

A Study on the Body Characteristics of Korean Obese Women (Part II)

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Abstract

This study classified the body shapes of Korean obese women and investigated the differences of each body shape, using 2004 Size Korea data. For selecting the obesity sample, 7 obesity judgment indices were chosen through previous clothing-related studies. A total of 636 females defined as "obese" by 5 out of 7 indices were selected as subjects and 54 body measurements and obesity judgment indices were used in this study. Firstly, mean, standard deviation, minimum, and maximum values of each measurement and item were obtained from the descriptive analysis of 53 measurements. According to the descriptive analysis, all measurements and obesity judgment indices of the subjects demonstrated a serious obesity level shown by BMI 27.11, Röhler index 1.76, Vervaeck index 104.77, Relative weight 133.00, WHR 0.90, and waist circumference 86.71cm. In addition, the measurements and indices showed considerable differences between minimum and maximum values. Significant differences were identified in all measurements and items at a significant level, $p=.001$. Each distribution of body types according to age, stature, bust, and waist circumference groups was provided in this study. Secondly, factor analyses were conducted using 38 measurement items to extract the body characteristics of obese women. Factor 1 was "circumference measurements & obesity judgment indices," Factor 2 was "heights & arm-related lengths," and Factor 3 was "size and ratio of waist circumference & hip circumference." Factor 4 was "lengths in upper body," Factor 5 was "back width in upper body," Factor 6 was "side neck point to bust & bust circumference," Factor 7 was "length in lower body & arm circumferences" and Factor 8 was "neck base circumference & front width in upper body." These 8 factors explained 76.54% of the total variance. Finally, 5 body types were selected in the cluster analysis. Type 1 (with big back widths & arm circumferences) was 15.5% of the entire subjects, Type 2 (the shortest and fattest, with big upper body) was 18.8%, Type 3 (with big breast) was 27.8%, Type 4 (the tallest and longest in arm lengths, with the smallest arm circumferences and lengths in torso) was 22.5%, and Type 5 (with big hips compared to waist circumferences, smaller height and upper body) was 15.5%. Fundamental differences were identified in all measurements and items at the significant level of $p=.001$. In addition, each distribution of body type according to age, height, bust, and waist circumference groups was provided in this study.

Key words: Body shape, Body characteristics, Obese women, Obesity

I. Introduction

The rate of obesity in Korea reached its highest level, nearing one third of the entire adult population,

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according to a report by the National Health Insurance Corporation. In the case of adult females, they are getting more obese according as they get older. In the results of the National Health & Nutrition Survey, 31.7% of the 4,600 people surveyed in 2007 were considered obese. 36.2% of men fell under the category of obesity, compared to 26.3% for women (National Health Insurance Corporation, 2009).

The obesity problem in female adults is much more serious than in males. As obesity rate grows, many obese people have big difficulty to find suitable garments that fit. Recently, several apparel brands for obese women have launched as the number of obese people is increasing. There is not enough variety to choose from compared with apparel brands producing the normal-sized wears (Yi, 2009a).

Sampling method is very critical in anthropometric studies because this will determine the size and characteristics of obese subjects. Many previous studies in obesity-related fields pointed out the importance of sampling methods in studying obese people. Previous studies required much stricter criteria on judging obesity, and suggested applying two and more obesity judgment indices in obesity sampling.

In general, single or two obesity criteria were utilized for sampling obese subjects until present. However, selecting methods using 1 obesity judgment index such as Rohrer index and BMI are very common in clothing and textile research field until now.

Enhancing the efficiency and reliability of sampling method, new method that satisfied the obese condition in 5 obesity judgment indices out of frequently used 7 indices was verified in previous study (Yi, 2009b). Yi (2009b) analyzed the body characteristics of 636 Korean obese women using the new sampling method. In this research following the previous study on body characteristics of Korean obese women, same obesity sampling method with stricter standards was applied for classifying the body types in this study.

Therefore this study was carried out in order to classify the body types of Korean obese women with stricter criteria for obesity than in previous researches

in clothing fields. In designing plus-size clothes and making patterns and garments for obese women, these results were shown to be feasible data through verification of the differences among these body types.

II. Methods

1. The Subjects and Measurement Items

The age distribution of subjects used in the study was given in <Table 1>. The subjects in the study were 636 females aged from the twenties to sixties. The body measurement data were originally from the 2003-2004 Size Korea Project. 7 obesity judgment indices (Röhrer index ≥ 1.6 , Vervaeck index ≥ 94.7 , BMI ≥ 25 , Relative weight ≥ 120 , WHR ≥ 0.85 , Bust girth ≥ 91 and Waist girth ≥ 78.5), the subjects satisfying the obese condition in 5 obesity judgment indices out of these 7 indices were utilized in this study.

A total of 53 measurements and items considered as key dimensions in making garments and necessary for understanding the degree of obesity were used in this study. Measurements of items used in the study are shown in <Table 2>.

2. Statistics

First, before analyzing the measurements according to age groups, the descriptive analysis of 53 body measurements, computed values and indices was analyzed to identify the subjects' body characteristic. Mean values, standard deviation and minimum and maximum values were obtained through the descriptive analysis.

Second, factor analysis was conducted to extract the

Table 1. Subjects distribution by age groups

Age groups	Size Korea (2004)		This study	
	Frequency	%	Frequency	%
20's	692	28.5	41	6.4
30's	735	30.3	116	18.2
40's	412	17.0	104	16.5
50's	373	15.4	238	37.4
60's	213	8.8	137	21.5
Total	2425	100.0	636	100.0

Table 2. Descriptive analysis of measurements and items

Measurements	Normal-sized women (N=1,682)					Obese women (N=636)				
	Mean	SD	Min	Max	Range	Mean	SD	Min	Max	Range
Stature	157.54	5.51	140.20	176.10	35.90	153.83	5.62	136.70	176.20	39.50
Cervical Height	133.97	5.06	116.30	151.50	35.20	131.02	5.27	116.20	151.40	35.20
Hip Height	76.08	3.83	66.00	90.70	24.70	73.85	3.85	64.10	85.90	21.80
Crotch Height	70.52	3.56	60.50	85.60	25.10	67.64	3.51	57.00	78.80	21.80
Waist Height	97.58	4.29	84.50	111.20	26.70	94.25	4.33	81.60	108.00	26.40
Biacromial Breadth	35.86	1.63	30.30	40.70	10.40	36.24	1.74	29.50	45.70	16.20
Chest Breadth	27.75	1.49	20.50	32.70	12.20	29.62	1.91	25.90	36.20	10.30
Bust Breadth	27.66	1.59	23.50	33.40	9.90	30.73	2.14	26.10	40.20	14.10
Waist Breadth	24.88	1.82	19.60	31.10	11.50	28.88	2.24	23.70	38.10	14.40
Hip Breadth	32.33	1.46	27.00	38.00	11.00	33.34	1.64	29.20	38.90	9.70
Chest Depth	18.72	1.49	13.50	26.40	12.90	21.29	1.70	16.80	27.30	10.50
Bust Depth	21.73	1.87	16.80	32.10	15.30	25.68	1.94	20.60	34.30	13.70
Waist Depth	19.03	2.17	14.00	25.80	11.80	24.15	2.23	19.20	31.30	12.10
Hip Depth	21.16	1.57	15.80	26.50	10.70	23.89	2.22	17.70	33.60	15.90
Body Rise	27.05	2.00	16.60	35.90	19.30	26.60	2.38	17.20	35.10	17.90
Waist Front Length	32.45	1.98	25.50	40.10	14.60	34.00	2.48	27.00	41.30	14.30
Interscye, Front	32.36	1.75	24.30	41.20	16.90	33.31	1.78	28.20	42.00	13.80
Bust Point-Bust Point	17.53	1.69	12.80	31.00	18.20	19.22	1.83	13.70	26.20	12.50
Shoulder Length	12.63	1.08	9.50	17.20	7.70	12.60	1.01	9.50	16.70	7.20
Sceye Depth	17.12	1.53	11.40	23.20	11.80	17.66	1.53	13.10	23.20	10.10
Waist Back Length	38.22	2.22	29.00	47.50	18.50	39.01	2.78	30.80	47.60	16.80
Total Length	136.31	5.18	118.40	154.60	36.20	133.94	5.44	120.00	152.00	32.00
Biacromion Length	39.42	2.18	28.00	47.20	19.20	40.03	2.37	31.50	49.70	18.20
Back Interscye, Length	36.57	2.09	26.20	46.40	20.20	37.88	2.40	29.80	47.20	17.40
Neck Point to Breast Point	26.03	2.11	20.00	35.20	15.20	28.87	2.37	22.50	36.30	13.80
Neck Point to Breast Point to Waistline	40.24	2.12	30.50	49.00	18.50	42.15	2.55	34.80	51.40	16.60
Arm Length	52.81	2.20	46.30	60.50	14.20	52.80	2.25	45.20	59.80	14.60
Cervicale to Wrist Length	74.71	3.36	64.00	87.10	23.10	74.42	3.47	64.00	89.90	25.90
Waist to Hip Length	22.74	2.51	14.30	39.50	25.20	22.25	3.36	14.40	38.00	23.60
Outside Leg Length	98.56	4.39	86.00	113.10	27.10	95.32	4.26	82.30	110.10	27.80
Crotch Length	72.73	4.04	60.00	92.00	32.00	75.49	4.77	63.20	98.40	35.20
Neck Base Circumference	37.10	1.96	30.00	43.00	13.00	39.02	2.11	33.20	49.20	16.00
Chest Circumference	84.41	4.05	71.00	97.30	26.30	92.69	4.60	80.50	115.50	35.00
Bust Circumference	85.03	5.11	72.30	100.50	28.20	96.93	5.67	86.60	123.70	37.10
Underbust Circumference	74.54	4.18	59.90	89.20	29.30	83.66	4.64	71.80	109.70	37.90
Waist Circumference	71.97	6.03	53.50	94.80	41.30	86.71	6.29	74.20	114.20	40.00
Hip Circumference	90.89	3.88	78.30	103.10	24.80	96.05	4.88	81.30	120.70	39.40
Thigh Circumference	53.60	3.31	42.40	64.20	21.80	57.06	4.04	46.00	78.50	32.50
Knee Circumference	34.14	1.90	28.30	41.60	13.30	35.76	2.31	30.20	44.80	14.60
Calf Circumference	33.62	1.88	27.50	40.60	13.10	35.53	2.67	29.20	44.70	15.50
Minimum Leg Circumference	20.52	1.09	17.30	24.60	7.30	21.45	1.34	18.00	26.20	8.20

Table 2. Continued

Measurements	Normal-sized women (N=1,682)					Obese women (N=636)				
	Mean	SD	Min	Max	Range	Mean	SD	Min	Max	Range
Armseye Circumference	37.55	2.62	29.40	49.90	20.50	41.60	2.91	30.80	55.60	24.80
Upper Arm Circumference	26.68	2.00	21.00	33.40	12.40	30.37	2.22	23.40	41.40	18.00
Elbow Circumference	25.13	1.82	20.40	31.90	11.50	27.46	2.13	22.30	40.00	17.70
Wrist Circumference	14.91	0.76	12.60	17.80	5.20	15.92	0.82	14.10	19.10	5.00
Weight	54.38	4.92	39.10	77.00	37.90	64.30	7.51	47.80	105.80	58.00
Hip Circumference-Bust Circumference	5.86	5.02	-9.90	21.00	30.90	-0.88	5.16	-18.90	17.70	36.60
Hip Circumference-Waist Circumference	18.92	5.98	-1.00	38.30	39.30	9.34	5.99	-7.60	27.70	35.30
BMI	21.92	1.76	18.52	25.00	6.48	27.11	2.23	23.60	38.90	15.30
Röhrer Index	1.39	0.14	1.08	1.72	0.64	1.76	0.15	1.50	2.50	1.00
Vervaeck Index	88.56	5.85	75.32	103.22	27.90	104.77	6.51	95.20	138.10	42.90
Relative Weight	105.54	9.83	84.99	129.88	44.89	133.00	11.31	117.90	188.60	70.70
WHR (Waist/Hip)	0.79	0.06	0.62	1.01	0.39	0.90	0.06	0.74	1.07	0.33

body characteristics of entire group of obese women, utilizing 38 measurements and items. For factor analysis, measurements which are more relevant to make garments and analyze body characteristics were chosen out of all measurements.

Finally, cluster analysis was conducted to classify the body shapes of Korean obese women. For this procedure, correlation matrix scores derived from factor analysis were utilized. According to the cluster analysis, optimal cluster numbers were selected. ANOVA analysis and Duncan multiple range test were conducted to verify the differences among 5 body types for all measurements and values. In addition, each distribution of body types according to age, stature, bust and waist circumference groups was given in this study. These three main measurements such as stature, bust circumference, and waist circumference were selected because these are highly correlated to the obesity or used as control dimensions in apparel sizes among necessary measurements in making garments. Before the analysis, these 3 measurements were divided into 5 groups by 5cm increments.

III. Results

1. Descriptive Analysis of Measurements and Computed items

As a preliminary test, descriptive analysis of 53 mea-

surements was conducted. Mean values, standard deviations, minimum and maximum values of obese women were compared to those of normal-sized women. These results were shown in <Table 2>. Measurements of Normal-sized women in the table were also obtained from 2003-2004 Size Korea data.

The cells where the mean and range of normal sized women were bigger than those of obese women were highlighted in <Table 2>. According to the results, obese women were much bigger than normal-sized women in all measurements except in height measurements, shoulder length, total length, arm length, cervical to wrist length, waist to hip length, outside leg length and drop values.

All measurements and obesity judgment indices of the subjects showed more severe obesity level compared to normal-sized women as demonstrated by the table: BMI 27.11, Röhrer index 1.76, Vervaeck index 104.77, Relative weight 133.00, WHR 0.90 and waist circumference 86.71cm. Also, big differences between minimum and maximum values were detected in the range of measurements. Conclusively, the body characteristics of Korean obese women can be summarized as "short and stocky shapes." In particular, from two drop values, it can be determined that they had an "H" shaped body line compared to normal-sized women.

2. Factors Analysis of Body Measurements in Obese Women

Before factor analysis, main measurements more closely related to make garments and understand body characteristics for obese women were selected. To extract factors of obese women's body characteristics, factor analysis was applied using 31 direct measurements and 7 computed measurement items out of 53 measurement items. The result of factor analysis was given in <Table 3>. A total of eight factors over eigen value 1.00 were obtained by factor analysis. Each factor was renamed after its characteristics as follows: Factor 1 "circumferences and obesity," Factor 2 "heights and arm lengths," Factor 3 "the difference of hip circumference and waist circumference," Factor 4 "lengths of upper body," Factor 5 "back breadth of upper body and arm depth," Factor 6 "the location of bust point and bust circumference," Factor 7 "lengths of lower body and upper limbs' circumferences," and Factor 8 "neck base circumference and front breadths of upper body." These eight factors explained 76.54% of the total variance.

When this result was compared to results of previous studies on normal-sized women, it was verified that the differences of factor components were detected each other. It was identified that the explained variance of obese women was much higher than those of regular-sized women.

3. Body Type Classification for Obese Women

1) Body Type Classification Using Correlation Matrix Scores

To classify the body types of Korean obese women, K-means cluster analysis was applied using correlation coefficient matrix scores which were obtained from factor analysis. When determining optimal cluster numbers, 3 to 5 cluster numbers were tested step by step in analyzing cluster analysis.

The entire subjects were divided into 5 different body types. Type 3, as the most typical of Korean obese women consisted of 27.8% out of the entire subjects. Type 4 showed 22.5% of the subjects. Type 2 consisted of 18.8% of the subjects. Type 1 and

Type 5 were 15.5% each. The subjects that belong to Type 1 (15.5%) had big back widths of upper body and upper limbs. Type 2 (18.8%) was characterized by short and the highest obesity index, with big upper body. Type 3 (27.8%) showed big bust and breast drooping, while Type 4 (22.5%) had the tallest and bigger hips compared to waist but short and small upper body. Type 5 (15.5%) was characterized as having the smallest obesity indices and the highest drop values.

These results were given in <Table 4>-<Table 6>. When cluster number was set on "3", the result of ANOVA analysis using correlation coefficients was shown in <Table 4>.

In selecting cluster number as 3, the distributions of each body type were pretty much the same in all subject numbers. Significant differences of each factor among three body types were recognized at level of $p < .001$. Type 1 can be summarized as "the most sagging breast, the biggest circumferences and upper body widths, the tallest but the smallest in back widths." Type 2 can be explained as "the smallest in circumferences, heights, lengths, back widths and sagging bust but the curviest in torso shape". Type 3 was similar to Type 1 but Type 3 can be characterized by "the smallest in neck base circumference and upper body's front widths as well as the biggest in upper body's back widths and arm depth".

<Table 5> shows the result of ANOVA analysis using correlation coefficients when cluster number was fixed on "4". Significant differences among 4 body types were identified in all factors except in heights and arm lengths factor. The most popular body type was "Type 1" which had the smallest bust circumference and the least sagging breast. Type 2 was least populated in 4 body types, and it can be summarized as "the biggest in circumferences and obesity and the curviest type." Type 3 represents the body type which was the biggest in bust girth, neck base girth, and front widths of upper body. Type 4 explains the body type which had the longest upper body and lower body, and the largest back widths in upper body. However, when cluster number was fixed to "4", big differences among 4 body types were not detected. Therefore, cluster number 4 was not the optimal num-

Table 3. Factor analysis of obese women

	1	2	3	4	5	6	7	8
BMI	0.872	-0.066	0.286	0.085	0.146	0.285	0.038	0.000
Relative Weight	0.798	-0.388	0.359	-0.017	0.050	0.198	0.003	0.013
Hip Circumference	0.789	0.311	-0.197	0.170	0.161	0.161	0.089	0.040
Röhrer Index	0.777	-0.428	0.362	-0.020	0.044	0.200	-0.007	0.008
Calf Circumference	0.738	0.361	-0.202	0.147	0.168	0.017	-0.060	-0.001
Vervaeck Index	0.733	-0.003	0.475	0.113	0.106	0.435	0.001	-0.012
Knee Circumference	0.721	0.371	-0.158	0.126	-0.020	-0.126	0.146	0.043
Thigh Circumference	0.719	0.264	-0.362	0.151	0.060	0.009	0.044	-0.010
Upper Arm Circumference	0.710	0.154	0.100	0.243	0.103	0.117	0.278	-0.044
Minimum Leg Circumference	0.653	0.208	-0.079	0.134	0.167	-0.186	0.142	0.115
Chest Circumference	0.538	0.358	0.371	0.178	0.209	0.386	0.008	-0.132
Crotch Height	0.041	0.887	-0.127	0.113	0.151	0.029	-0.007	0.014
Cervical Height	0.141	0.864	-0.162	0.231	0.240	0.178	0.094	-0.014
Stature	0.141	0.861	-0.210	0.241	0.224	0.178	0.098	-0.009
Waist Height	0.077	0.856	-0.235	-0.134	0.214	0.182	0.119	0.040
Arm Length	0.103	0.844	0.163	0.109	-0.067	-0.145	0.086	0.046
Cervicale to Wrist Length	0.225	0.748	-0.045	0.228	0.149	-0.043	0.035	-0.023
WHR (Waist/Hip)	-0.078	-0.155	0.954	0.106	-0.037	0.007	-0.014	0.021
Hip Circumference-Waist Circumference	0.127	0.176	-0.947	-0.091	0.049	0.002	0.020	-0.014
Hip Circumference-Bust Circumference	0.179	0.034	-0.761	-0.029	0.040	-0.440	0.098	0.065
Waist Circumference	0.490	0.073	0.756	0.220	0.077	0.123	0.050	0.045
Waist Front Length	0.245	0.139	0.188	0.818	0.027	0.170	-0.036	0.069
Neck Point to Breast Point to Waistline	0.243	0.204	0.146	0.770	0.117	0.275	-0.009	0.078
Waist Back Length	0.231	0.314	0.068	0.753	0.158	0.038	-0.072	-0.121
Shoulder Length	0.076	0.119	-0.097	0.053	0.820	-0.037	0.116	0.126
Biacromion Length	0.221	0.316	0.033	0.075	0.718	0.091	-0.040	-0.261
Back Interscye, Length	0.280	0.337	0.074	0.013	0.591	0.191	-0.090	-0.439
Scye Depth	0.068	0.137	0.002	0.394	0.422	-0.024	0.225	0.130
Neck Point to Breast Point	0.202	0.09	0.183	0.328	0.023	0.680	0.078	0.029
Bust Circumference	0.512	0.235	0.530	0.173	0.101	0.543	-0.014	-0.026
Waist to Hip Length	-0.065	-0.015	-0.214	-0.120	0.095	0.033	0.707	0.086
Elbow Circumference	0.432	0.181	0.129	-0.001	-0.063	-0.044	0.516	-0.149
Crotch Length	0.260	0.134	-0.157	-0.472	0.193	0.252	0.493	0.118
Wrist Circumference	0.443	0.136	0.237	0.202	0.157	-0.054	0.455	0.070
Armscye Circumference	0.398	0.22	0.251	0.277	-0.019	0.001	0.424	-0.166
Neck Base Circumference	0.268	0.236	0.200	0.125	-0.051	0.222	0.243	-0.512
Bust Point-Bust Point	0.207	0.163	0.198	0.061	-0.126	0.181	0.108	0.477
Interscye, Front	0.236	0.283	0.061	0.183	0.428	0.002	0.129	0.461
Eigen Value	7.920	6.170	5.400	3.040	2.440	1.980	1.760	1.150
Explained Variance	20.300	15.820	13.850	7.790	6.240	5.080	4.500	2.950
Cumulative Variance	20.300	36.120	49.980	57.770	64.010	69.090	73.590	76.540

Table 4. ANOVA analysis using correlation coefficients for selecting optimal cluster number (cluster=3)

Factor name	Type 1 (N=216)		Type 2 (N=218)		Type 3 (N=202)		F-value
	Mean	SD	Mean	SD	Mean	SD	
circumferences and obesity	0.207A	1.061	-0.491B	0.706	0.304A	1.007	45.185***
heights and arm lengths	0.129A	1.061	-0.160B	0.949	0.034A	0.966	4.699***
the difference of hip circumference and waist circumference	-0.104B	1.049	0.252A	0.856	-0.159B	1.040	10.843***
lengths of upper body	0.364A	0.873	-0.769B	0.793	0.436A	0.829	139.138***
back width of upper body and arm depth	-0.640C	0.875	0.116B	0.877	0.558A	0.861	100.378***
the location of bust point, and bust circumference	0.263A	1.004	-0.310C	1.024	0.052B	0.876	18.934***
lengths of lower body and upper limb circumferences	-0.302B	0.856	-0.244B	0.891	0.584A	1.005	59.685***
neck base circumference and front widths of upper body	0.684A	0.914	-0.188B	0.784	-0.526C	0.883	109.640***

*** $p < .001$ **Table 5. ANOVA analysis using correlation coefficients for selecting optimal cluster number (cluster=4)**

Factor name	Type 1 (N=231)		Type 2 (N=94)		Type 3 (N=196)		Type 4 (N=115)		F-value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
circumferences and obesity	-0.248BC	0.671	1.601A	0.905	-0.392C	0.750	-0.114B	0.747	166.610***
heights and arm lengths	0.094	1.016	-0.243	1.042	-0.001	0.949	0.006	0.995	2.498 ^{NS}
the difference of hip circumference and waist circumference	-0.096BC	0.855	0.781A	0.994	-0.284C	0.961	0.053B	1.030	27.623***
lengths of upper body	-0.308C	0.930	-0.028B	1.005	-0.000B	0.962	0.658A	0.847	26.368***
back width of upper body and arm depth	-0.081B	0.908	-0.277B	0.997	-0.300B	0.884	0.905A	0.847	47.811***
the location of bust point, and bust circumference	-0.801D	0.682	0.269B	0.984	0.789A	0.706	0.072C	0.740	163.200***
lengths of lower body and upper limb circumferences	-0.302B	0.886	-0.192B	0.861	-0.089B	0.842	0.933A	1.037	50.981***
neck base circumference and front widths of upper body	-0.178B	0.858	-0.319B	1.048	0.457A	1.014	-0.161B	0.949	21.931***

*** $p < .001$, NS: no significance

ber in classifying the body types of Korean obese women.

<Table 6> shows the result of cluster analysis when cluster number was set on "5".

Significant differences of 5 clusters were identified by 8 factors at $p < .001$ level. The entire subjects were divided into 5 different body types. Type 3, as the most typical of Korean obese women consisted of 27.8% out of the entire subjects. Type 4 showed 22.5% of the subjects. Type 2 consisted of 18.8% of the subjects. Type 1 and Type 5 were 15.5% each. The subjects that belong to Type 1 (15.5%) had big back widths of upper body and upper limbs. Type 2 (18.8%) was characterized by short and the highest obesity index, with big upper body. Type 3 (27.8%) showed

big bust and breast drooping, while Type 4 (22.5%) had the tallest and bigger hips compared to waist but short and small upper body. Type 5 (15.5%) was characterized as having the smallest obesity indices and the highest drop values.

2) Body Classification Using Direct Measurements and Items

According to the cluster analysis applying results of factor analysis, 3 or 5 cluster numbers can be suggested as optimal cluster numbers, because these showed the biggest differences among all correlation coefficients. Cluster number 3 and 5 were selected as the best criterion for body classification in the first step. Therefore, one more step was needed for select-

Table 6. ANOVA analysis using correlation coefficients for selecting optimal cluster number (cluster=5)

Factor name	Type 1 (N=97)		Type 2 (N=121)		Type 3 (N=177)		Type 4 (N=144)		Type 5 (N=97)		F-value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
circumferences and obesity	-0.162C	0.735	0.862A	1.096	-0.346C	0.822	0.242B	0.923	-0.618D	0.653	51.760***
heights and arm lengths	0.182B	0.855	-0.389C	0.934	-0.435C	0.750	1.039A	0.763	-0.438C	0.722	87.094***
the difference of hip circumference and waist circumference	-0.346C	0.927	0.394A	1.060	-0.006B	1.045	-0.384C	0.918	0.436A	0.612	19.335***
lengths of upper body	0.363B	0.824	0.644A	0.884	0.244B	0.869	-0.380C	0.808	-1.032D	0.736	70.646***
back width of upper body and arm depth	0.676A	0.930	-0.061B	1.008	0.083B	0.932	-0.521C	0.898	0.005B	0.894	24.189***
the location of bust point, and bust circumference	-0.012BC	0.797	-0.175C	0.941	0.555A	0.889	0.125B	0.875	-0.095D	0.855	47.907***
lengths of lower body and upper limb circumferences	1.266A	0.962	-0.457D	0.822	-0.345CD	0.745	-0.140C	0.761	0.114B	0.889	75.646***
neck base circumference and front widths of upper body	0.047B	0.917	0.785A	1.039	-0.728C	0.843	0.058B	0.787	0.220B	0.640	58.025***

*** $p < .001$

ing the best cluster number. In this study, body classification method using direct measurements and items were proposed for verifying the optimal cluster number.

These results were illustrated in <Table 7>-<Table 8>. When cluster numbers was fixed on “3”, the result of ANOVA analysis using direct measurements and items was shown in <Table 7>. All measurements and other computed measurement items showed significant differences among 3 body types. From a view-

point of significance level, body rise and drop value (hip circumference-bust circumference) showed significant differences at level $p < .05$ and $p < .01$ respectively, while all other measurements were significantly different at level $p < .001$.

<Table 8> indicates the result of ANOVA analysis using direct measurements and items when cluster numbers was decided to “5”.

Significant differences among 5 body types were identified in all measurements and other computed

Table 7. ANOVA analysis using measurements for selecting optimal cluster number (cluster=3)

Measurement item	Type 1 (N=216)		Type 2 (N=218)		Type 3 (N=202)		F-value
	Mean	SD	Mean	SD	Mean	SD	
Stature	154.51B	5.24	151.05C	5.47	156.09A	4.63	52.66***
Cervical Height	131.60B	4.90	128.50C	5.31	133.09A	4.27	48.39***
Hip Height	74.46B	3.76	72.46C	4.02	74.68A	3.27	9.45***
Crotch Height	68.04A	3.45	66.62B	3.53	68.35A	3.30	22.92***
Waist Height	94.33A	4.39	93.34B	4.57	95.16A	3.71	15.14***
Biacromial Breadth	35.52C	1.69	36.10B	1.49	37.11A	1.57	52.94***
Chest Breadth	29.51B	1.68	28.99C	1.93	30.37A	1.79	30.83***
Bust Breadth	31.16A	1.86	29.68B	2.31	31.36A	1.81	43.74***
Waist Breadth	29.37A	2.14	27.80B	1.97	29.48A	2.19	41.98***
Hip Breadth	33.73B	1.54	32.33C	1.38	34.02A	1.43	81.02***
Chest Depth	21.51A	1.61	20.63B	1.58	21.74A	1.67	27.64***
Bust Depth	26.01A	1.96	24.94B	1.72	26.11A	1.92	25.54***
Waist Depth	24.25A	2.30	23.57B	1.93	24.62A	2.28	12.45***

Table 7. Continued

Measurement item	Type 1 (N=216)		Type 2 (N=218)		Type 3 (N=202)		F-value
	Mean	SD	Mean	SD	Mean	SD	
Hip Depth	24.08B	1.89	22.86C	2.12	24.72A	2.21	43.37***
Body Rise	26.29B	2.48	26.72AB	2.21	26.81A	2.43	2.82*
Waist Front Length	35.06A	2.20	32.12B	1.84	34.85A	2.17	133.41***
Interscye, Front	33.49A	1.86	32.75B	1.42	33.67A	1.82	17.05***
Bust Point-Bust Point	20.10A	1.82	18.67B	1.48	18.88B	1.79	43.33***
Shoulder Length	12.18C	0.96	12.50B	0.83	13.16A	0.97	59.51***
Scye Depth	17.56B	1.38	16.99C	1.30	18.51A	1.49	62.82***
Waist Back Length	39.66B	2.24	37.06C	2.49	40.38A	2.40	113.00***
Total Length	134.48B	4.88	131.18C	5.66	136.38A	4.29	57.89***
Biacromion Length	38.80C	2.07	39.84B	2.26	41.46A	1.86	85.29***
Back Interscye, Length	36.72C	2.13	37.75B	2.32	39.19A	2.03	67.66***
Neck Point to Breast Point	29.59A	2.20	27.48B	2.20	29.58A	2.08	66.50***
Neck Point to Breast Point to Waistline	43.15A	2.27	40.21B	1.93	43.16A	2.22	133.14***
Arm Length	53.14A	2.31	52.29B	2.01	52.97A	2.30	8.78***
Cervicale to Wrist Length	74.62B	3.26	73.22C	3.29	75.44A	3.33	24.33***
Waist to Hip Length	21.62B	2.95	22.02B	2.44	23.23A	4.29	13.24***
Outside Leg Length	95.25B	4.26	94.33C	4.47	96.50A	3.60	14.29***
Crotch Length	74.49B	4.72	75.40C	4.54	76.63A	4.89	10.65***
Neck Base Circumference	38.49B	2.04	38.51B	1.88	40.16A	1.92	49.51***
Chest Circumference	92.90B	4.24	90.69C	4.42	94.47A	4.06	41.49***
Bust Circumference	98.11A	5.54	94.42B	5.21	98.27A	5.34	34.72***
Underbust Circumference	83.78A	4.93	82.56B	3.81	84.63A	4.75	10.99***
Waist Circumference	87.42A	6.60	84.95B	4.81	87.69A	6.82	12.83***
Hip Circumference	97.09B	4.45	92.80C	3.76	98.38A	4.42	100.44***
Thigh Circumference	58.01A	3.90	54.65B	3.11	58.58A	3.78	73.14***
Knee Circumference	36.38A	2.43	34.42B	1.69	36.52A	2.05	66.99***
Calf Circumference	36.05B	2.56	34.05C	2.18	36.53A	2.49	62.48***
Minimum Leg Circumference	21.57B	1.33	20.84C	1.03	21.95A	1.31	44.23***
Armscye Circumference	41.41B	2.81	40.34C	2.24	43.07A	2.83	56.01***
Upper Arm Circumference	30.52B	2.04	28.96C	1.67	31.65A	2.03	103.22***
Elbow Circumference	27.18B	1.98	26.76C	1.73	28.51A	2.28	42.53***
Wrist Circumference	15.85B	0.78	15.56C	0.62	16.37A	0.82	61.46***
Weight	65.44B	6.16	59.49C	6.31	68.09A	6.63	100.05***
Hip Circumference-Bust Circumference	-1.02B	5.64	-1.62B	4.66	0.11A	5.10	5.99**
Hip Circumference-Waist Circumference	9.67A	6.33	7.86B	5.10	10.69A	6.16	12.39***
BMI	27.42B	2.29	26.01C	1.59	27.93A	2.18	49.56***
Röhrer Index	1.78A	0.17	1.72B	0.11	1.79A	0.15	12.47***
Vervaeck Index	105.90A	6.67	101.84B	5.15	106.58A	6.39	37.08***
Relative Weight	134.01A	12.93	129.74B	8.07	135.18A	11.29	14.38***
WHR (Waist/Hip)	0.90B	0.06	0.92A	0.05	0.89B	0.06	9.01***

** $p < .01$, *** $p < .001$

Table 8. ANOVA analysis using measurements for selecting optimal cluster number (cluster=5)

Measurement item	Type 1 (N=97)		Type 2 (N=121)		Type 3 (N=177)		Type 4 (N=144)		Type 5 (N=97)		F-value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Stature	157.11B	4.01	152.53C	5.18	152.23C	3.81	158.31A	4.34	148.52D	4.73	85.16***
Cervical Height	134.01A	3.83	129.89B	4.83	129.55B	3.66	135.07A	4.01	126.14C	4.88	83.46***
Hip Height	74.89B	3.09	73.35C	3.55	72.69C	2.97	76.91A	2.99	71.03D	4.04	73.77***
Crotch Height	69.09B	3.00	66.59C	3.20	66.27C	2.78	70.75A	2.72	65.48D	2.86	96.38***
Waist Height	96.36B	3.37	92.07C	3.86	92.55C	2.94	98.38A	3.05	91.88C	4.01	73.96***
Biacromial Breadth	37.12A	1.83	36.11BC	1.70	36.00BC	1.72	36.29B	1.68	35.78C	1.29	21.32***
Chest Breadth	30.01A	1.58	29.96A	1.85	29.83A	2.02	29.78A	1.64	28.14B	1.64	49.50***
Bust Breadth	30.84B	1.54	31.72A	2.08	30.97B	1.94	31.12B	1.58	28.36C	2.15	43.68***
Waist Breadth	28.97B	2.08	30.67A	2.12	28.68B	2.05	28.73B	1.78	27.13C	1.85	50.50***
Hip Breadth	34.07A	1.22	33.96A	1.53	32.67B	1.40	34.26B	1.33	31.74C	1.06	19.64***
Chest Depth	21.33B	1.49	21.97A	1.82	21.25B	1.65	21.51B	1.44	20.10C	1.51	26.71***
Bust Depth	25.53B	1.62	26.71A	2.19	25.87B	1.88	25.69B	1.67	24.20C	1.43	19.28***
Waist Depth	24.16B	1.90	25.54A	2.47	24.06B	2.11	23.62BC	2.02	23.31C	1.85	26.66***
Hip Depth	23.92B	1.89	25.10A	2.28	23.75B	2.01	24.09B	1.89	22.17C	2.14	17.71***
Body Rise	27.27A	2.43	25.48C	2.52	26.28B	2.17	27.63A	2.17	26.40B	2.08	42.92***
Waist Front Length	34.38B	2.09	35.84A	2.32	34.24B	2.25	33.70C	1.96	31.33D	1.52	29.50***
Interscye, Front	34.16A	1.75	34.21A	1.89	32.43C	1.60	33.34B	1.49	32.82C	1.18	19.26***
Bust Point-Bust Point	19.18C	1.73	20.29A	1.83	18.44D	1.81	19.69B	1.62	18.69D	1.25	19.66***
Shoulder Length	13.46A	1.01	12.58B	0.95	12.45BC	0.93	12.24C	0.94	12.56B	0.77	25.96***
Scoye Depth	18.66A	1.35	18.11B	1.48	17.52C	1.55	17.38C	1.39	16.80D	1.14	60.93***
Waist Back Length	39.76AB	2.42	40.52A	2.46	39.34BC	2.32	39.02C	2.38	35.78D	2.17	47.23***
Total length	137.17A	3.95	132.89B	4.71	132.69B	3.80	137.95A	4.28	128.50C	5.32	12.70***
Biacromion Length	41.04A	2.12	39.78B	2.36	40.26B	2.28	39.99B	2.32	38.81C	2.13	14.16***
Back Interscye, Length	38.34A	2.05	37.33B	2.50	38.49A	2.23	38.08A	2.26	36.56C	2.39	29.01***
Neck Point to Breast Point	29.41A	2.04	29.62A	2.14	29.58A	2.34	28.66B	2.01	26.44C	1.86	65.51***
Neck Point to Breast Point to Waistline	42.76B	2.26	43.84A	2.42	42.52B	2.22	41.83C	1.92	39.29D	1.81	48.51***
Arm Length	53.20B	2.22	52.61B	2.08	51.68D	2.09	54.54A	1.83	52.08D	1.53	42.69***

***p<.001

Table 8. Continued

Measurement item	Type 1 (N=97)		Type 2 (N=121)		Type 3 (N=177)		Type 4 (N=144)		Type 5 (N=97)		F-value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Cervicale to Wrist Length	75.26B	3.19	74.42B	3.11	73.28D	3.15	76.78A	2.85	72.08E	2.73	17.83***
Waist to Hip Length	25.64A	4.78	20.56C	2.76	21.19C	2.51	22.54B	2.25	22.53B	2.33	93.54***
Outside Leg Length	97.72B	3.37	93.08CD	3.64	93.79C	2.95	99.15A	3.19	92.88D	3.81	34.04***
Crotch Length	77.94A	4.83	73.60C	4.59	73.97C	4.23	76.91AB	4.55	75.98B	4.49	7.71***
Neck Base Circumference	39.40A	1.98	38.59B	2.35	39.54A	2.03	39.50A	1.88	37.60C	1.49	32.79***
Chest Circumference	92.87B	3.10	94.31A	5.20	92.81B	4.22	93.79AB	3.59	88.46C	4.05	36.50***
Bust Circumference	96.32B	3.99	99.96A	6.49	97.44B	5.17	97.60B	4.64	91.79C	4.63	12.92***
Underbust Circumference	83.53B	3.88	85.76A	5.58	83.23B	4.50	83.89B	4.13	81.51C	3.55	31.72***
Waist Circumference	85.84B	5.27	91.95A	6.98	85.71B	6.03	85.25B	5.30	84.81B	4.17	36.10***
Hip Circumference	97.44B	3.65	98.88A	4.55	94.35C	4.23	98.08AB	4.10	91.24D	3.31	44.60***
Thigh Circumference	57.72B	3.23	58.59AB	4.04	55.77C	3.43	59.10A	3.92	53.79D	2.67	34.82***
Knee Circumference	36.24B	1.86	36.78A	2.25	34.61C	1.87	37.01A	2.31	34.26C	1.45	66.38***
Calf Circumference	35.87B	2.28	36.88A	2.49	34.61C	2.05	36.97A	2.48	33.04D	1.69	38.13***
Minimum Leg Circumference	21.89B	1.24	22.18A	1.38	20.79C	1.10	21.76A	1.19	20.80D	0.94	46.53***
Armscye Circumference	43.26A	3.21	42.11C	2.88	41.01C	2.72	41.55B	2.58	40.28D	2.06	39.32***
Upper Arm Circumference	31.21A	2.08	31.61A	2.36	29.80B	1.97	30.58B	1.90	28.60C	1.43	10.91***
Elbow Circumference	28.50A	2.59	27.53B	2.40	26.81C	1.70	27.63B	1.98	27.25BC	1.76	35.51***
Wrist Circumference	16.51A	0.85	16.23B	0.85	15.57D	0.68	15.89C	0.68	15.59D	0.64	47.85***
Weight	66.57A	5.36	67.55A	7.29	62.34B	5.42	67.77A	6.20	56.26C	6.10	70.18***
Hip Circumference-Bust Circumference	1.13A	4.62	-1.08C	5.32	-3.09D	5.42	0.48AB	5.03	-0.55BC	3.75	15.38***
Hip Circumference-Waist Circumference	11.60A	5.49	6.94C	5.91	8.63B	5.99	12.83A	5.51	6.43C	3.51	94.32***
BMI	1.72C	0.11	1.91A	0.19	1.77B	0.12	1.71C	0.12	1.71C	0.09	31.73***
Röhrer Index	103.67B	4.54	109.84A	7.78	104.94B	5.41	104.45B	5.31	99.61C	4.75	48.35***
Vervaeck Index	26.95B	1.58	29.02A	2.60	26.88B	1.77	27.01B	1.85	25.44C	1.60	47.10***
Relative Weight	129.64C	7.87	143.47A	14.31	132.79B	9.07	129.29C	9.15	128.89C	7.02	44.16***
WHR (Waist/Hip)	0.88C	0.05	0.93A	0.06	0.91B	0.06	0.87C	0.05	0.93A	0.04	54.09***

*** $p < .001$

measurement items at level $p < .001$.

Conclusively, an optimal cluster number was determined by cluster analysis and Duncan's multiple range tests. After trial and error where the cluster numbers were tried from 3 to 5 gradually in cluster analysis, selecting cluster number 5 as the optimal cluster number was the most reasonable because there were the biggest differences among correlation coefficients and measurements and items.

The result of ANOVA analysis using direct measurements and computed measurement items according to five body types was given in <Table 8>. In the ANOVA analysis, significant differences among five body types were examined at $p < .001$ level. The measurement characteristics of each body type were very similar to the result of ANOVA analysis using correlation coefficient matrix. Measurement characteristics depending on each body type can be summarized as follows. Type 1 consisted of the subjects having the largest back width, armscye depth, lower body lengths and upper limb circumferences while the values regarding heights, arm length, upper body length, neck base circumference, front upper body widths were the second-largest. Circumference measurements, obesity judgment indices, the difference values between waist and hip circumferences, neck point to breast point were the third-largest among all body types. Type 2 was characterized by having the highest WHR, obesity judgment indices, the difference values between waist and hip circumferences; the largest circumference measurements, upper body lengths, neck base circumference and front upper body widths. However, the subjects that belong to Type 2 showed middle-sized back upper body widths, armscye depth and these subjects were the shortest in stature, and lower body lengths with the smallest upper arm circumferences. Type 3 can be defined as the most drooped breast and the biggest bust circumference. However, these subjects had the second-biggest difference values between waist and hip circumference, upper body lengths, back upper body widths and armscye depth. On the other hand, they had the second smallest circumference measurements, obesity judgment indices, neck base circumference and front upper body's lengths. Type 4 was characterized by

having the longest height measurements and arm length while its circumference measurements, obesity judgment indices, neck point to breast point and bust circumference were the second-biggest. These measurements of the subjects were the smallest among all types in the difference values between waist and hip circumference, back upper body widths, armscye depth, lower body lengths and arm circumference. The characteristics of Type 4 were defined as the biggest differences between waist and hip circumferences and the tallest and second-smallest circumferences, obesity judgment indices. The stature of Type 5 was determined to be the shortest, and most measurements and obesity judgment indices were the smallest. On the contrary, WHR was the second-highest among all types. This results from waist circumference being much larger than hip circumference.

<Table 9> indicates the body type distribution by age groups and stature groups. In case of the stature groups, the total numbers ($n=636$) of subjects was not same as original subject numbers, because some rarely distributed cells were omitted from statistic processing. The most frequently observed cells in each group were highlighted in <Table 9>. In cases of age groups, many subjects in their twenties and thirties belong to Type 4 with the tallest and bigger hips but short and small upper body. Many subjects in their forties and fifties belong to Type 3, having big bust and sagging breast. Subjects in their fifties were highly distributed in Type 5, having the lowest obesity and the highest drop values. However, many subjects in their sixties were included in Type 2, having short heights and the highest obesity index with big upper body.

According to the analysis on body type distribution by stature groups, differences among stature groups were distinct. 145 stature group was characterized by "the lowest obesity and the highest drop values," 150 and 155 groups were frequently found in big bust & sagging breast type. 160 and 165 groups mostly belong to Type 4: the tallest and bigger hips but short and small upper body.

The body type distribution by bust circumference and waist circumference groups was shown in <Table 10>. In case of the stature groups, the total numbers

Table 9. Body type distribution by age and stature groups

Body type	Body type specification	Stat.	Age groups					Total	Stature groups					Total
			20's	30's	40's	50's	60's		145	150	155	160	165	
Type 1 (N=97)	big back widths of upper body & big upper limbs	Freq %	3 0.5%	19 3.0%	14 2.2%	34 5.4%	27 4.3%	97 15.3%	0 0.0%	9 1.5%	47 7.6%	28 4.5%	12 1.9%	96 15.6%
Type 2 (N=118)	short & the highest obesity index, with big upper body	Freq %	8 1.3%	14 2.2%	17 2.7%	43 6.8%	39 6.2%	121 19.0%	11 1.8%	43 7.0%	41 6.7%	14 2.3%	4 0.6%	113 18.3%
Type 3 (N=174)	big bust & breast drooping	Freq %	8 1.3%	38 6.0%	36 5.7%	60 9.6%	35 5.5%	177 27.8%	17 2.8%	78 12.7%	63 10.2%	15 2.4%	0 0.0%	173 28.1%
Type 4 (N=141)	the tallest & bigger hips but short and small upper body	Freq %	22 3.5%	42 6.7%	27 4.3%	41 6.5%	12 1.9%	144 22.6%	2 0.3%	10 1.6%	43 7.0%	66 10.7%	17 2.8%	138 22.4%
Type 5 (N=97)	the lowest obesity & the highest drop values	Freq %	2 0.3%	2 0.3%	10 1.6%	59 9.4%	24 3.8%	97 15.5%	42 6.8%	34 5.5%	17 2.8%	3 0.5%	0 0.0%	96 15.6%
Total		Freq %	41 6.5%	113 18.0%	102 16.3%	236 37.6%	135 21.5%	636 100.0%	72 11.7%	174 28.2%	211 34.3%	126 20.5%	33 5.4%	616 100.0%
Significance test		$\chi^2=98.39^{***}$, df=16						$\chi^2=300.29^{***}$, df=16						

*** $p<.001$

of subjects was not same as original subject numbers, because some rarely distributed cells were omitted from statistic processing. Highlighted cells mean the most frequently observed cells in each body type. Body Type 2 was the most popular in all bust circumference groups except 105 bust group. This result was pretty different from age and stature groups because distribution of the most popular body type according to bust circumference groups is deeply relevant to the degree of obesity. Subjects belong to 90 were overwhelmingly in body Type 5. In cases of 95 and 100 groups, body Type 3 was the most frequent out of all body types. Body Type 2 was the most popular in 105 bust groups. Otherwise, body Type 2 and 3 equally distributed in 110 bust group as the most frequent body type.

To verify the differences of body types among age and stature groups, χ^2 tests were tried in <Table 10>. The differences of body types among age groups were identified at $p<.001$ level. Also, the differences of body types among stature groups were recognized at $p<.001$ level.

Waist circumference is the most influential key dimension deciding the degree of obesity while bust circumference is partially correlated to the degree of obesity. Therefore, distribution of body types accord-

ing to waist circumference group showed quite differences compared to the result of bust circumference group. Subjects belong to 80 and 85 waist groups occupied in body Type 3. In cases of 90, body Type 4 was the most popular in all body types. Subjects belong to 95 and 100 waist groups mostly showed body Type 2.

To recognize the differences of body types among bust circumference and waist circumference groups, χ^2 tests were tried in <Table 10>. The statistical differences of body types by bust circumference groups were investigated at $p<.001$ level. The differences of body types by waist circumference groups were recognized at $p<.001$ level too.

IV. Conclusions

The purpose of this study was to utilize body characteristic information for making patterns and garments, based on analyzing the body measurement data for obese women in their twenties to sixties. Size Korea body measurement data of 2,425 females were used for sampling the obese subjects by obesity judgment indices. 7 obesity judgment indices frequently used in the clothing field were inspected, 636 females' measurement data defined as "obese" by over

Table 10. Body type distribution by bust and waist circumference groups

Body type	Body type specification	Stat.	Bust circumference groups					Total	Waist circumference groups					Total
			90	95	100	105	110		80	85	90	95	100	
Type 1 (N=97)	big back widths of upper body & big upper limbs	Freq %	15 2.4%	44 7.1%	31 5.0%	6 1.0%	1 0.2%	97 15.6%	29 4.8%	29 4.8%	25 4.1%	9 1.5%	3 0.5%	95 15.7%
Type 2 (N=118)	short & the highest obesity index, with big upper body	Freq %	14 2.3%	32 5.2%	35 5.6%	22 3.5%	11 1.8%	114 18.4%	7 1.2%	27 4.5%	25 4.1%	34 5.6%	17 2.8%	110 18.2%
Type 3 (N=174)	big bust & breast drooping	Freq %	30 4.8%	69 11.1%	48 7.7%	16 2.6%	11 1.8%	174 28.0%	54 8.9%	59 9.7%	28 4.6%	19 3.1%	8 1.3%	168 27.7%
Type 4 (N=141)	the tallest & bigger hips but short and small upper body	Freq %	18 2.9%	57 9.2%	46 7.4%	14 2.3%	5 0.8%	140 22.5%	40 6.6%	55 9.1%	34 5.6%	7 1.2%	1 0.2%	137 22.6%
Type 5 (N=97)	the lowest obesity & the highest drop values	Freq %	61 9.8%	21 3.4%	11 1.8%	3 0.5%	0 0.0%	96 15.5%	18 3.0%	54 8.9%	18 3.0%	5 0.8%	1 0.2%	96 15.8%
Total		Freq %	138 22.2%	223 35.9%	171 27.5%	61 9.8%	28 4.5%	621 100.0%	148 24.4%	224 37.0%	130 21.5%	74 12.2%	30 5.0%	606 100.0%
Significance test			$\chi^2=142.39^{***}$, df=16					$\chi^2=117.34^{***}$, df=16						

*** $p < .001$

5 obesity judgment indices were analyzed. 48 measurement data and 5 obesity judgment indices were used in this study. The results of the study were as follows:

The averages of the main measurements regarding obesity were BMI 27.11, Röhrer index 1.76, Vervaeck index 104.77, Relative weight 133.0 and WHR 0.90. The women in their fifties were more obese than other age groups in the obesity distribution by ages (37.4%) out of 636 subjects. The obesity distribution of women in their sixties also showed a high percentage (21.5%).

Through factor analysis on obese women's body measurements and items, eight factors of over 1.00 eigen value were extracted. Factor 1 can be summarized as "circumferences and obesity". Factor 2 can be interpreted as "heights and arm lengths". Factor 3 can be explained as "the difference of hip circumference and waist circumference". Factor 4 was on "lengths of upper body". Factor 5 can be summarized as "back width of upper body and arm depth". Factor 6 can be summarized as "the location of bust point and bust circumference". Factor 7 can be explained as "lengths of lower body & upper limbs' circumferences". Factor 8 can be interpreted as "neck base circumference & front widths of upper body". These

eight factors explained 76.54% of the total variance. The body characteristics of obese women were quite different from those of normal-sized women. It was determined that the extracted factors and components showed differences among subjects, the explanation of total variance on obese women was much higher than those of normal-sized women.

Next, five body types were selected by cluster analysis. For determining the optimal cluster numbers, 3 to 5 cluster numbers were tried step by step in analyzing cluster analysis. In this study, two different body classification method using correlation coefficients derived by factor analysis and direct measurements were proposed for verifying the optimal cluster number.

Through the two step investigations, cluster number 5 was chosen as the best criterion for body classification by cluster analysis. The subjects belong to Type 1 (15.5%) had big back widths of upper body and upper limbs. Type 2 (18.8%) was characterized by short and the highest obesity index, with big upper body. Type 3 (27.8%) showed big bust and drooping breasts, while Type 4 (22.5%) had bigger hips than waist but short and small upper body. Type 5 (15.5%) was characterized by having smallest obesity indices and the highest drop values.

Lastly, each distribution of body types according to age, height, bust and waist circumference groups was investigated. According to the results of χ^2 tests, the distribution differences of body types among age, height, bust and waist circumference groups were identified at $p < .001$ level.

Body classification methods using stricter obesity criteria were tried in this study. To determine the optimal cluster number on Korean obese women, ANOVAs of correlation coefficients and direct measurements were compared. The results on classified body types can be used in various subsequent studies such as developing block patterns for each somatotype and suggesting new apparel sizing systems.

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