A Study on the Characteristics of the Upper-Body Surface for Clothing Construction: Focus on Women Aged 60 or Older
의복설계를 위한 상반신체표면특성 연구
-60세 이상 노년여성을 대상으로-

*Division of Digital Design, Dongseo University
Dept. of Clothing and Textiles, Yeungnam University

HaeKyung Shin* · YounSoon Lee

*동서대학교 디지털디자인학부 패션디자인전공, 영남대학교 생활과학대학 의류학전공
신 혜 경* · 이 연 순
(2001. 9. 30 접수)

Abstract

본 연구는 노년여성을 위한 의복 원형을 설계하기 위하여 60~80세의 노년여성을 대상으로 직접계측을 실시하여 체형을 유형화하고 동작에 따른 체표면 특성을 분석하였다. 인자분석을 실시한 결과 상반신 비만요인, 높이요인, 상반신앞면길이, 어깨형태, 상반신 뒷면 길이, 어깨경사도, 목형태, 진동깊이의 8개 인자가 추출되었다. 군집분석에 의한 체형분류 결과, 유형 1은 상반신의 골격이 가장 작고 왜소하며 가슴의 하수가 작은편의 앞으로 굴신된 체형이며, 유형 2는 키가 작고 보통인 체형으로 상반신의 앞뒤면 길이가 짧으며 가슴의 하수가 크고 어깨가 넓고 약간 앞으로 숙여진 체형이다. 유형 3은 키가 가장 크고 등과 어깨가 두꺼운 골격이 큰 체형이다. 유형 4는 키가 약간 크고 마른 체형에 상반신 앞면길이 인자가 큰 유형으로 약간 뒤로 젖혀진 체형이라 할 수 있다. 동작에 따른 체표면의 변화를 델마토그래프법 (Dermatograph method)에 의해 측정한 결과, 가로방향에서 동작에 따라 유의한 차이를 나타낸 기준선은 뒤목점-어깨끝점길이, 어깨길이 및 앞가슴둘레선, 후액와선이며, 세로 방향에서는 어깨끝점-BP-허리중심점, 어깨중심에서 앞허리선까지의 앞길이 및 옆선길이로 나타났다.

Key words: eldery women, somatotype, upper body surface; 노년여성, 체형, 상반신 체표면

I. Introduction

In modern society, the elderly population is increasing due mainly to advanced medical technology and improved living standards. According to the Office of Statistics(2000), 3,370,000 people in Korea are over the age of 65. They currently account for 7.1% of the population and are expected to represent 10% in 2010. Ours is increasingly becoming an aging society.

In old age, the body physically deteriorates. There are many changes in body type and physiology(Hahm 1985): people become shorter, more fat accumulates in the belly and hips, backs are more bent, breasts sag, and legs and arms become thinner. These changes have a marked influence on the fit of clothing. These days, more

ready-to-wear clothes are being made for elderly women. For better pattern designs, we need more information on the elderly's body shape(or somatotype) and the changes in their body surface(Kim 1997). In regard to clothing design for elderly women, most studies have classified somatotypes(Goldsberry et al. 1996, Kim and Choi 1995, Kim and Sohn 1996, Nam and Choi 1997, Kim 2000, Yoo 2000) and suggested a size system(Jo et al. 1997). However, few have analyzed the body surface of older people. Tomita et al.(1987) examined the body-surface characteristics by moire topography.

The purpose of this study is to provide fundamental data on elderly women relevant to clothing design. It aims to discuss the characteristics of their somatotypes and measure variations in the

upper- body surface using the dermatograph method.

II. Methods

1. Anthropometric measurement

Subjects and measurements. The subjects are 260 women over 60 years old living in the Daegu metropolitan city and Kyungbook province. The age range is presented in Table 1. A total of 39

Table 1. Distribution of age for subjects

Age		N(%)	N(%)	Total(%)
Elderly Women	60 ~ 64	77(29.7)	146(57.9)	260(100%)
	65 ~ 69	69(26.5)		
	70 ~ 74	64(24.6)	114(42.1)	
	Above 75	50(19.2)		

Table 2. Items for measurement of the upper body

Item	Detail	Mark	Item	Detail	Mark
Length	L1	Shoulder point-Fossa jugularis point	Height	H1	Stature
	L2	Shoulder length		H2	Posterior neck height
	L3	Side neck point-Thelion length		H3	Acromion height
	L4	Side neck point-B.P-Waist line		H4	Waist height
	L5	Waist front length		H5	Upper chest height
	L6	Shoulder point - B.P - Front waist point		H6	Bust height
	L7	Front interscye breadth		H7	Lower chest height
	L8	Cervicale - Waist girth line	Breadth	B1	Neck breadth
	L9	Posterior shoulder point length		B2	Acromion to acromion breadth
	L10	Back interscye breadth		B3	Nipple to nipple breadth
	L11	Side neck point - Angulus scapulae point - Waist line		B4	Upper chest breadth
	L12	Shoulder point-Angulus scapulae point - Back waist point		B5	Bust breadth
				B6	Lower chest breadth
	L13	Side length		B7	Waist breadth
	L14	Armhole length	Depth	D1	Upper chest depth
Girth	G1	Upper chest girth		D2	Bust depth
	G2	Bust girth		D3	Lower chest depth
	G3	Lower chest girth		D4	Waist depth
	G4	Waist girth	Other	S1	Slope of the right shoulder
	G5	Armhole girth		W	Weight(Kg)

measurements were taken: height(7), length(14), depth(4), breadth(7), girth(5), weight, and slope of the right shoulder. The measurements are shown in Table 2. Martin's anthropometric instruments were used, and KSA 7003 and KSA 7004 standards were applied to anthropometry.
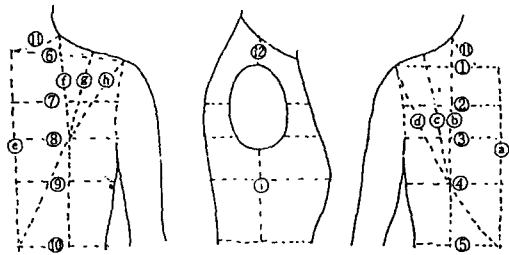
Item	Detail	Mark
Horizontal line	①	Fossa-jugularis point to shoulder point line
	②	Front interscye breadth line
	③	Anterior armpit line
	④	Anterior bust girth line
	⑤	Anterior waist girth line
	⑥	Cervical point to shoulder point line
	⑦	Back interscye breadth line
	⑧	Posterior armpit line
	⑨	Posterior bust girth
	⑩	Posterior waist girth line
	⑪	Neck base line
	⑫	Shoulder line
Vertical line	ⓐ	Front center line
	ⓑ	Neck side point, BP to anterior waist line
	ⓒ	Shoulder center point, BP to anterior waist line
	ⓓ	Shoulder point , BP to anterior waist point
	ⓔ	Back center line
	ⓕ	Neck side point, scapulae angulus point to posterior waist line
	ⓖ	Shoulder center point, scapulae angulus point to posterior waistline
	ⓗ	Shoulder point, scapulae angulus point to posterior waist point
	ⓘ	Side line

Fig. 1. Areas of body surface for measurement

Table 3. Measurements of subjects

(unit: cm)

Item		Subject I	Subject II	Subject III	Subject IV
Height	H1	146.4	145.8	153.5	149.9
	H2	125	123.2	128	127.8
	H3	118.1	115.4	122.6	122.8
	H4	91.9	89.7	93.5	96
	H5	107.5	106.05	113	113.3
	H6	97.7	97.6	104.2	106.3
	H7	98.7	94.5	101.1	105.2
Breadth	B1	11.6	10.9	11.1	10.7
	B2	30.7	28.7	32	31
	B3	19.5	20	21	19
	B4	23.6	27.7	25.4	24
	B5	24.7	26.7	28.6	24.2
	B6	24	25.4	25.7	23.9
	B7	25	24.6	25.8	23.3
Depth	D1	20.3	19.1	19.8	19.4
	D2	22.3	23.6	24	23.0
	D3	20.7	20.1	18.8	17.1
	D4	20.7	21.8	21.6	19
Girth	G1	37.5	36.5	37	36
	G2	82	84	90.5	84
	G3	88	91	94	86
	G4	85	86	80	79
	G5	85	78	84	80
Length	L1	16.5	16.1	16.6	17
	L2	11.5	10.9	12	11.5
	L3	28.5	26.9	28.5	25
	L4	36	35.5	38	36
	L5	29	28	34	27.5
	L6	34.5	34	40	36.5
	L7	31	33.5	37	29
	L8	36	36.5	39	35
	L9	37.8	36.8	39.5	36.5
	L10	35	38	36	30.5
	L11	38	38.8	43	38.5
	L12	39.4	40	46	36.5
	L13	15.5	17.2	19.5	16
	L14	15.5	16	16.5	14.5
Slope(°)	S1	21	21	22	20
Weight(kg)	W	53.5	50	55.5	46

Data analysis. The analysis of variance and the SNK test per type were used to clarify the concrete characteristics of each somatotype.

The factor analysis was conducted using principal component analysis. Each factor score was selected as an independent variable, and cluster analysis was made to categorize body types. The multiple comparative test based on the SNK test was used to find out if there were any differences between the categorized body types.

2. Characteristics of the upper-body surface

Subjects and measurements. Four subjects were selected to represent each body type. The length of their upper-body surface was examined for changes caused by movement. And each change was measured three times, using the dermatograph method. The measurements of subjects are presented in Table 3. The areas of body surface for measurement are presented in Fig. 1.

Data analysis. The horizontal and vertical change ratio in each part caused by the motions was measured. The Anova and SNK tests were used to verify the significance of the changes.

III. Results and Discussion

1. Factor analysis on the upper body

Based on somatotype distribution, eight factors were extracted by the factor analysis of anthropometric measurements. The selected factors predicted by 72.85% accuracy the shape of the upper-body surface. Each type's characteristics that resulted from factor differences are shown in Table 4. Factor 1 includes the factor loading of waist depth, waist girth, and bust girth. It is the highest in percentage of variance. Obesity and emaciation are the major factors to determine the body type of elderly women; chest and waist sizes

are the chief determinants of obesity. These results confirm the findings of other studies(Kim and Choi 1995; Choi 1996) that analyzed the body type of elderly people and identified obesity as the primary factor. Factor 2 represents the height of the upper body as all six height items showed a higher factor loading. Factor 3 indicates the length of the front part of the body, since the factor loading of waist-front length, side neck BP front waist point, and side length were higher. Factor 4 suggests the form of the shoulder because of the factor loading of shoulder length and acromion-to-acromion breadth. Factor 5 refers to the length of the back part of the body, since the factor loading of shoulder point, Angulus scapulae pointback waist point, side neck point, Angulus scapulae pointwaist line, and cervicale-waist girth line were higher. Factor 6 signifies the slope of the shoulder, and Factor 7 is associated with the form of the neck. Factor 8 indicates the armpit dimension.

Table 4. The contents of factor analysis on upper body

Factor	Eigen value	% of Variance	Cumulative %	Contents of factor
1	20.73	35.13	35.13	Extent of fat on upper body
2	7.30	12.38	47.52	Height of upper body
3	4.13	7.01	54.53	Front length of upper body
4	2.71	4.60	59.14	Shoulder form
5	2.46	4.17	63.31	Rear length of upper body
6	2.07	3.51	66.82	Shoulder slope
7	1.88	3.19	70.02	Form of neck
8	1.66	2.82	72.85	Armpit dimension.

2. Classification of somatotype

The factor scores were selected as independent variables. Using four cluster analyses, body types were categorized. Type 1 is the smallest with breasts hanging lower, a short back-waist line and a bent forward shape . For this somatotype,

Table 5. The results of cluster analysis
(unit: cm)

Item	Detail	Type I(n=59)	Type II(n=67)	Type III(n=88)	Type IV(n=46)	F-value
Height	H1	150.2(4.2) B	149.8(4.7) B	153.2(4.2) A	151.3(3.9) B	6.31***
	H2	126.4(3.6) B	125.2(4.2) B	128.7(4.4) A	127.4(4.2) AB	5.89***
	H3	122.3(3.5) AB	121.5(4.5) B	123.7(4.0) A	122.8(3.7) AB	3.34*
	H4	92.5(3.2) B	92.3(4.1) B	94.5(4.3) A	93.9(3.6) A	3.47*
	H5	110.9(4.1) B	110.6(4.1) B	112.8(4.1) A	112.7(4.2) A	3.01*
	H6	103.5(3.9) B	103.1(5.2) B	105.3(4.6) A	104.2(4.4) B	3.21*
	H7	100.1(3.5) B	100.5(4.0) B	102.3(4.0) A	100.9(3.5) B	2.78*
Breadth	B1	10.8(0.6) AB	10.9(0.7) B	11.4(0.7) A	10.6(0.6) C	12.57***
	B2	31.6(1.5) A	30.6(1.4) B	31.4(1.5) A	29.9(1.6) C	11.36***
	B3	18.4(2.4) B	19.2(1.8) B	20.4(1.7) A	18.5(2.5) B	11.62***
	B4	25.6(2.0) B	26.4(1.5) B	27.1(1.6) A	26.0(2.0) B	7.59***
	B5	25.4(2.0) C	26.4(1.6) B	27.9(1.8) A	25.4(2.5) C	21.83***
	B6	24.8(1.7) B	25.4(1.1) B	26.8(1.4) A	24.8(1.8) B	25.81***
	B7	24.8(2.1) AB	25.0(1.6) B	26.6(1.6) A	24.1(2.2) C	19.35***
Girth	G1	41.0(1.9) A	40.8(2.2) A	41.3(2.3) A	41.0(1.9) A	0.52
	G2	87.4(4.5) B	98.3(4.1) B	91.2(4.1) A	85.9(5.0) B	15.75***
	G3	91.0(6.1) B	91.0(5.4) B	96.2(5.7) A	90.0(8.0) B	12.47***
	G4	83.0(5.5) B	82.2(4.0) B	86.9(5.2) A	81.6(6.5) B	12.60***
	G5	82.2(7.1) B	80.7(6.1) B	85.9(5.2) A	79.6(8.8) B	10.27***
Depth	D1	20.0(1.4) A	18.9(1.3) B	19.7(1.5) A	20.0(1.6) A	6.87***
	D2	23.1(1.7) B	23.1(2.2) B	24.5(2.2) A	23.0(2.6) B	6.61***
	D3	20.4(2.1) AB	20.0(2.1) B	21.1(1.8) A	20.1(2.3)AB	34.92*
	D4	21.0(2.3) B	20.6(2.1) B	22.3(2.0) A	20.3(3.2) B	7.73***
Length	L1	17.6(1.2) A	17.1(0.8) A	17.4(1.2) A	17.1(1.3) A	1.74
	L2	12.2(0.9) A	11.2(0.7) C	11.7(1.1) B	10.9(1.1) C	12.96***
	L3	28.9(2.7) A	22.7(2.5) B	29.2(2.1) A	29.6(2.6) A	5.82***
	L4	36.2(1.9) C	36.9(1.8) C	40.0(2.3) A	39.1(1.9) B	39.40***
	L5	27.8(1.9) D	28.7(2.3) C	31.7(2.0) A	30.7(2.0) B	38.16***
	L6	35.2(2.0) C	36.4(1.9) B	39.1(1.9) A	38.7(2.2) A	42.28***
	L7	30.3(2.1) AB	30.1(1.6) B	30.9(2.1) AB	31.2(1.7) A	2.85*
	L8	35.9(3.4) B	35.1(1.9) B	37.0(2.5) A	35.5(2.3) B	5.20**
	L9	38.3(2.2) AB	37.7(1.9) B	38.7(1.8) A	35.3(2.1) C	22.50***
	L10	32.9(1.9) B	31.9(1.9) C	34.1(1.8) A	30.9(2.3) D	23.41***
	L11	39.5(2.1) B	39.5(2.3) B	41.1(2.5) A	39.3(2.5) B	7.89***
	L12	40.9(2.8) B	40.9(2.2) B	43.0(2.3) A	40.9(1.8) B	11.61***
	L13	15.7(1.6) B	17.2(1.7) A	18.0(2.2) A	18.1(2.1) A	14.45***
	L14	16.2(1.5) A	15.0(1.1) B	15.5(1.4) B	16.4(1.2) A	11.03***
Slope(°)	S1	20.8(2.6) A	19.2(2.5) B	20.4(3.1) AB	20.0(2.8) AB	3.13*
Other(kg)	W	53.8(7.7) B	55.6(6.3) B	56.7(6.7) A	53.4(8.5) B	6.54***
Characteristics		The smallest type, shortback waist length, somatotype is slightly bent forward	Short and standard physique, somatotype is slightly bent forward	Tall and big physique with thick shoulder and back, straight somatotype	Tall and thin, long front waist length, somatotype is slightly bent backward	

*p ≤ .05, **p ≤ .01, ***p ≤ .001
A>B>C: significantly different by SNK test

dimensions are lowest for stature, posterior-neck height, waist height, upper-chest height, bust height, acromion-to-acromion breadth, bust girth, front-interscye breadth, and back-interscye breadth. Side neck point-Angulus scapulae point-waist line back side is longer than the shoulder point -BP - Front waist point. Type 2 is short and standard with a slightly bent forward form. This type is generally less in height, girth, depth, breadth, and length. This type is also shorter, and tends to be heavier and have sagging breasts. Type 3 is tall and obese with a straight posture shape. This type is significantly bigger in height, girth, depth, and breadth. Type 4 is tall and thin with a bent backward shape . The shoulder point-BP-front waist point is larger than the cervicale-waist girth line. Acromion-to-acromion breadth, bust breadth, and waist breadth are smaller.

Type 1 accounts for 22.68% of the women. They are the smallest in upper-body form. They are short, tend to bend forward, and have chests hanging low. Type 2 women(25.8%) are shorter and moderately obese. Their upper front and back sides are shorter, and their chests hang lower. Those in the type 3 category(33.8%) are the tallest. They are stout, with broad backs and shoulders. Type 4 women(27.8%) are slightly tall, and tend to be slim, with backs bent backward. The body-type characteristics of the elderly women appear to depend on obesity and posture.

3. Characteristics of the upper-body surface

Four subjects who were typical of each of the four body types were selected to see how the body surface changed with motion. The dermatograph method was used to calculate the change ratio of the body-surface length. Three different kinds of motions were measured three times each: standing posture, arm lifting to front 90°, and arm lifting to

front 135°. Measurements of the change in the horizontal length of the upper-body surface showed a significant difference in some base lines: cervical point to shoulder point line, shoulder line (p<0.001), anterior bust girth line(p<0.01), and posterior armpit line(p<0.05). But posterior armpit line showed a bigger change. In a pattern design, this position should be given more space for ease of movement.

The back side showed a bigger change than the front one. The degree of the horizontal change of the former was −6.83 to 4.32cm(−33% to 23%); that of the latter was −2.28 to 0.5cm(−10% to 3.4%). The part that changed the most was the shoulder length, which decreased with the motions and underwent a −27% change with arm lifting to front 135, compared with the length in a correct posture. Every front part, except for waist girth, showed a negative change when the arm lifting to front 90° changed to other motions of a greater angle. This suggests that the front parts shrank.

The arm movement brought a reverse change to the horizontal body surface between the front and back sides. This is because most of the base lines are based on girth. Shoulder line, cervical point to shoulder point line, and the length elements. decreased since the arm-raising motion resulted in multiplying the motor area of the shoulder joint; thus, the shoulder point moved closer to the neck point. Shoulder line, cervical point to shoulder point line, and posterior armpit line showed a bigger change with the arm motions. These results emphasize the need to allot enough space in pattern designs.

Changes in the vertical length of the upper-body surface were measured as well. Shoulder point and BP to anterior waist point changed significantly at p<.001. Shoulder center point, BP to anterior waist line and side line also showed a significant

Table 6. Value of measurement in horizontal and vertical line by movement   (unit: cm)

Item	Movement		M1 M(SD)	M2 M(SD)	M3 M(SD)	F-value
Horizontal line	H6	Cervical point to shoulder point line	20.3(0.9) A	17.5(1.1) B	15.4(1.1) C	12.64***
	H8	Posterior armpit line	18.7(1.3) A	21.8(1.7) AB	23.0(2.5) B	5.28*
	H9	Posterior bust girth line	22.8(0.6) A	24.2(0.7) B	25.5(1.1) B	9.52**
	H12	Shoulder line	11.7(0.2) A	9.7(0.1) B	8.5(0.7) C	10.46***
Vertical line	V3	Shoulder center point, BP to Anterior waist line	36.2(2.0) A	37.4(2.0) AB	39.0(2.0) B	4.77*
	V4	Shoulder point, BP to Anterior waist point	29.3(1.7) A	41.6(1.8) B	42.5(1.3) C	8.52***
	V9	Side line	17.9(1.3) A	20.7(1.6) B	21.6(2.4) B	4.93*

***P<.001, **P<.01, P<.05

A>B>C : Alphabet letters are significantly different by SNK test

M1 : standing posture

M2 : arm lifting to front 90°

M3 : arm lifting to front 135°

change at p<.05. The upper back side did not change.

The vertical length of the front upper part continued to increase with the rise in the motion angle after the forward vertical motion was taken. Every base line, including the side one, reached the maximum with the 135° motion. On the back, shoulder point and scapulae angulus point to posterior waist point diminished with arm lifting to front 135°. The change was due to the altered shoulder point position caused by the shoulder joint movement and the expanded chest.

Standing postures were compared. The arm motions brought more change to the front side body surface, by 0.58 to 3.16cm(1% to 8%), than to the back. The side line showed a bigger change, by 3.37cm(20.6%), than the center front line. This fact confirms findings in Kim(1992) that the part farther from the torso and closer to the side, namely the shoulder joint, changes more.

The vertical body-surface base lines generally increased on the front side, but decreased on the back.

IV. Conclusions

This study aims to provide basic data on elderly women for clothing construction. It classifies somatotypes and measures variations in the upper- body surface using the dermatograph method with arm movements. It analyzes data collected from anthropometric measurements of 260 elderly women aged 60~80 years old, including four subjects selected from classified types and evaluated changes in the upper-body surface. The data were analyzed using an SAS package. The results of this study were as follows:

1. Upon analysis of the somatotype distribution, eight factors were extracted using the factor analysis of anthropometric measurements. The selected factors predicted by 72.85% accuracy the shape of the upper-body surface. The factors included the extent of fat on the upper body, the upper-body height, front and rear length of the

upper body, shoulder form, shoulder slope, form of neck, and armpit dimension.

2. Using the factor scores of cluster analysis, four clusters were categorized according to body shapes: Type 1 the smallest, breasts hanging lower, short back-waist line, slightly bent forward; Type 2 short and standard, a few slightly bent forward; Type 3 tall, with big physique(heavy back and shoulders), straight; and Type 4 tall and thin, long front-waist line, bent backward.

3. Arm movements caused changes in the upper-body surface. The vertical base line changes were in the BP to shoulder, the shoulder length, front bust line, and back armpit line. On the other hand, changes in the horizontal base lines were in the shoulder through the BP to the center of the waist, front-waist length from center shoulder to the front waist line, and the side-seam length.

References

Goldsberry, E., Shim S., et al. Women 55 Years and Older(I) Current Body Measurements as Contrasted with the PS 42−70 Data. *Clothing and Textiles Research Journal* 14(2) , 108−120(1996).

Hahm, O.S. A Study of Body Types of the Korean Elderly for Clothing Construction. Unpublished doctoral thesis, Kyungpook National University (1985).

Jo, J.S., Park, S.H., and Choi, C.O. A Study of Sizing System for Elderly Women. *Journal of the Korean*

Society of Clothing and Textile, 21(5), 835−844(1997).

Kim, H.K., et. al. Clothing Ergonomics Experimental Methodology. Seoul: Kyomoon Press(1998).

Kim, I.S. A Study of Characteristics and Classification of Elderly Women's Body Types. Unpublished doctoral thesis, Korea University(2000).

Kim, K.H. & Choi, H.S. A Study of Somatotypes of Elderly Women. *Journal of the Korean Society of Costume* 26, 279−288(1995).

Kim, M.K. Clothing Ergonomical Analysis of the Basic Bodice Pattern for Korea Men. Unpublished masteral thesis, Younsei University(1992).

Kim, Y.S. and Sohn, H.S. A study of Classification of Elderly Women's Upper Body Shapes. *Journal of the Korean Home Economics Association* 34(3), 219−232(1996).

Nam, Y.J. and Choi, I.S. An Analysis of the Somatotype of Elderly Women. *Journal of the Korean Society of Costume* 34, 19−36(1997).

Office of Statistics, Life Table(2000).

Tomita, A., Iwasa, K., and Nakaho, Y. An Experiment on Basic Dress Pattern for Aged Women, *Journal of Japan's Textile End−Users*, 197−204(1987).

Woo, M.H. and Harm, O.S, A study on the bodice patterns by Human Engineering for Eldery Women. *Journal of Korean Home Economics Association*, 32(2), 231−244(1992).

Yoo, H.S. Classification of Somatotypes of Elderly Women by Lateral View. *Journal of the Korean Society of Clothing Industry* 2(5), 391−397(2000).