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Classification of Upper Body Somatotypes according to the Age Group : Using 3D-Body Scan Data

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ABSTRACT

Two hundreds of female aged 19 years old and up were recruited to evaluate the postural changes and bilateral variation of asymmetry over age. To find out the differences among the age group, subjects were classified into 5 groups, early young age(19-29), late young age(30-39), early middle age(40-49), late middle age(50-59), and old age(60-). 35 body measurements were taken by the 3-D body scanner which allowed us to take measurements which cannot be measured using traditional methods, including the shape of a cross section, slice area surface are, and volume.

Bilateral variations were observed as a function of age; Depth of scapular point level, scapular point to center back, and blade angle. Postural change of anterior cervical angle, upper anterior thoracic angle, upper posterior thoracic angle, posterior cervical angle, and center back/center front ratio were also exhibited. In each measurements, subjects were classified into normal, and abnormal group. Percentiles of abnormal in shoulder line angle, blade angle, neck point ~acromial point ~scapular point, posterior cervical angle, and upper posterior thoracic angle were increased over age group.

The upper body of lateral view was classified into 3 types of posture based on the previous research; straight, erect(leaning back), and stooped(bent forward). The percentiles of subjects who have straight postures were decreased as a function of age, but those of stooped postures were increased. Subjects who have erect postures did not so. The stooped posture group shows the big cervical fossa angle, anterior cervical angle, posterior cervical angle, upper posterior thoracic angle, and the small upper anterior thoracic angle comparing to the straight and erect posture group.

These results could be apply for clothing construction reflecting the changes in back, shoulder, neck, and the bilateral asymmetry according to the target age group.

Key Words : 3D body scan, bilateral asymmetry, sizing system, somatotype, upper body.

Ⅰ. Introduction

Somatotype is human body shape and physique type[1] which can be classified not only by the size, but also by the shape or posture of the body[2]. The body size can be easily classified by the measurements such as length, girth, and depth of the body, but the classification by the shape or posture is not so simple since there are so many variations in the human body types. Previous studies[3][4][5] have proved that somatotype is mainly influenced by aging.

Changes of body occur with age, circumferences such as bust, waist, hip are getting bigger[6], and

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body shape variation and postural changes are shown by the curvature of the spine[7]. Researchers found that certain predictable physical changes take place as the body ages. Goldsberry and Reich[8] noted that the more obvious changes are the expansion of the waist and abdominal girth, coupled with a shortening of the spinal column. Katou and Nakaho[9] found that the lower half of the body of elderly women, especially the abdomen and hips, undergo noticeable changes as they grow older. Similarly, Le Pechoux and Ghosh[10] found that elderly women tend to become larger around the waist, hips and thighs, with spinal column curving and shortening[11].

Age-related postural changes such as a forward positioning of the shoulder in relation to spine, an increased back curvature of the spine, and a forward projection of the head and neck can affect the fit of clothing. These postural variations in the alignment of the back, shoulder, and neck can have an adverse effect on the fit of garments designed to hang from the shoulders[12].

Therefore, an understanding of body proportions and the posture resulting form age induced anatomical and physiological changes are necessary for designing clothes. Sizing system based on the subjective test measures is developed to quantify garment fit for many people as possible[13].

In general, consumers have been dissatisfied with fit associated with the fact that the current sizing system for the manufacturing of garments is only based on body measurements[14]. The problem of size and fit cause the highest number of returns to retailers. It is very hard to quantify losses related to lost sales, brand dissatisfaction, and time wasted in fitting problems, which are all indicators of the costs of fit problems[15].

To solve these problems, it is necessary to classify somatotype based on the body shape and posture according to the age group. In this study, the upper body changes that can affect the body shape and posture were studied by examining neck, shoulder, and back area measurements. Also, lateral postures were classified into three types and bilateral variations and gradual postural changes in lateral view were examined as a function of the age group. There are several studies[16],[17],[18],[19]about the lateral postures which have a limit since they focused only on a certain age range[20]. In this study, ages of test subjects were widely recruited to evaluate the gradual postural changes as a function of age.

Body measurements were taken by the new improved technology 3-D body scanner. The body scanner has the ability to save time and labor to take measurements comparing to the traditional way, obtain abundant data from the saved image of human body in any time. And another significant advantage of 3-D body scan is to take measurements which cannot be measured using traditional methods, including the shape of a cross section, slice area surface area, and volume.

This study focused on following objectives.; to classify the somatotype according to the age, provide the useful data base which truthfully reflect the different body shapes and dimensions, and develop well fitting clothing for each target market population of an apparel form. For this purpose 1) Postural changes of upper body and bilateral variation of asymmetry, 2) Distribution of normal and abnormal in each parameters, 3) Classification of upper lateral torso and the distribution were examined according to the age group.

Ⅱ. Method

1. Subjects

The test subjects for this study were two hun-

dreds of female aged 19 years old and up. They were recruited to evaluate the postural changes of upper body, bilateral variation of asymmetry, and lateral torso changes over age in Cornell university body scan research team. All subjects were free of any known disorder that could influence the posture. To find out the differences among the age group, subjects were classified into 5 groups, early young age(19-29), late young age(30-39), early middle age(40-49), late middle age(50-59), and old age(60-).

Participants wore Lycra scan suit over underwear, and a narrow elastic band was placed at their waist. They were asked to stand erect but relaxed with arms and legs abducted slightly so that the cameras in the scanner could capture the full torso.

<Table 1> Distribution of Subjects

Group	Age	Mean	Number	Percentage(%)
I. Early Young Age	19 - 29	21.7 ± 2.5	25	12.5
II. Late Young Age	30 - 39	35.7 ± 2.8	35	17.5
III. Early Middle Age	40 - 49	45.7 ± 2.7	79	39.5
IV. Late Middle Age	50 - 59	53.8 ± 2.5	48	24.0
V. Old Age	60 & Up	68.9 ± 7.0	13	6.5
Total		45.2 ± 3.5	200	100

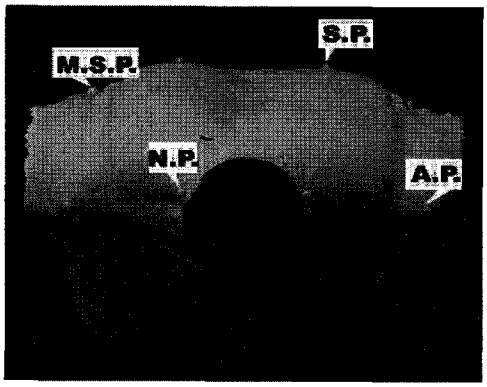
A Human Solutions VITUS/smart 3-D scanner with eight cameras and four eye-safe laser light sources was used to capture 300,000 spatial data points per scan for each participant in the study. Any missing areas in the body scan which were not captured due to body part blocking the cameras were patched to create a smoothed 3-D model for landmarks. The Polyworks software suite from Innovmetric was used for 3-D visualization and measurements of circumferences and body angles.

In a first step in the measurements, landmarks were placed with reference to definite points. In order to take these measurements reliably, landmarks<Pig. 1> were marked manually on the scan. Head and arms were removed before placing these landmarks since some landmarks are hidden by hair or arms. Figure was carefully observed by rotating and zooming in and out and checking for reliable and consistent placement of each landmark.

Neck point (N.P.) is located at the intersection of the neck and shoulder line. Acromial point (A.P.) is located by finding the point of greatest curvature before the rounding of the upper arm, and Bust point (B.P.) is the apex of the bust. Scapular point (S.P.) is the outmost point in the posterior upper torso in the sagittal view. A horizontal plane is made at this S.P., and named the S.P. level. In the transverse view of this S.P. level, Mid scapular point (M.S.P) is located by drawing a tangent line at the S.P.. These landmarks are located with reference to definite points on the body scan which can be seen and identified reliably in the scanned image.

2. Material & Method

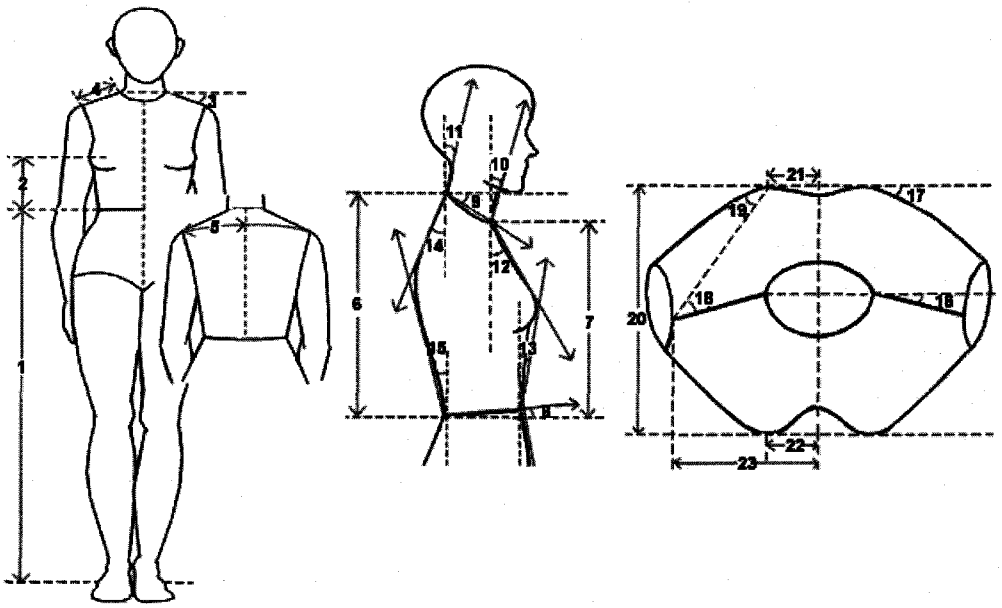
Twenty-three parameters were decided based on these landmarks<Fig. 2>. Waist height (1) is measured vertically from the waist point at the side of the body to the soles of the feet. Bust Point (B.P.) to waist (2) is the vertical distance from the level of the Bust point to the side waist point. Shoulder



<Figure 1> Landmarks in Transverse View

length (4) is measured from the side neck point to the acromial· point at the shoulder joint. 1/2 cross shoulder (5) is half of the distance across the back from one acromial point to the other. This measurement is taken on the surface of the body on a line at approximately 45 degrees that curves up to follow the curve of the body. Center back length (6) and/ Center front length (7) are vertical distances from posterior/ and anterior neck points to the waist level measured on the surface of the body.

The measurements in the frontal & back view



<Figure 2> Parameters in Frontal/Back, Sagittal, Transverse View

Frontal/Back View	Sagittal View		Transverse View	
1.Waist Height*	6.Center Back Length	11.Posterior Cervical Angle	16.Shoulder Line Angle*	20.Depth of S.P. Level*
2.B.P. to Waist*	7.Center Front Length	12.Upper Anterior Thoracic Angle	17.Blade Angle*	21.S.P. to Center Back*
3.Shoulder Slope*	8.Waist Angle	13.Lower Anterior Thoracic Angle	18.N.P.~A.P.~S.P.*	22.B.P. to Center Front
4.Shoulder Length*	9.Cervical Fossa Angle	14.Upper Posterior Thoracic Angle	19.A.P.~S.P.~M.S.P*	23.A.P. to Center Front
5.1/2 Cross Shoulder*	10.Anterior Cervical Angle	15.Lower Posterior Torso Angle		

* Measured on Left & Right Side

and the transverse view were taken on both sides of the body. Absolute values of the differences between the right and left side measurements are used to quantify the bilateral variation. Based on all these measurements, 35 body measurements were taken.

3. Classification of Lateral Posture

In this study, a modification of Yoon Ja Nam's study(1991)[21], the shape of upper lateral figure was classified into 3 types of posture. It is decided depending on where the guide line is placed.; straight, erect (leaning back), and stooped (bent forward). Guide line is a plumb line passing through the tragion. It passes through the center of the shoulder and the abdomen in the straight posture and is placed in the forward/back of the side body in the erect/stopped posture(Tab.2). Distribution and the gradual changes in lateral posture were examined according to the age group.

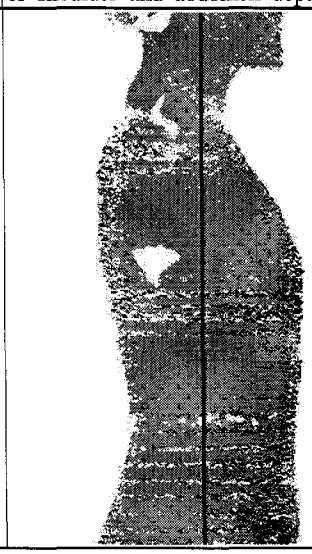
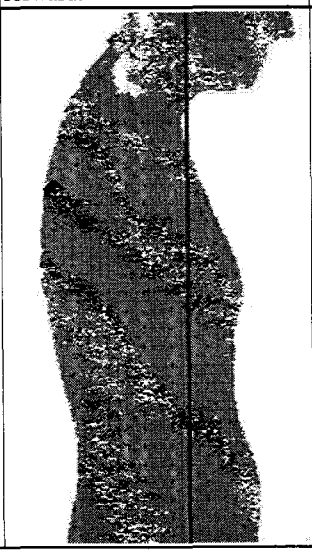
4. Analysis

Data were coded for statistical computation and analyzed using the computer program of the Statistical Package for the Social Sciences(SPSS) 11.5 for window version. Certain types of descriptive statistics such as means, medians, odes, standard deviations, coefficients of variations etc. were used to renewal some of the characteristics of the body measurements taken.

ANOVA test followed by posthoc Bonferroni t-test comparison was computed to describe the postural changes and bilateral variations as a function of age.

In each parameters, subjects were classified into normal(≤ |Mean±2SD|) and abnormal (> |Mean±2SD|)

<Table 2> Classification of Lateral Posture

Type	Straight	Stooped	Erect
Traits	Guide line* pass through the center of shoulder and abdomen depth.	Guide line is placed in forward.	Guide line is placed in backward.
Illustration			

Guide Line*; plumb line passed through tragion

and the distribution of normal and abnormal group was analyzed by chi-square analysis.

For the comparison of measurements according to lateral posture, 3-D scan data was analyzed by ANOVA. The .05 level of significance was used in the analysis of data.

Ⅲ. Results

1. Postural changes according to the age group

Mean and standard deviation of 3-D scan data according to the age group and Post hoc comparisons of group Ⅴ and the other group are as follows(Tab.3&4).

The difference between left and right tended to be greater as people ages. Bilateral differences in waist height, B.P. to waist, and A.P.~S.P.~M.S.P. were gradually increased. Shoulder line angle, B.P. to center front distance also tended to increase. Bilateral variations were ascended sharply at group 5; Depth of S.P. level, S.P. to CB, and blade angle($p<0.05$)<Fig.3-A,B,C>. CB/CF ratio was gradually increased as a function of the age group because the back is getting longer and front is getting shorter owing to the back curvature ($p<0.05$)<Fig. 3-D>. Upper posterior thoracic angle was significantly increased owing to the rounded back and upper anterior thoracic angle was significantly decreased at the group 5($p<0.05$)<Fig.3-E,F>. Along with the back curvature, the neck and head are tilted forward. Gradual postural change of anterior cervical angle was observed and posterior cervical angle was significantly increased at the group5($p<0.05$)<Fig.3-G,H>. The turning point was observed in the group age 60 & up which shows the greater asymmetries in the body configuration of the elderly women.

<Table 3> Mean & Standard Deviation of 3-D Scan Data According to the Age Group

	Parameter	Group / M SD	Group I M	Group I SD	Group II M	Group II SD	Group III M	Group III SD	Group IV M	Group IV SD	Group V M	Group V SD	F	Sig. (*p<0.05)
FRONTAL	1.Waist Height(cm)	L	1050.83	62.92	1025.27	45.65	1014.89	47.17	1013.88	56.53	1032.35	47.01	3.238	.013*
		R	1050.26	63.10	1027.32	46.11	1017.82	46.12	1018.26	54.64	1036.78	47.30	2.707	.031*
		L~R	2.47	2.67	4.70	4.42	5.68	5.39	7.64	6.68	9.97	12.49	5.554	.000*
	2.B.P. to Waist(cm)	L	128.16	21.01	148.09	25.35	142.64	21.79	128.11	23.42	109.06	29.80	11.185	.000*
		R	128.41	21.20	147.43	26.27	144.21	21.85	129.92	23.24	108.92	32.01	10.849	.000*
		L~R	2.74	2.78	3.53	3.49	3.76	4.04	4.94	4.72	7.15	5.64	3.707	.006*
	3.Shoulder Slope(°)	L	20.73	3.39	21.34	3.77	22.85	4.21	22.94	4.35	22.46	5.27	2.255	.064
		R	20.72	3.73	22.09	3.56	23.52	4.29	23.85	4.12	23.31	5.39	3.691	.006*
		L~R	0.77	1.25	2.00	2.81	2.39	1.96	2.38	2.65	2.38	1.85	3.507	.009*
	4.Shoulder Length(cm)	L	109.86	10.66	116.13	13.93	117.17	12.47	114.52	11.47	103.73	14.50	4.970	.001*
		R	112.46	10.37	115.87	13.30	117.63	12.07	115.89	10.44	106.44	15.91	3.272	.013*
		L~R	6.18	4.50	3.00	3.39	3.22	2.90	6.25	4.40	7.24	9.46	7.370	.000*
	5.1/2 Cross Shoulder(cm)	L	185.44	11.57	199.00	15.06	204.51	16.85	198.01	15.71	188.69	17.84	9.164	.000*
		R	187.82	11.80	198.94	16.34	203.97	16.67	199.05	12.68	190.88	18.83	6.851	.000*
		L~R	5.54	5.76	1.91	2.17	4.39	4.94	6.60	5.58	7.95	7.55	5.871	.000*
SAGITTAL	6/7.CB/CF Ratio		1.14	0.04	1.16	0.05	1.17	0.06	1.18	0.04	1.20	0.05	4.516	.002*
	8.Waist Angle(°)		6.03	4.05	4.03	3.17	4.41	3.54	4.53	3.85	4.40	4.19	1.520	.198
	9.Cervical Fossa Angle(°)		25.94	6.53	29.31	6.49	30.04	6.96	29.31	7.38	29.13	6.72	2.009	.095
	10.Anterior Cervical Angle(°)		14.45	6.05	19.37	6.95	20.66	7.59	25.10	10.56	31.47	15.94	12.602	.000*
	11.Posterior Cervical Angle(°)		16.06	6.40	16.54	6.49	14.67	6.06	16.98	7.94	22.47	11.22	3.989	.004*
	12.Upper Anterior Thoracic Angle(°)		31.82	5.07	28.60	6.98	29.33	6.97	29.21	7.08	23.31	6.70	3.831	.005*
	13.Lower Anterior Torso Angle(°)		7.50	5.44	8.49	4.72	7.25	4.30	7.25	5.16	7.69	8.35	.408	.803
	14.Upper Posterior Thoracic Angle(°)		30.10	5.94	35.51	5.76	34.58	7.18	36.23	6.44	43.54	9.43	9.739	.000*
	15.Lower Posterior Torso Angle(°)		13.38	4.38	11.63	4.64	11.53	3.78	11.63	3.96	11.46	5.49	1.337	.257
TRANSVERSE	16.Shoulder Line Angle(°)	L	6.32	4.45	8.94	4.27	11.28	4.95	9.12	3.89	10.05	6.50	6.777	.000*
		R	7.34	4.59	8.51	3.99	11.75	5.05	9.36	5.34	8.99	7.74	5.416	.000*
		L~R	3.40	2.26	2.31	1.95	2.35	2.29	3.89	4.87	4.88	3.91	3.507	.009*
	17.Blade Angle(°)	L	14.64	4.80	17.20	5.05	16.68	5.70	17.33	6.43	15.33	4.84	1.413	.231
		R	15.14	6.54	19.05	7.04	20.97	7.05	22.97	7.35	31.58	8.41	13.939	.000*
		L~R	4.05	3.68	5.01	4.91	6.23	4.93	7.63	5.84	16.46	9.85	13.767	.000*
	18.N.P.~A.P.~S.P.(°)	L	43.47	8.40	42.24	7.55	41.41	6.67	45.59	5.56	46.43	6.08	3.721	.006*
		R	42.76	6.72	44.77	8.40	45.00	8.32	47.82	6.44	51.45	8.36	4.135	.003*
		L~R	4.16	4.11	3.48	2.60	4.14	5.34	4.27	2.83	6.19	4.09	.994	.412
	19.A.P.~S.P.~M.S.P.(°)	L	33.73	4.86	35.29	5.53	37.09	5.93	36.85	4.41	36.63	5.91	2.621	.036*
		R	34.28	4.98	36.58	6.75	37.12	8.16	34.77	5.67	33.38	3.98	1.955	.103
		L~R	3.21	3.20	3.93	3.85	4.27	5.26	5.20	3.78	6.50	5.00	1.801	.130
	20.Depth of S.P. Level(cm)	L	217.54	27.17	214.15	26.34	215.47	25.75	218.79	31.62	218.42	25.92	.205	.935
		R	216.26	27.61	212.65	27.02	212.56	23.75	216.39	31.47	222.20	19.29	.554	.696
		L~R	3.98	3.26	5.78	5.75	5.74	3.76	5.81	4.75	9.12	7.95	3.034	.019*
	21.S.P. to CB(cm)	L	69.54	9.75	71.74	10.06	72.78	10.49	73.02	11.07	67.92	11.35	1.203	.311
		R	71.68	11.53	75.08	11.87	78.66	10.42	78.54	9.98	79.68	13.74	2.765	.029*
		L~R	7.82	5.78	6.81	6.16	8.73	6.26	8.28	6.83	14.72	12.93	3.589	.007*
	22.B.P. to CF(cm)	L	97.64	12.89	102.88	13.24	108.38	11.73	108.86	13.40	106.85	11.68	5.332	.000*
		R	95.44	11.06	99.13	12.04	100.36	11.66	102.79	12.74	101.44	11.76	1.930	.107
		L~R	8.47	8.59	6.09	5.22	9.86	6.97	8.87	7.22	9.28	6.02	1.797	.131
	23.A.P. to CF(cm)	L	160.94	9.91	163.76	12.44	167.06	12.02	162.40	11.43	158.44	13.10	2.933	.022*
		R	161.23	10.82	160.98	11.91	162.39	11.03	160.47	11.36	152.35	7.84	2.633	.035*
		L~R	8.03	6.30	7.36	4.89	7.24	5.46	9.84	8.66	10.49	8.28	1.776	.135

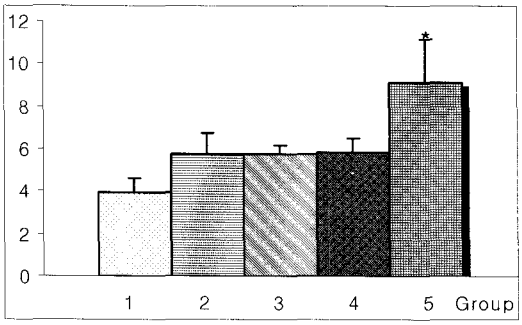
Group Ⅰ; Early Young Age(19-29) / Group Ⅱ; Late Young Age(30-39) / Group Ⅲ; Early Middle Age(40-49) / Group Ⅳ; Late Middle Age(50-59) / Group Ⅴ; Old Age(60& Up).

<Table 4> Post Hoc Comparisons of Group V and the other group

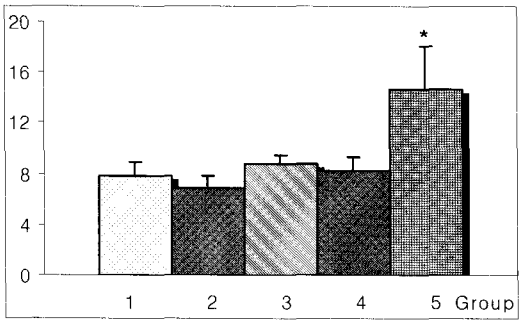
	Group / Parameter		Group V (*p<0.05)			
			Group I	Group II	Group III	Group IV
FRONTAL	1. Waist Height(cm)	L	.258	.658	.233	.228
		R	.402	.549	.189	.221
		L~R	.000*	.005*	.013*	.193
	2. B.P. to Waist(cm)	L	.010*	.000*	.000*	.006*
		R	.010*	.000*	.000*	.003*
		L~R	.001*	.005*	.004*	.070
	3. Shoulder Slope(°)	L	.205	.405	.755	.713
		R	.058	.363	.864	.672
		L~R	.027*	.593	.991	.989
	4. Shoulder Length(cm)	L	.117	.001*	.000*	.004*
		R	.112	.012*	.001*	.008*
		L~R	.438	.002*	.001*	.442
	5. 1/2 Cross Shoulder(cm)	L	.519	.036*	.000*	.046*
		R	.534	.091	.003*	.072
		L~R	.142	.000*	.014*	.369
SAGITTAL	6/7.CB/CF Ratio		.000*	.013*	.043*	.111*
	8. Waist Angle(°)		.157	.744	.996	.905
	9. Cervical Fossa Angle(°)		.143	.932	.642	.933
	10. Anterior Cervical Angle(°)		.000*	.000*	.000*	.016*
	11. Posterior Cervical Angle(°)		.005*	.008*	.000*	.010*
	12. Upper Anterior Thoracic Angle(°)		.000*	.016*	.003*	.005*
	13. Lower Anterior Torso Angle(°)		.908	.631	.773	.781
	14. Upper Posterior Thoracic Angle(°)		.000*	.000*	.000*	.001*
	15. Lower Posterior Torso Angle(°)		.161	.902	.955	.901
TRANSVERSE	16. Shoulder Line Angle(°)	L	.016*	.464	.377	.524
		R	.329	.773	.072	.819
		L~R	.158	.013*	.008*	.317
	17. Blade Angle(°)	L	.711	.304	.423	.254
		R	.000*	.000*	.000*	.000*
		L~R	.000*	.000*	.000*	.000*
	18. N.P.~A.P.~S.P.(°)	L	.192	.061	.015*	.696
		R	.001*	.008*	.006*	.134
		L~R	.145	.048*	.104	.145
	19. A.P.~S.P.~M.S.P.(°)	L	.105	.445	.775	.892
		R	.689	.147	.066	.512
		L~R	.026*	.076	.095	.350
	20. Depth of S.P. Level(cm)	L	.919	.616	.704	.964
		R	.479	.246	.200	.460
		L~R	.001*	.022*	.011*	.018*
	21. S.P. to CB(cm)	L	.623	.240	.102	.102
		R	.022*	.289	.742	.725
		L~R	.002*	.000*	.003*	.002*
	22. B.P. to CF(cm)	L	.021*	.306	.666	.588
		R	.110	.529	.747	.702
		L~R	.712	.141	.770	.845
	23. A.P. to CF(cm)	L	.500	.144	.010*	.255
		R	.011*	.012*	.001*	.013*
		L~R	.237	.126	.081	.738

Group Ⅰ; Early Young Age(19-29) / Group Ⅱ; Late Young Age(30-39) / Group Ⅲ; Early Middle Age(40-49) / Group Ⅳ; Late Middle Age(50-59) / Group Ⅴ; Old Age(60& Up).

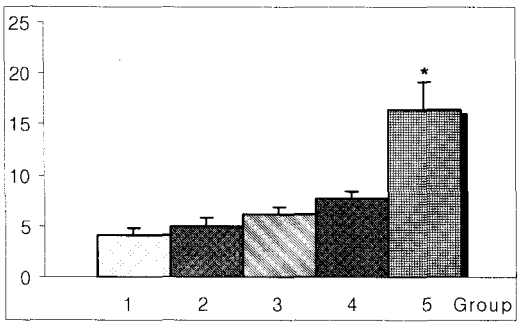
A. Depth of S.P. Level(cm); L~R



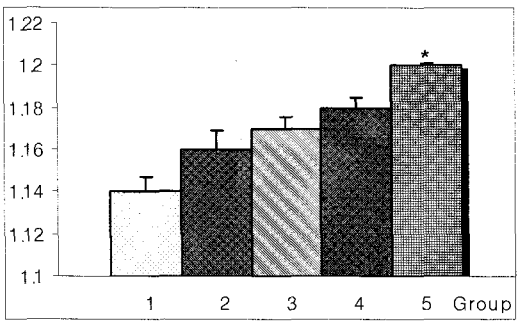
B. S.P. to CB(cm); L~R



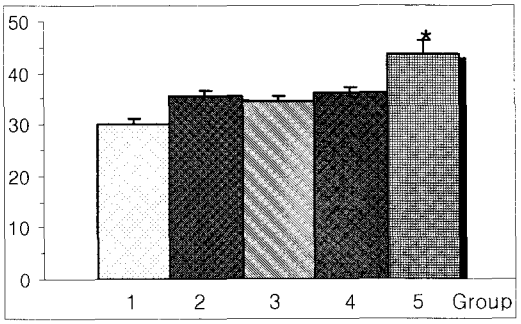
C. Blade Angle(°); L~R



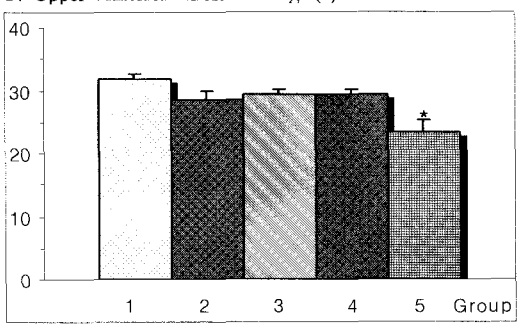
D. CB/CF Ratio



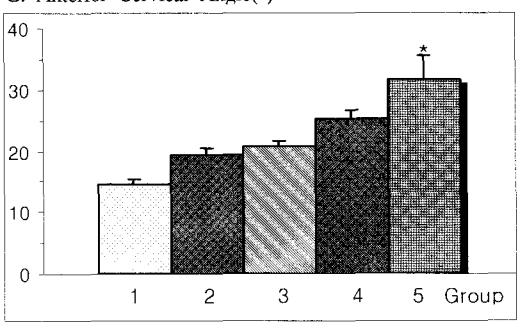
E. Upper Posterior Thoracic Angle(°)



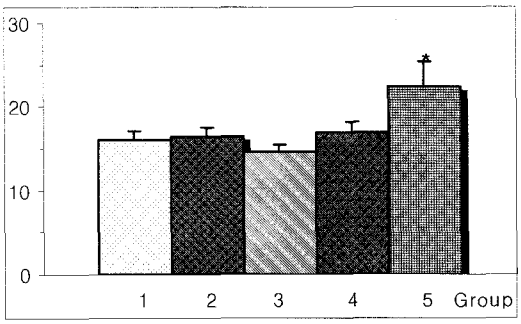
F. Upper Anterior Thoracic Angle(°)



G. Anterior Cervical Angle(°)



H. Posterior Cervical Angle(°)



<Figure 3> Postural Changes According to the Age Group

*p<0.05 by ANOVA-test followed by posthoc Bonferroni t-test comparison

Group Ⅰ; Early Young Age(19-29) / Group Ⅱ; Late Young Age(30-39) / Group Ⅲ; Early Middle Age(40-49) / Group Ⅳ; Late Middle Age(50-59) / Group Ⅴ; Old Age(60& Up).

In each parameters, subjects were classified into normal(≤ |Mean±2SD|) and abnormal(> |Mean±2SD|) groups. Percentages of subjects who were abnormal in shoulder line angle, blade angle, N.P.~A.P.~S.P., posterior cervical angle, and upper posterior thoracic angle were increased over the age group. Abnormalities of the blade angle, N.P.~A.P.~S.P., and posterior cervical angle were sharply increased at the group 5 whereas abnormality of the shoulder line angle was increased in group 4 & 5($p<0.05$)(Table 5).

<Table 5> Distribution of Normal/Abnormal of Parameter According to the Age Group

Parameter \ Group	Normal / Abnormal	Group Ⅰ	Group Ⅱ	Group Ⅲ	Group Ⅳ	Group Ⅴ	Value	Sig (*p<0.05)
Shoulder Line Angle(°); L~R	Normal	25(100%)	35(100%)	77(98%)	43(90%)	11(85%)	11.631	.020*
	Abnormal	0(0%)	0(0%)	2(2%)	5(10%)	2(15%)		
Blade Angle(°); L~R	Normal	25(100%)	33(94%)	76(97%)	46(96%)	10(77%)	11.224	.024*
	Abnormal	0(0%)	2(6%)	3(4%)	2(4%)	3(23%)		
N.P.~A.P.~S.P.(°); L~R	Normal	25(100%)	35(100%)	79(100%)	48(100%)	11(85%)	11.368	.023*
	Abnormal	0(0%)	0(0%)	0(0%)	0(0%)	2(15%)		
Posterior Cervical Angle(°)	Normal	25(100%)	35(100%)	79(100%)	46(96%)	10(77%)	19.425	.001*
	Abnormal	0(0%)	0(0%)	0(0%)	2(4%)	3(23%)		
Upper Posterior Thoracic Angle(°)	Normal	25(100%)	35(100%)	79(100%)	48(100%)	10(77%)	45.197	.000*
	Abnormal	0(0%)	0(0%)	0(0%)	0(0%)	3(23%)		

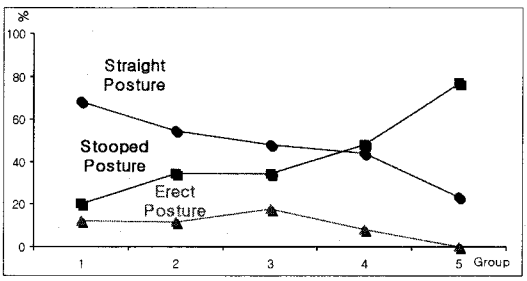
*p<0.05 by Chi-square
Group Ⅰ; Early Young Age(19-29) / Group Ⅱ; Late Young Age(30-39) / Group Ⅲ; Early Middle Age(40-49) / Group Ⅳ; Late Middle Age(50-59) / Group Ⅴ; Old Age(60& Up).

2. Lateral Posture

Lateral snap shots from 3-D images were used to classify upper lateral body shapes into straight, stooped, and erect types. The results are as follows(Tab.6); The percentages of subjects who have straight postures were decreased as a function of age($p<0.05$), but those of stooped postures were increased($p<0.05$). Subjects who have erect postures did not so.

As a results of 3-D body scan data analysis, the stooped posture group is characterized by large cervical fossa angle, anterior cervical angle, posterior cervical angle, upper posterior thoracic angle, and the small upper anterior thoracic angle comparing to the straight and erect posture group ($p<0.05$ by ANOVA)(Table 7).

<Table 6> Distribution of Lateral Posture According to the Age Group



Pearson Chi-square; Value=20.926, df=8, sig.=.007
Group Ⅰ; Early Young Age(19-29) / Group Ⅱ; Late Young Age(30-39) / Group Ⅲ; Early Middle Age(40-49) / Group Ⅳ; Late Middle Age(50-59) / Group Ⅴ; Old Age(60& Up).

<Table 7> Comparison of Measurements According to the Lateral Posture

Parameter \ Bilateral Posture	Bilateral Posture			F	Sig. (*p<0.05)
	Straight Posture	Erect Posture	Stooped Posture		
Cervical Fossa Angle(°)	27.05 ± 6.41	29.0 ± 6.19	32.12 ± 6.98*	13.026	.000*
Anterior Cervical Angle(°)	18.02 ± 7.2	19.4 ± 9.3	26.31 ± 11.19*	18.946	.000*
Posterior Cervical Angle(°)	15.17 ± 6.11	13.79 ± 7.14	18.77 ± 8.24*	7.450	.001*
Upper Posterior Thoracic Angle(°)	30.05 ± 6.55	34.96 ± 6.08	26.09 ± 6.1*	23.660	.000*
Upper Anterior Thoracic Angle(°)	32.62 ± 6.43	32.08 ± 8.15	39.1 ± 6.39*	20.592	.000*

*p<0.05 by ANOVA-test followed by post hoc Bonferroni t-test comparison

Ⅳ. Conclusion

The purpose of this study is to examine the somatotype based on the body shapes and dimensions, and to provide the useful data for well fitting garments for each target market. After organizing 3-D body scan data, statistical analyses were conducted to compare 1) postural changes and bilateral variations in upper body 2) Distribution of normal and abnormal group in each parameters, and 3) classification of upper lateral torso and the distribution as a function of the age group.

Back curvature is the major postural change of aging. The center back/center front ratio is getting greater according to the age group because the back is getting longer and front is getting shorter. In upper posterior thoracic angle, measurement was significantly increased in group 5 owing to the rounded back and abnormal group was dramatically increased in group 5. The stooped posture group shows the significantly big upper posterior thoracic angle comparing to other posture group. Gradual increase of back curvature was also shown in the stooped postures as a function of age. This back curvature can affect the uneven hemline, and length adjustment is required by shorten the front and lengthen the back.

Along with the back curvature, the neck and head are tilted forward. Anterior cervical angle was gradually increased as a function of the age group. In posterior cervical angle, measurements shows the significant ascend, and the abnormal group was dramatically increased in group 5. The stooped posture group shows the significantly big cervical fossa angle, anterior cervical angle, and posterior cervical angle. For this neck projection in elderly group, neck line should be adjusted by raising the back neckline, and lower the front neckline.

The indications of shoulder lower movement can be examined by the increase of shoulder angle by the age group. But significant result about shoulder forward movement was not found in shoulder line angle, and N.P.~ A.P.~S.P..

Shape and the placement of bust also changes by aging. Upper anterior thoracic angle was significantly decreased, B.P. to center front distances was increased. The stooped posture group shows the significantly small upper anterior thoracic angle. In other words, bust is getting lower, fuller, and bust points are further apart according to age. To solve the problems in fitting, adjustment of length, depth, and position of the bodice dart is necessary.

In group 5, depth of the S.P. level, S.P. to center back distance, and blade angle show big differences between left and right side contributing to an asymmetrical body configuration. The distribution of

abnormal within group 5 was drastically increased in the bilateral differences of blade angle and N.P.~A.P.~S.P. angle. The difference between left and right of A.P.~S.P.~M.S.P. angle tended to be greater as people ages.

In the bilateral difference of shoulder line angle, the distribution of abnormal group was also drastically increased in group 4, and 5. The bilateral measurement differences of waist height and B.P. to waist distance were gradually increased according to the age group.

Clothing companies usually design with standard figures in mind, based on the company's background and the statistical average of many figures. Such standards are considered as 'ideal' in terms of proportions, contours, symmetry and posture. However, due to heredity, ethnic origin, growth patterns, disease or accident, the figure of the individual may vary from the standard[22].

For asymmetrical variations, it is suggested to avoid of fitted style and strong center lines in the design and to use shoulder pads for even hang. Liechty et al. noted that when the left side of the body differs significantly from the right side, the fitting pattern must be duplicated to have a pattern for each side of the body. Each side is then altered where necessary. This results in different pattern outlines for each side of the body for the bodice, skirt, or sleeve units[23].

A major limitation to the study was that the subject numbers were limited and the distribution was not even. For the future studies large database with wide variety of age is needed.

This study found that body changes occur with age and finding well-fitting clothing can be a big challenge for old age group, especially in the areas of the shoulders, back, bust. Apparel designers should be aware that apparel made for the younger body frame will hang differently in aging figure. To improve the fit and satisfaction of silver customer and the business performance of silver market retailers, future research should address an elderly subjects only which will allow for a greater understanding of the specific postural changes by aging.

Reference

1) Sept./5/2005, http://www.britannica.com/eb/article-9068646
2) Kim, Sora (2003). A study for the properties of upper body somatotpe of lateral view for middle-aged women. *Korean home economics association, 41*(11), pp. 1-9.
3) Goldsberry, E. & Reich, N. (1989). It either fits or it doesn't. *ASTM standardization News,* Sept, pp. 42-44.
4) Katou, C. & Nakaho, Y. (2001), Shapes of abdomen and hips of elderly women for the drafting pattern of basic blocks. *Japan Res Assoc Text-Uses, 42*(4), pp. 251-261.
5) Le Pechoux, B. & Ghosh, T. K. (2002). Apparel sizing and fit. *The Text Inst, 32*(1), p. 3.
6) Smathers, D. G. & Horridge, P. E. (1978-1979). The effects of physical changes on clothing preferences of elderly women. *International Journal of Aging and Human Development, 9*(3), pp. 273-278.
7) Woodson, E. M. & Horridge, P. E. (1990). Apparel sizing as it relates to women age sixty-five plus, *Clothing and Textiles Research Journal, 8*(4), pp. 7-13.
8) Goldsberry, E. & Reich, N. (1989). It either fits or it doesn't. *ASTM standardization News,* Sept., pp. 42-44.
9) Katou, C. & Nakaho, Y. (2001). *op. cit.*
10) Le Pechoux, B. & Ghosh, T. K. (2002). *op. cit.*
11) Fan, J., Yu, W., & Hunter, L. (2004). *Clothing appearance and fit: Science and technology.* Cambridge, Woodhead Publishing Ltd., p.200.
12) Kohn, I. L. (1996). Importance of posture and changed body configuration for garment fit for women aged 55-65, Masters thesis, Cornell University.
13) Ashdown, S. P. (1998). An investigation of the structure of sizing systems. *International Journal of Clothing Science and Technology, 10*(5), pp. 324-341.
14) Simmons, C., Istook, C. L., & Devarajan, P. (2004). Female figure identification technique(FFIT) for apparel - Part I: Describing female shapes. *Journal of Textile and Apparel, Technology and Management, 4*(1), pp. 1-16.
15) DesMarteau, Kathleen (2000). CAD: Let the fit revolution begin. *Bobbin, 42*(2), pp. 42-56.

16) Nam, Yoon Ja (1991). *A study on the upper body somatotpe of lateral view,* ph.D. thesis, Seoul National University.

17) Kim, Soon Ja (1992). *Development of dress form for the construction of middle-aged Women's clothing.* ph.D. thesis, Yonsei University.

18) Kim, Hae Koung & Kim, Soon Ja (1995). Classification of upper torso somatotype for the construction of middle-aged Women's clothing. *Korean Society of Clothing and Textiles, 19*(6), pp. 1027-1039.

19) Kim, Sora (2003). *op. cit.*, pp. 1-9.

20)

Researcher (Year)	Subjects	Classification
Nam, Yoon Ja (1991)	collage female students; age 18-26	Straight, Erect, Stooped, Curved
Kim, Soon Ja (1992)	middle-aged women; age 35-54	Straight, Erect, Stooped, Curved
Kim, Haekyoung Kim, Soon Ja (1995)	middle-aged women; age35-54	Standard, Stooped, Curved
Kim, Sora (2003)	middle-aged women; age 40-50	Standard, Erect, Stooped, Curved

21) Nam, Yoon Ja (1991). *op. cit.*

22) Liechty, E. G., Pottberg, D. N., & Rasband, J. A. (1986). *Fitting and pattern alteration: A multi-method approach.* New York, Fairchild Publication Co.

23) Fan, J., Yu, W., & Hunter, L. (2004). Clothing appearance and fit: Science and technology. Cambridge, Woodhead Publishing Ltd., p. 200.