

Analysis on Lower Body Type of Korean Women in Their Early 20's

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Abstract

The purpose of this study is to analyze lower body types of women and provide information of body improvement of Korean adult female clothing product to ready-made clothes companies. As for the method of this study, it was conducted to measure the parts of the lower body of adult women at the age from 19 to 24 years, to analyze their characteristics and to categorize body types. For study, it was measured 150 female women in Seoul. Data was analyzed by used SPSS/WIN 19.0 Program. The results of this study are as follows. The means of the subjects in their early 20s are 159.8cm in height, 67.0cm in waist circumference, 91.6cm in hip and 52.0kg in weight. As a result of comparison with the 5th Korean's human body size on measurement data, 20 items out of 33 items showed significant difference. Factor analysis was executed for 66 body measure and calculation items to draw the body construction factors of the women's lower body in their early 20s and principal component analysis was performed by orthogonal varimax rotation to clarify the measurement of factors and to derive explanatory factors. As result of Cluster analysis, body types' characteristics divide into 3 types. Type1 has tall and fat body form, type2 has shortest and curvy body form and type3 has average height and the most skinny body form.

Key Words : Lower Body Type, Factor analysis, Cluster analysis

I . Purpose of Study

Along with the development of industrial economies, the improvement of living standard

brought change in consumers' recognition for fashion rather than just solving food, clothing, and shelter. They require clothing to fit with their physical characteristic, and to cover their physical

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defects as ideal form for the mental satisfaction¹⁾.

The human body appears other morphological differences by several factors, but despite these differences, some similarities can be found. Therefore, as it is identified those characteristics and is attempted to stereotyping of body type through the appropriate standards, it can be obtained information of clothing design with high suitability²⁾.

Because upper body and lower body have low correlation by parts of the body and clothing prototype is produced separately, it is the tendency to research by dividing upper body and lower body by subjects depending on the age and gender. The reason is that because upper body is difficult to set the reference points and there are non-exposed parts (especially Crotch part), it is difficult to measure.

Lower body is very important to measure the body surface changes and the shape of lower body in order to develop lower clothing types such as slacks prototype or skirts prototype with high suitability. Since 2007, preceding studies related with the lower body type of adult women^{3),4),5),6),7)} are being done depending on the measurement method and by age. But most of the studies targeting the young ladies among these studies already passed more than 5 years due to the result of the 5th Korean Anthropometric Survey(2004) from Korean Agency for Technology and Standard.

Therefore this study targets on the young ladies aged from 19~24 who will not have much change in body shapes as they reached to the adult body, measures lower body, analyzes the characteristics, classifies the body types, compares the relations between groups, and utilizes them as basic materials to develop the original form, pattern, and size and to improve

the fit which is the whole purpose.

II. Methodology

1. Body measurement

1) Measurement Subject and Sample

In the study, 150 college women at the age from 19 to 24 living in Seoul were selected for the body measurement to collect material by simple random sampling. The measurement was executed from Mar. 3, 2011 to May 25, 2011. To minimize any measuring error and time, training for skilled measurement were performed for 4 researchers from Clothing Construction Lab, Dept. of Clothing and Textiles, Sookmyung Women's University and they practiced a preliminary measurement before actual one.

2) Measurement Method

Body measurement was performed according to the method of R. Martin. For measurement, the subjects put their eyes to the front, put their heels together by spreading tiptoes at a 30° angle and let both arms hang downward naturally.

3) Measurement items

Measurement items are required to understand the parts location of the lower body and the characteristics of body types for the women in their early 20s. And they were set up by referring to ISO 8559⁸⁾ and the Standard Glossary of Body Measurement from the 5th Size Korea⁹⁾. Part items consist of 58 ones in total of 14 height, 10 width, 6 depth, 11 circumference, 7 length, 9 sitting posture and 1 weight item, which are shown in <Tab.1>.

<Tab. 1> Measurement items for the women in their early 20s

Measurement items					
Height (14)	Stature	Depth (6)	Minimum Leg Breadth	Length (7)	Crotch Length
	Waist Height		Ankle Breadth		Gluteal Fold Length
	Waist Height(Omphalion)		Foot Breadth, horizontal		Thigh Vertical Length
	Abdominal Protrusion Height		Waist depth		Hip Length
	Iliocristale Height		Abdominal Protrusion depth		Waist to Lateral Malleous Length
	Hip Height		Hip depth		Outside Leg Length
	Gluteal Fold Height	Gluteal Fold depth	Crotch to Medial Malleous Length		
	Crotch Height	Knee depth	Sitting posture (9)	Sitting Height	
	Thigh Height	Calf depth		Thigh Clearance	
	Calf Height	Circumference (11)		Waist Circumference	Knee Height, sitting
	Knee Height			Abdominal Protrusion	Popliteal Height
	Minimum Leg Height			Hip Circumference	Hip Breadth, sitting
	Lateral Malleolus Height			Hip Circumference(with plate)	Abdominal Depth, sitting
	Medial Malleolus Height			Thigh Circumference	Knee Circumference, sitting
Breadth (10)	Waist Breadth			Midthigh Circumference	Buttock-Knee Length
	Abdominal Protrusion Breadth			Knee Circumference	Buttock-Popliteal Length
	Hip Breadth		Lower Knee Circumference	Weight	
	Thigh to Thigh Breadth		Calf Circumference		
	Thigh Breadth		Minimum Leg Circumference		
	Knee Breadth		Ankle Circumference		
	Calf Breadth				

2. Data process and analysis methods

In the study, to enhance reliability, any value from body measures was set to a missing value as an extreme outlier if deviating as much as $\pm 3\delta$ (δ : standard deviation) from the mean of measures per item. And then they were processed with SPSSWIN 19.0 Program. Analysis material was 66 items of 58 measures and 8 calculations totally.

1) Lower body measures analysis

The mean and standard deviation were calculated for 66 body measure and calculation items to understand the body characteristics of the women in their early 20s.

2) Comparison with the 5th Korean's human body size on measurement data

T-test was conducted on the 5th Korean's human body size (Ministry of Commerce, Industry, and Energy, Agency for Technology and Standard, 2004) and 33 of common items of measurements of this study for objectification and comparison of test subjects.

3) Factor analysis

Factor analysis was executed for 66 body measure and calculation items to draw the body construction factors of the women's lower body in their early 20s and principal component analysis was performed by orthogonal varimax rotation to clarify the measurement of factors

and to derive explanatory factors.

4) Cluster analysis

Group analysis was executed through 5 factors derived from the factor analysis of direct measures to categorize the shapes of the lower body. Classified groups were from 2 to 4 and the number of groups were finally decided by considering the similarity of subject distribution per type and the characteristics of types.

III. Results

1. Lower body measures analysis

For Lower body type analysis, descriptive statistic is composed of the mean, standard deviation, maximum and minimum values and range of 58 direct measures, 1 Rohrer's index and 7 calculation values. And the means of the subjects in their early 20s are 159.8cm in height, 67.0cm in waist circumference, 91.6cm in hip and 52.0kg in weight, which are shown in <Tab.2>.

2. Comparison with the 5th Korean's human body size on measurement data

In this study, the 5th Korean's human body size on measurement data and those derived this study were compared in order to verify validation of the measurement data and a trend of body type changes of test subjects. As a result of T-test conducted on 501 females in early 20's(20~24 years old), the same age in the report of the 5th Korean's human body size on measurement data, there was a significant difference in the 20 different items at $p \leq 0.05$, which are shown in <Tab.3>.

As for height, there was a significant difference in the waist height, waist height (omphalion), hip height, knee height, and lateral malleolus height. This indicates a trend of Westernization that people in their 20's have longer legs than before that consistent with report from Ministry of Knowledge Economy, Agency for Technology and Standard(2010). As for the width, there was a significant difference only in the feet width, and the average of estimated values in this study were lower in the waist and hip thickness that can be interpreted to a trend with thinner waist and hip.

As for circumference, it turned out that it became thinner in 2011 compared to the year of 2004. As for the length, direct length thighs, hip length, and leg length showed significant difference. This indicated that the length of legs became longer just like height. There was a significant difference in the weight that test subjects became lighter when this study was conducted in 2011 compared to the year of 2004. Such a result of the study regarding low weight is influenced by a cultural phenomenon putting priority on currently preferred diet and well-being that consistent with data, indicating the fact that low-weight oriented phenomenon is diffusing with increased proportion of population with low weight compared to 7 years ago.

3. Derivation of body construction factors

From a result of factor analysis to understand the body construction factors of various data for 66 body items, 5 factors were derived and explained 72.0% of the total variation, which are shown in <Tab.4>.

<Tab. 2> Lower body measures analysis

unit: cm

items		M	SD	Min.	Max.	CV	Range
Height	1 Statue	159.8	15.3	155.5	175.8	3.3	20.3
	2 Waist Height	101.3	3.6	92.7	110.8	3.7	18.1
	3 Waist Height(Omphalion)	95.6	3.4	88.3	104.6	3.7	16.3
	4 Abdominal Protrusion Height	90.6	3.5	82.6	101.3	3.9	18.7
	5 Iliocristale Height	91.3	3.5	82.9	100.6	3.9	17.7
	6 Hip Height	79.4	3.5	71.9	94.0	4.4	22.1
	7 Gluteal Fold Height	72.0	4.6	63.1	97.7	6.0	34.6
	8 Crotch Height	72.7	3.1	64.8	80.3	4.1	15.5
	9 Thigh Height	73.5	3.4	65.3	89.9	5.1	24.6
	10 Calf Height	42.9	2.0	24.7	34.2	6.5	9.5
	11 Knee Height	10.5	1.0	37.9	48.7	4.7	10.8
	12 Minimum Leg Height	6.4	0.6	6.5	13.2	9.5	6.7
	13 Lateral Malleolus Height	7.7	0.6	4.9	8.3	9.3	3.4
	14 Medial Malleolus Height	23.3	1.3	6.3	9.3	7.7	3.0
Breadth	15 Waist Breadth	29.7	1.5	19.9	28.0	6.3	8.1
	16 Abdominal Protrusion Breadth	32.7	1.5	24.0	35.2	5.8	11.2
	17 Hip Breadth	33.0	1.5	24.8	38.4	5.5	13.6
	18 Thigh to Thigh Breadth	15.7	1.2	29.9	37.9	5.1	8.0
	19 Thigh Breadth	10.2	0.7	13.0	19.3	7.9	6.3
	20 Knee Breadth	10.0	0.7	8.7	14.5	8.7	5.8
	21 Calf Breadth	5.1	0.4	8.5	14.3	8.6	5.8
	22 Minimum Leg Breadth	6.2	0.4	4.3	6.7	8.1	2.4
	23 Ankle Breadth	8.8	0.6	5.0	10.8	8.9	5.8
	24 Foot Breadth, horizontal	16.8	1.2	5.2	13.8	10.3	8.6
Depth	25 Waist depth	16.8	1.2	14.1	22.0	8.3	7.9
	26 Abdominal Protrusion depth	19.7	1.5	16.0	25.5	8.3	9.5
	27 Hip depth	20.2	1.3	17.5	24.0	6.6	6.5
	28 Gluteal Fold depth	16.5	1.2	13.8	21.4	8.3	7.6
	29 Knee depth	10.5	0.7	8.9	12.8	6.9	3.9
	30 Calf depth	10.3	0.6	8.8	12.8	7.0	4.0
Circumference	31 Waist Circumference	67.0	3.3	57.0	97.3	6.9	40.3
	32 Abdominal Protrusion	80.9	4.3	70.7	93.7	5.7	23.0
	33 Hip Circumference	91.6	3.8	82.3	107.3	4.7	25.0
	34 Hip Circumference(with plate)	92.2	3.8	82.8	108.4	4.7	25.6
	35 Thigh Circumference	54.4	2.7	46.0	67.3	5.9	21.3
	36 Midthigh Circumference	46.2	2.9	38.8	60.3	7.1	21.5
	37 Knee Circumference	34.6	1.9	29.5	43.6	6.3	14.1
	38 Lower Knee Circumference	31.3	1.6	27.0	60.3	9.3	33.3
	39 Calf Circumference	33.8	2.1	29.3	42.7	7.2	13.4
	40 Minimum Leg Circumference	20.4	1.0	16.8	23.6	5.7	6.8
	41 Ankle Circumference	23.1	1.1	20.0	32.3	6.1	12.3

<Tab. 2> Continued

	items	M	SD	Min.	Max.	CV	Range
Length	42 Crotch Length	72.9	4.1	64.8	84.4	5.6	19.6
	43 Gluteal Fold Length	31.7	1.8	21.2	35.8	6.4	14.6
	44 Thigh Vertical Length	28.8	1.8	24.1	33.1	6.1	9.0
	45 Hip Length	22.5	2.0	16.3	29.2	9.2	12.9
	46 Waist to Lateral Malleous Length	97.1	3.6	88.5	106.8	3.8	18.3
	47 Outside Leg Length	102.8	3.7	93.7	113.4	3.7	19.7
	48 Crotch to Medial Malleous Length	65.8	3.0	58.1	81.9	4.9	23.8
Sitting posture	49 Sitting Height	86.4	2.8	77.9	94.0	3.3	16.1
	50 Thigh Clearance	13.2	1.1	10.1	17.1	8.8	7.0
	51 Knee Height, sitting	45.7	2.0	39.3	56.9	4.9	17.6
	52 Popliteal Height	38.8	1.7	34.0	43.2	4.5	9.2
	53 Hip Breadth, sitting	35.5	1.9	31.8	42.5	6.0	10.7
	54 Abdominal Depth, sitting	19.1	1.4	15.6	28.9	9.2	13.3
	55 Knee Circumference, sitting	36.2	2.4	23.6	46.0	6.9	22.4
	56 Buttock-Knee Length	55.1	2.2	45.9	64.5	4.5	18.6
Estimated Items	57 Buttock-Popliteal Length	46.3	2.2	39.7	57.5	5.1	17.8
	58 Weight	52.0	5.0	38.0	77.0	11.5	39.0
	59 Röhrer's index	124.7	13.1	100.8	168.8	10.5	68.1
	60 Waist depth/Waist Breadth	0.7	0.1	0.0	1.0	12.7	1.0
	61 Abdominal Protrusion depth/ Abdominal Protrusion Breadth	0.7	0.0	0.6	0.8	5.9	0.2
	62 Hip depth/Hip Breadth	0.6	0.0	0.5	0.6	5.3	0.1
	63 Abdominal Protrusion Breadth/ Waist Breadth	1.3	0.1	1.1	1.4	5.0	0.3
	64 Hip Breadth/Waist Breadth	1.5	0.1	1.3	1.8	5.8	0.5
	65 Hip Breadth-Waist Breadth	12.4	1.8	7.5	17.0	14.4	9.5
	66 Hip Circumference-Waist Circumference	1.4	0.1	0.9	1.5	4.7	0.6

Factor1 was weighted to the circumference, width and weight related to the horizontal size of the lower body and Rohrer's index to show the 'obesity and horizontal size of the lower body'. They were Hip Circumference, Thigh Circumference, Weight, Hip Depth, Thigh Breadth, Midthigh Circumference, Abdomen Circumference, Waist Circumference, Gluteal Furrow Breadth and Hip Breadth(sitting) in order of importance, which were weighted to 21 items totally. It was the greatest value among 5 factors

with the eigenvalue of 19.92 and had the explanatory power of 36.89% out of the total variation.

Factor2 was weighted to the items related to the height and vertical length of the lower body including stature, which shows the 'vertical size of the lower body'. They were Crotch Height, Waist Height(Omphalion), Inside Leg Length, Outside Leg Length, Lateral Waist to Lateral Malleolus Length, Abdominal Height, Waist Height, Iliocristale Height, Stature and Thigh

<Tab. 3> A result of comparison with the 5th Korean's human body size on measurement data
unit: cm

Items		2004		2011		t-value	
		M	SD	M	SD		
Height	1	Statue	160.4	5.2	159.8	15.3	0.5
	2	Waist Height	100.2	4.0	101.3	3.6	6.9**
	3	Waist Height(Omphalion)	94.4	3.7	95.6	3.4	9.6**
	4	Hip Height	78.4	3.6	79.4	3.5	8.1**
	5	Crotch Height	72.6	3.4	72.7	3.1	0.1
	6	Knee Height	40.8	2.1	42.9	2.0	94.5***
	7	Lateral Malleolus Height	6.2	0.5	6.4	0.6	15.0***
Breadth	8	Waist Breadth	23.6	1.8	23.3	1.3	2.9
	9	Hip Breadth	32.4	1.6	32.7	1.5	3.6
	10	Foot Breadth, horizontal	9.1	0.5	8.8	0.6	36.6***
Depth	11	Waist depth	17.3	1.9	16.8	1.2	6.6**
	12	Hip depth	20.8	1.9	20.2	1.3	11.3***
Circumference	13	Waist Circumference	67.1	5.7	67.0	3.3	0.0
	14	Hip Circumference	91.3	4.8	91.6	3.8	0.3
	15	Thigh Circumference	53.9	4.2	54.4	2.7	1.7
	16	Midhigh Circumference	47.6	4.0	46.2	2.9	13.4***
	17	Knee Circumference	35.0	2.4	34.6	1.9	2.7
	18	Lower Knee Circumference	32.3	2.1	31.3	1.6	27.9***
	19	Calf Circumference	34.2	2.4	33.8	2.1	3.8
	20	Minimum Leg Circumference	20.6	1.2	20.4	1.0	2.9
	21	Ankle Circumference	23.3	1.1	23.1	1.1	3.4
Length	22	Thigh Vertical Length	27.8	2.1	28.8	1.8	23.3***
	23	Hip Length	23.0	2.3	22.5	2.0	4.9*
	24	Outside Leg Length	101.1	4.2	102.8	3.7	15.6***
Sitting posture	25	Sitting Height	86.6	2.8	86.4	2.8	0.6
	26	Thigh Clearance	13.6	1.2	13.2	1.1	9.7**
	27	Knee Height, sitting	48.3	2.1	45.7	2.0	149.8***
	28	Popliteal Height	37.7	2.0	38.8	1.7	33.4***
	29	Hip Breadth, sitting	34.9	2.0	35.5	1.9	8.0**
	30	Abdominal Depth, sitting	19.2	2.2	19.1	1.4	0.1
	31	Buttock-Knee Length	54.6	2.3	55.1	2.2	3.9*
	32	Buttock-Popliteal Length	44.9	2.2	46.3	2.2	45.1***
	33	Weight	53.6	7.0	52.0	5.0	5.2*

*p≤.05, **p≤.01, ***p≤.001

<Tab. 4> Factor contents

	Factor contents	Eigenvalues	Variance(%)	Cumulative(%)
1	Obesity and horizontal size of the lower body	19.9	36.9	36.9
2	Vertical size of the lower body	11.1	20.5	57.4
3	Horizontal size from the calf to the ankle	3.9	7.2	64.6
4	Width and breadth of the waist	2.3	4.2	68.8
5	Vertical size of the ankle	1.7	3.2	72.0

Height in order of importance, which were weighted to 18 items totally. It was second value among 5 factors with the eigenvalue of 11.07 and had the explanatory power of 20.50% out of the total variation.

Factor3 was weighted to the circumference and width from the calf to the ankle showing the 'horizontal size from the calf to the ankle'. They were Minimum Leg Circumference, Calf Depth, Minimum Leg Breadth, Calf Circumference, Calf Breadth, Ankle Circumference and Ankle Breadth in order of importance, which were weighted to 7 items totally. It was the eigenvalue of 3.91 and had the explanatory power of 7.24% out of the total variation.

Factor4 was weighted to the items related to the width and circumference of the waist and

shows the 'width and breadth of the waist'. They were Hip Width/Waist Width, Hip Width-Waist Width, Abdominal Breadth/Waist Width and Hip Circumference-Waist Circumference in order of importance, which were weighted to 4 items totally. It was the eigenvalue of 2.25 and had the explanatory power of 4.16% out of the total variation.

Factor5 was weighted to the height of the ankle that shows the 'vertical size of the ankle'. They were Minimum Leg Height, Lateral Malleolus Height and Medial Malleolus Height in order of importance, which were weighted to 3 items totally. It was the eigenvalue of 1.74 and had the explanatory power of 3.22% out of the total variation, <Tab.5> is the result of the body construction factor analysis.

<Tab. 5> A result of the body construction factor analysis

unit: cm

Items	1	2	3	4	5	Communalities (h ²)
Hip Circumference(with plate)	0.908	0.200	0.177	0.129	0.079	0.956
Hip Circumference	0.902	0.195	0.183	0.136	0.085	0.950
Thigh Circumference	0.897	-0.011	0.109	0.043	0.007	0.843
Weight	0.833	0.295	0.333	-0.028	0.157	0.919
Hip depth	0.802	-0.091	0.109	0.031	0.047	0.673
Thigh Breadth	0.791	0.134	0.182	0.027	-0.087	0.723
Midthigh Circumference	0.788	-0.088	0.347	0.137	-0.017	0.777
Abdominal Protrusion	0.769	0.209	0.106	-0.078	0.184	0.846
Waist Circumference	0.765	0.135	0.156	-0.456	0.134	0.924
Gluteal Fold depth	0.759	-0.049	0.180	0.169	0.028	0.719
Hip Breadth, sitting	0.753	0.192	0.281	0.392	0.010	0.851
Thigh to Thigh Breadth	0.749	0.279	0.230	0.248	0.153	0.869
Waist depth	0.735	-0.070	0.098	-0.177	0.032	0.706
Hip Breadth	0.723	0.254	0.217	0.184	0.028	0.779
Abdominal Protrusion Breadth	0.685	0.153	0.173	0.126	0.134	0.851
Röhrer's index	0.683	-0.558	0.114	-0.160	-0.100	0.834
Abdomial Depth, sitting	0.676	0.116	0.072	-0.090	0.131	0.687
Lower Knee Circumference	0.665	0.110	0.572	0.051	0.184	0.823
Knee Circumference	0.650	0.126	0.421	0.122	0.187	0.684
Knee Breadth	0.622	0.068	0.404	0.002	0.138	0.616

<Tab. 5> Continued

unit: cm

Items	1	2	3	4	5	Communalities (h ²)
Thigh Clearance	0.565	0.130	0.230	0.045	-0.283	0.556
Crotch Height	-0.026	0.945	0.080	0.020	0.048	0.908
Waist Height(Omphalion)	0.110	0.931	0.108	0.058	0.154	0.920
Crotch to Medial Malleous Length	0.011	0.918	0.016	-0.063	-0.041	0.852
Outside Leg Length	0.161	0.915	0.072	0.063	0.161	0.905
Waist to Lateral Malleous Length	0.146	0.906	0.088	0.079	0.099	0.873
Abdominal Protrusion Height	0.108	0.903	0.114	-0.032	0.113	0.869
Waist Height	0.186	0.900	0.122	0.082	0.118	0.887
Iliocristale Height	0.079	0.898	0.085	-0.045	0.116	0.851
Statue	0.123	0.853	0.185	0.123	0.238	0.855
Thigh Height	-0.052	0.836	0.068	-0.033	0.061	0.715
Knee Height	0.074	0.807	0.093	0.091	0.048	0.733
Hip Height	0.054	0.806	0.067	0.019	-0.006	0.731
Popliteal Height	-0.010	0.756	0.010	-0.004	-0.100	0.612
Buttock-Knee Length	0.389	0.713	0.018	-0.230	0.118	0.759
Thigh Vertical Length	-0.052	0.689	-0.062	-0.078	-0.008	0.574
Buttock-Knee Length	0.244	0.656	-0.067	-0.181	0.087	0.614
Sitting Height	0.083	0.601	0.089	0.337	0.314	0.600
Calf Height	0.051	0.552	-0.026	0.192	-0.107	0.889
Minimum Leg Circumference	0.438	0.163	0.753	0.022	0.036	0.790
Calf depth	0.485	0.021	0.744	0.002	-0.085	0.859
Minimum Leg Breadth	0.406	0.093	0.733	0.123	0.052	0.782
Calf Circumference	0.553	0.017	0.719	0.003	0.001	0.426
Calf Breadth	0.535	-0.063	0.678	0.001	0.141	0.808
Ankle Circumference	0.301	0.322	0.607	-0.032	-0.048	0.604
Ankle Breadth	0.366	0.184	0.593	-0.016	0.021	0.728
Hip Breadth/Waist Breadth	0.098	0.025	0.040	0.947	-0.011	0.920
Hip Breadth-Waist Breadth	0.364	0.092	0.138	0.867	0.003	0.913
Abdominal Protrusion Breadth /Waist Breadth	0.010	-0.014	-0.075	0.821	0.118	0.803
Minimum Leg Height	0.127	0.252	0.028	-0.127	0.723	0.621
Lateral Malleolus Height	0.246	0.211	-0.144	0.013	0.687	0.666
Medial Malleolus Height	-0.001	0.171	0.217	0.170	0.655	0.573
Eigenvalues	19.921	11.070	3.911	2.247	1.737	-
Variance(%)	36.890	20.499	7.243	4.160	3.216	-
Cumulative(%)	36.890	57.389	64.632	68.792	72.008	-

3. Body types classification according to Cluster analysis

In order to classify the lower body type of overall women aged 20th and to identify its characteristics, it was performed the group analysis in order to classify the types as variables of the items obtained from factor analysis, and the result is the same as the <Tab.6>. The number of the group was against 123 peoples except 27 peoples of extreme body type, and 2~4 numbers of group designated so as to be distributed evenly for the number of peoples. Finally, the number of groups determined after identifying its characteristics of

each group.

The researcher of this study analyzed it by categorizing into 3 types because it is considered that percentage distribution or characteristics of the types were the best represented if the number of groups were classified as 3.

The frequency of the types and the factor scores per each types are shown as <Tab.7>. Distribution analysis and Duncan-test was performed in order to verify the type differences by the classified factors and the structure of the type differences. and the results are the same as <Tab.9>. 3 factors had significant differences of the types among 5 and 50 items among 53 had significant differences.

<Tab. 6> Number of cases in each cluster

unit : N(%)

Number	Cluster1	Cluster2	Cluster3	Cluster4
2	79(64.2)	44(35.8)		
3	30(24.4)	31(25.2)	62(50.4)	
4	41(33.3)	30(24.4)	33(26.8)	19(15.5)

<Tab. 7> Examination result of factors score per each type, type difference per each factor and structure of type difference

Factor	Type	Type1	Type2	Type3	F-value
	Factor1 Obesity and horizontal size of the lower body		1.02 C	0.31 B	
Factor2 Vertical size of the lower body		0.45 B	-1.17 A	0.37 B	52.279***
Factor3 Horizontal size from the calf to the ankle		0.51 B	-0.15 A	-0.17 A	5.460**
Factor4 Width and breadth of the waist		0.06 A	-0.25 A	0.10 A	1.351
Factor5 Vertical size of the ankle		0.16 A	-0.15 A	-0.004 A	0.719

*p≤.05 **p≤.01 ***p≤.001

A,B,C expresses the groups that had significant differences of p≤.05 from Duncan test result.(A<B<C).

- Type 1

In type1, factor1, factor2 and factor3 showed the most highest value. In other words, lower body's obesity factor and horizontal size, lower body's vertical size and horizontal size from calf to the ankle are the large. The analyzed result for the anthropometry showed that factor1 had a high average value from 21 items among 22 items excluding Rohrer's index such as Hip Circumference, Hip depth, Hip Breadth, Waist, Waist depth, Weight and etc, factor2 had a high average value from 18 items such as Statue, Waist Height, Hip Height, Crotch Height and etc and factor3 had a high average value from 7 items.

- Type 2

In type2, factor1 showed middle range of average value and factor2 and factor3 showed the lowest value. In other words, lower body's vertical size and horizontal size from calf to the ankle are lowest, and lower body's obesity factor and horizontal size are middle size. The factor1 had a middle average value from 13 items among 22 items such as Hip Circumference, Thigh Circumference, Weight ,Hip

depth, Waist, Waist depth, and etc and showed the highest value in Rohrer's index. The factor2 had a low value from 18 items such as Statue, Waist Height, Hip Height, Crotch Height and etc. The factor3 had the 2nd value from 3 items such as Calf depth, Calf circumference, and Calf Breadth.

- Type 3

In type3, factor1 and factor3 showed the minimum value and factor2 showed high value so lower body's obesity factor, horizontal size, and horizontal size from calf to the ankle are low but lower body's vertical size is middle size. The factor1 had a lowest value from 13 items among 22 items such as Hip Circumference, Thigh Circumference, Weight, Abdominal Protrusion, Waist, and etc and the factor2 showed the 2nd value among 18 items.

The results analyzing the characteristics by the body type of 3 types by integrating the differences between the factor scores by the types appeared in <Tab. 7> and the measured values appeared in <Tab.6> is the same as <Tab. 8> and the front of he women in their early 20s is shown as <Fig.1>.

<Tab. 8> A result of cluster analysis

unit: cm

Classification	Type1(n=30)			Type2(n=31)			Type3(n=62)			F-value	
	Mean	S.D	D	Mean	S.D	D	Mean	S.D	D		
Factor1 (22)	Hip Circumference(with plate)	96.7	3.0	c	92.0	2.8	b	90.2	2.4	a	59.698 ***
	Hip Circumference	96.0	3.0	c	91.3	2.8	b	89.5	2.4	a	60.514 ***
	Thigh Circumference	57.0	2.6	c	55.2	2.0	b	52.8	1.8	a	43.733 ***
	Weight	58.2	3.6	c	51.4	3.9	b	49.4	3.3	a	62.722 ***
	Hip depth	21.3	0.9	c	20.6	1.1	b	19.6	1.0	a	32.173 ***
	Thigh Breadth	16.8	1.1	c	15.7	1.1	b	15.2	0.9	a	25.005 ***
	Midthigh Circumference	49.0	2.7	c	47.1	2.1	b	44.3	1.7	a	53.077 ***
	Abdominal Protrusion	85.6	3.1	c	80.6	3.9	b	78.8	3.1	a	42.636 ***
	Waist Circumference	70.2	2.2	c	67.4	2.8	b	65.2	2.7	a	37.223 ***
	Gluteal Fold depth	17.5	1.0	c	16.8	1.0	b	15.9	1.0	a	25.165 ***
	Hip Breadth, sitting	37.5	1.8	b	35.2	1.5	a	34.7	1.5	a	32.150 ***
	Thigh to Thigh Breadth	34.6	1.6	b	32.5	1.1	a	32.4	1.1	a	35.592 ***

*p≤.05 **p≤.01 ***p≤.001

a,b,c expresses the groups that had significant differences of p≤.05 from Duncan test result.(a<b<c).

<Tab. 8> Continued

unit: cm

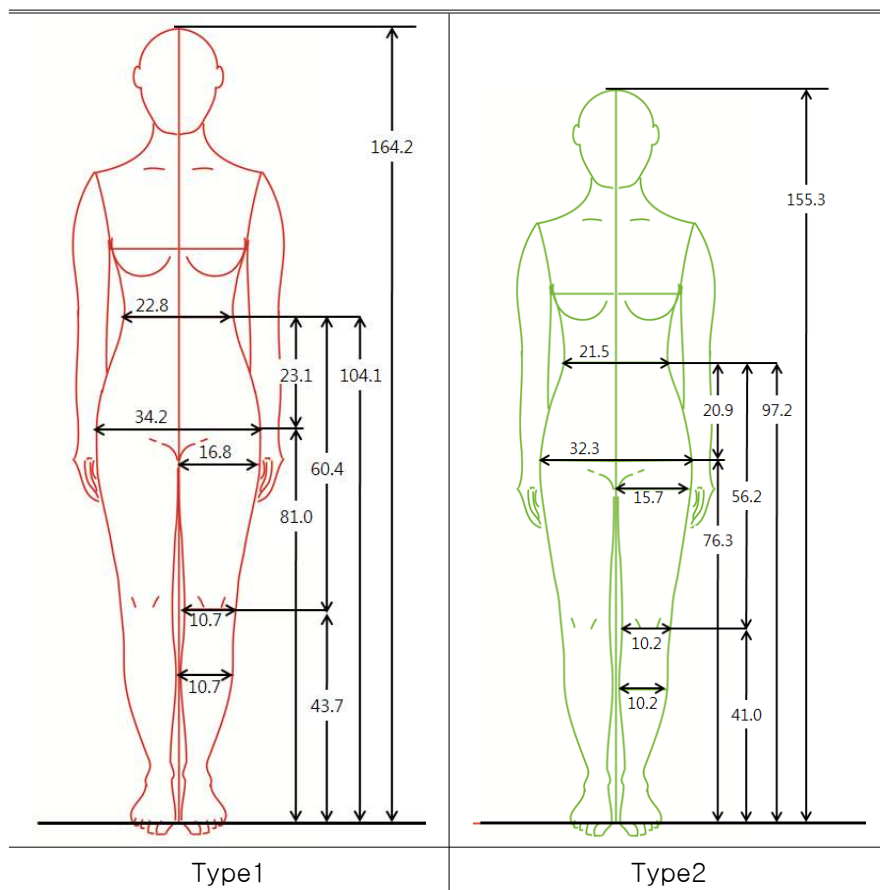
Classification	Type1 (n=30)			Type2 (n=31)			Type3 (n=62)			F-value	
	Mean	S.D	D	Mean	S.D	D	Mean	S.D	D		
Factor1 (22)	Waist depth	17.8	0.9	c	17.3	1.2	b	16.1	1.0	a	30.835 ***
	Hip Breadth	34.2	1.7	b	32.3	1.3	a	32.2	1.0	a	26.890 ***
	Abdominal Protrusion Breadth	31.0	1.5	b	29.4	1.5	a	29.2	1.1	a	21.412 ***
	Röhler's index	131.3	7.0	b	137.4	10.0	c	115.0	6.1	a	108.185 ***
	Abdomial Depth, sitting	20.5	1.3	c	19.2	1.3	b	18.5	1.1	a	27.157 ***
	Lower Knee Circumference	32.9	1.1	b	31.1	1.5	a	30.6	1.3	a	32.636 ***
	Knee Circumference	36.4	1.6	b	34.4	1.9	a	33.9	1.4	a	24.827 ***
	Knee Breadth	10.7	0.7	c	10.2	0.7	b	9.9	0.6	a	17.568 ***
	Thigh Clearance	13.9	1.0	b	13.3	1.2	a	12.9	1.0	a	9.053 ***
Factor2 (18)	Crotch Height	74.0	2.1	b	69.3	2.2	a	73.7	2.5	b	44.886 ***
	Waist Height(Omphalion)	97.7	2.4	c	91.6	2.0	a	96.6	2.8	b	53.355 ***
	Crotch to Medial Malleous Length	67.2	2.3	b	62.6	1.6	a	66.8	2.6	b	40.356 ***
	Outside Leg Length	105.3	2.2	c	98.5	2.1	a	103.7	3.1	b	55.064 ***
	Waist to Lateral Malleous Length	99.5	2.1	c	93.0	2.1	a	98.1	3.1	b	52.193 ***
	Abdominal Protrusion Height	92.6	2.6	b	87.1	1.9	a	91.5	3.1	b	36.458 ***
	Waist Height	104.1	2.2	c	97.2	2.2	a	102.0	3.0	b	55.692 ***
	Iliocristale Height	92.9	2.5	b	87.8	2.8	a	92.3	3.0	b	32.754 ***
	Stature	164.2	3.3	b	155.3	4.5	a	162.5	3.8	b	48.333 ***
	Thigh Height	74.6	2.8	b	70.5	2.6	a	74.5	2.8	b	23.155 ***
	Knee Height	43.7	1.6	b	41.0	1.4	a	43.4	1.9	b	24.410 ***
	Hip Height	81.0	2.5	b	76.3	4.0	a	80.2	2.7	b	22.305 ***
	Popliteal Height	39.3	1.6	b	37.3	1.5	a	39.2	1.4	b	20.875 ***
	Buttock-Knee Length	56.5	1.9	c	53.6	1.6	a	55.1	2.2	b	16.299 ***
	Thigh Vertical Length	29.4	1.6	b	27.3	1.4	a	29.3	1.7	b	18.855 ***
	Buttock-Knee Length	47.3	2.2	b	45.0	1.8	a	46.5	2.1	b	10.357 ***
	Sitting Height	87.6	2.3	b	83.8	2.4	a	87.0	2.3	b	24.587 ***
	Calf Height	30.2	1.8	b	28.4	1.8	a	30.0	1.8	b	10.395 ***
Factor3 (7)	Minimum Leg Circumference	21.5	0.8	b	20.3	0.8	a	20.0	0.9	a	28.579 ***
	Calf depth	10.8	0.5	c	10.3	0.6	b	10.0	0.6	a	16.602 ***
	Minimum Leg Breadth	5.4	0.4	b	5.0	0.2	a	4.9	0.3	a	20.146 ***
	Calf Circumference	35.8	2.0	c	33.9	1.7	b	32.8	1.7	a	29.186 ***
	Calf Breadth	10.7	0.6	c	10.2	0.6	b	9.7	0.6	a	28.229 ***
	Ankle Circumference	24.2	1.1	b	22.6	0.8	a	22.8	1.0	a	24.951 ***
Factor4 (3)	Ankle Breadth	6.6	0.4	b	6.1	0.3	a	6.1	0.3	a	20.942 ***
	Hip Breadth/Waist Breadth	1.5	0.1	a	1.5	0.1	a	1.5	0.1	a	0.995
	Hip Breadth-Waist Breadth	13.2	1.8	b	11.8	1.8	a	11.9	1.6	a	6.150 **
Factor5 (3)	Abdominal Protrusion Breadth /Waist Breadth	1.3	0.1	a	1.3	0.1	a	1.3	0.1	a	0.881
	Minimum Leg Height	10.7	1.0	a	10.3	0.9	a	10.5	1.0	a	1.305
	Lateral Malleolus Height	6.7	0.6	b	6.3	0.6	a	6.4	0.5	a	4.974 **
Medial Malleolus Height	7.8	0.7	b	7.4	0.5	a	7.7	0.6	b	3.535 *	

*p≤.05 **p≤.01 ***p≤.001

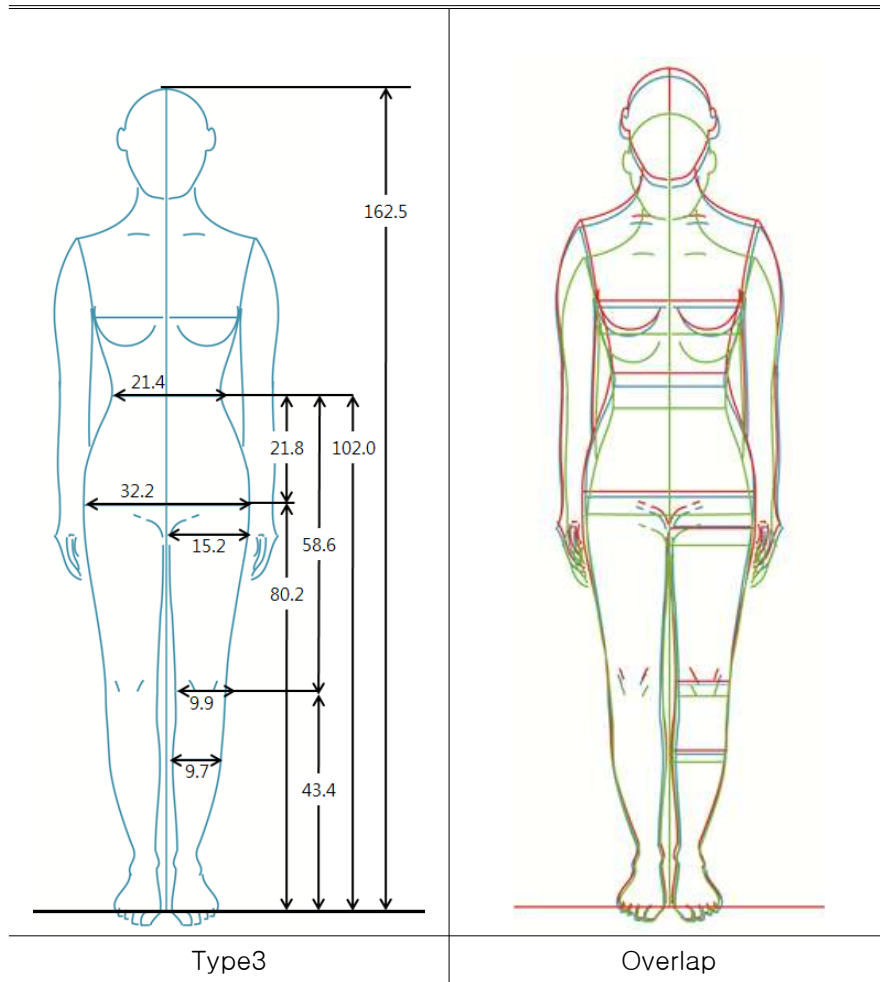
a,b,c expresses the groups that had significant differences of p≤.05 from Duncan test result.(a<b<c).

<Tab. 9> Characteristics per each types

Type(N)	Body Type Characteristics
Type1(30)	Lower body's obesity factor and horizontal size, lower body's vertical size, horizontal size from calf to the ankle are large - Tall and fat type
Type2(31)	Lower body's obesity factor and horizontal size are middle, lower body's vertical size and horizontal size from calf to the ankle are small - Shortest and a little curvy type
Type3(62)	Lower body's obesity factor and horizontal size is smallest, lower body's vertical size and horizontal size from calf to the ankle are small - Average height and the most skinny type



<Fig. 1> The front of the women in their early 20s.



<Fig. 1> Continued

IV. Conclusion

This study has a purpose to provide the lower body characteristics of the overall adult women aged 20th as a way to improve the fitness of lower clothing products such as skirts or slacks of adult women. After lower body was measured directly by the Martin instrument and doing stereotyping of these measured values, it was investigated the body types characteristics by the types by comparing the relationships between

groups. The main results of this study are as follows.

1. According to the body measurement of the women in their early 20s, the average for height is 159.8cm, Waist is 67.0cm, Hip Circumference is 91.6cm and weight is 52.0kg.

2. As a result of comparison with the 5th Korean's human body size on measurement data, 20 items out of 33 items showed significant difference. Especially, height and length showed higher significant difference,

indicating that the length of the legs became longer compared to the year of 2004. Weight has reduced by 1kg compared to the year of 2004, indicating significant difference that this is regarded as a part of cultural phenomena putting priority on diet and well-being.

3. According to the result of factor analysis for body measurement of the women in their early 20s, the factors that composes body shape are obesity and horizontal size (factor1), vertical size (factor2), horizontal size from calf to the ankle (factor3), form factor from waist to hip (factor4) and vertical size of ankle area (factor5).

4. According to the group analysis done with items showed from factor analysis result of the women in their early 20s, body types' characteristics divided into 3 types. Type1(24.4%) had tall and fat body form, type2(25.2%) had shortest and curvy body form and type3(50.4%)had average height and the most skinny body form.

With the above result, actual measurement of lower body that had similar range were divided into 3 groups and there were characteristics per each type. Therefore according to the type characteristics, it is considered to improve the pattern, size development, fit, and wear sensation.

Finally, as the objects of this study were from capital region and were university students, the result should not be generalized.

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