try to optimize it. In this paper we use linear regression for modifying based on Muller definition. Beta values for all equation were good but in two equations this value is lower than 0.5. However RMS and visual comparison proved that proposed model has good fitness with selected population.

For further work, other statistical method like factor analysis and so on can performed on selected population, in fact divided the population according to statistical analysis not Muller method and find better systems.

REFERENCES

1. Ashdown, S.P., Sizing in clothing, 2007, wood head publishing.
2. Fan, J. and W. Yu, 2004. Clothing appearance and fit Science and Technology.
3. Bagherzadeh, R., M. Latifi and A.R. Faramarzi, 2010. Employing a Three-Stage Data Mining Procedure to Develop Sizing System, World Applied Sciences Journal, 8: 8.
4. Doustaneh, A.H., M. Gorji and M. Varsei, 2010. Using Self Organization Method to Establish Nonlinear Sizing System, World Applied Sciences Journal, 9: 12.
5. Davodi, A., M. Latifi, S. Saharkhiz and Aboltakhty, 2012. Human Body Measurement System in Clothing Using Image Processing, World Applied Sciences Journal, 19: 1.
6. Majidi, M.M., M.E. Moghadam, G. Nourani and R. Pourtaheri, 2011. Development of Sizing Systems for Iranian High-School Male Students, World Applied Sciences Journal, 13(8): 1807-1813.
7. Meng-Jung Chung, Hai-Fen Lin, Mao-Jiun J. Wang, 2007. The development of sizing systems for Taiwanese elementary- and high-school students, International Journal of Industrial Ergonomics, pp: 37.

8. Rong Zheng, Winnie Yu and Jintu Fan, 2007. Development of new Chinese bra sizing system based on breast anthropometric measurements,
9. Ameersing Luximon, Yifan Zhang, Yan Luximon, Ma Xiao, Sizing and grading for wearable products, 2012. Computer-Aided Design, 44: 1.
10. Hyunsook Han and Yunja Nam, 2011. Automatic body landmark identification for various body figures, International Journal of Industrial Ergonomics, 41: 6.
11. Ochae Kwon *et al*, 2009. Determination of key dimensions for a glove sizing system by analyzing the relationships between hand dimensions, Applied Ergonomics,
12. Emanuel, 1., M. Alexander, E. Churchill and B. Truett, 1959. A height-weight sizing system for flight clothing. In: Wright Air development Center. WADC Technical Report. Wright-Patterson Air Force Base, Ohio,
13. Ashdown, S.P., 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. International Journal of Clothing Science and Technol.,
14. Gupta, D. and B.R. Gangadhar, 2004. A statistical model for developing body size charts for garments. International J. Clothing Science and Technol.,