

A Study of Somatotype Discrimination for Middle-aged Women

중년여성의 체형 분류 및 판별에 관한 연구

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Abstract

이 연구의 목적은 중년여성들의 체형을 분류하고 이들 체형을 분류하는 판별기준을 세우고자 하는 것이다. 이 연구에서 개발한 판별방법은 중년여성들의 체형을 간편하게 판별할 수 있도록 해주므로 이 방법을 활용하여 중년여성복을 제작할 경우, 소비자들은 인체적합도가 높은 의복을 구입할 수 있고 의류업체들은 이에 따른 매출증대를 가져올 수 있다.

연구의 진행절차와 이에 따른 결과는 다음과 같다.

1. 만 40세~59세 중년여성 279명에 대한 인체계측을 하였다. 인체계측항목은 34개의 직접계측항목과 측면사진 촬영을 통한 3개의 간접계측항목, 11개의 지수치, 5개의 계산치 등의 총 53개 항목이다. 인체계측치에 대한 통계분석 방법으로는 분산분석과 SNK 검정, 판별분석 방법을 사용하였다.

2. 피험자는 몇 가지 체형으로 분류되었다. 상반신 체형분류는 인체측면 자세와 유방크기를 분류기준으로 하여 바른-유방중소 체형, 바른-유방대 체형, 젓힌-유방중소 체형, 숙인/횡-유방중소 체형, 숙인/횡-유방대 체형의 5가지로 분류하였다. 하반신 체형분류는 배와 엉덩이의 돌출정도에 따라 분류하여 배정상-엉덩이정상 체형, 배정상-엉덩이돌출 체형, 배돌출-엉덩이정상 체형, 배돌출-엉덩이돌출 체형의 4가지로 분류하였다.

3. 분류된 체형은 다음의 판별변수에 따라 체형이 판별되었다. 상반신 체형의 판별변수는 앞폭/뒤폭, 가슴둘레/밑가슴둘레, 앞길이/뒤길이, 앞허리선→어깨선 길이/어깨선→뒤허리선 길이의 4가지 항목이고, 하반신 판별변수는 엉덩이상부각도, 배하부각도, 배상부 각도, 엉덩이둘레/엉덩이최대둘레, 뒤엉덩이둘레의 5가지 항목이다. 상반신 체형과 하반신 체형 판별함수 모두 70% 이상의 높은 적중률을 나타내었다.

Key words: somatotype, somatotype discriminating system, middle-aged women;
체형, 체형분류 시스템, 중년여성

I. Introduction

It is not easy to find well-fitting clothes for middle-aged women. One of the most frequent reasons is that their somatotypes are diverse, but ready-to-wear manufacturers produce very limited number of sizes. Consequently it is hard to satisfy

middle-aged customers.

In order to manufacture well-fitting clothes, it is prerequisite to research on somatotypes as well as anthropometric data of the specific target customers. In this project we developed a somatotype discriminating system, which is aimed to clarify the figure distinctiveness. The developed discriminating system enables middle-aged

women to recognize which somatotype they belong to, and give necessary information about somatotypes as well as size to manufacturers.

II. Methods

1. Collecting anthropometric data

1) Subjects

Initially measured subjects were 279 women in their 40's and 50's, but final measurements actually used in statistical analysis were of 252 subjects excluding incomplete data. Trained assistants measured subjects at various women education centers, universities, swimming pools, and general hospitals in Seoul and Kyungki province in July 2000.

2) Measuring devices & methods

Martin's measuring instruments, tape measures, scales, waist belts, round stickers, cards for recording, leggings, leotards, a Pentax 50mm camera, a Samsung Kenox Z115f camera, a tripod, and a semicircular protractor were used as measuring devices. Anthropometric data were measured by either direct methods or indirect methods. The indirect measurements were taken on photographed lateral views.

3) Items of anthropometric data

The anthropometric data consist of 34 direct measurements, 11 indexes, 5 different values between measurements, and 3 angles (Table 1).

It was expected that there must be distinctive indexes and different values between measurements, among different somatotypes. Previous studies (Sohn, 1994; Choi, 1997) showed that somatotype classification using indexes was effective to discriminate body shapes and postures more easily. Therefore considering the research purpose,

as somatotype discriminating criteria, certain indexes and different values between measurements were selected based on previous researches.

By indirect measurement, such as three angles on the photographed side view, the distinctive upper body shape was classified. In order to discriminate the characteristic shape of the abdomen, upper abdomen angle and lower abdomen angle were measured. Prominent abdomen has two different shapes. One is lower abdominal prominence, which has a bigger upper abdomen angle. The other is entire abdominal prominence, which has a bigger lower abdomen angle than the upper one, like a pregnant woman. Upper buttock angle was measured to discriminate the characteristic shape of buttocks. Anthropometric data of abdomen and buttocks were measured by the methods based on previous studies (Lim & Moon, 1998; Nam & Choi, 1997).

2. Criteria of somatotypes

The somatotype classification of this study was to manufacture well-fitting clothes for middle-aged women, so it might be different from other somatotype classifications.

1) Upper body

(1) Lateral view

The somatotype classification of the upper body of lateral view was based on previous studies (Nam, 1991; Kim, 1992). *Straight posture, leaning back posture, bent forward posture, and swayback posture* were selected for this study (Fig. 1).

However, from the results of anthropometric data analysis, it was evident that *bent forward posture* and *swayback posture* could be classified into the same group, especially for pattern making.

(2) Bust development

Another characteristic figure of the upper body

Table 1. Items of anthropometric data

Method	Division	Item
Direct measurement	Height	1. stature 2. neck height posterior
	Breadth	*3. back neck breadth *4. front neck breadth *5. back neck depth *6. front neck depth 7. nipple to nipple breadth
	Circumference	8. chest circumference 9. bust circumference 10. under-bust circumference 11. waist circumference *12. front abdominal circumference 13. abdominal circumference *14. back hip circumference 15. hip circumference *16. maximum hip circumference
	Length	*17. back shoulder length *18. back interscye breadth 19. back length *20. S.N.P.→scapular→back waistline length *21. back diagonal length *22. chest shoulder length *23. front interscye breadth 24. waist front length 25. S.N.P.→B.P. length *26. S.N.P.→B.P.→front waistline length *27. front diagonal length *28. front waistline→shoulder line length *29. shoulder line→back waistline length 30. shoulder length 31. abdominal length 32. hip length 33. crotch length
	Others	34. weight
	Index	*35. Rohrer index 36. chest shoulder length / back shoulder length 37. front interscye breadth / back interscye breadth 38. waist front length / back length 39. S.N.P.→B.P.→front waistline length / S.N.P.→scapular→back waistline length 40. front diagonal length / back diagonal length 41. bust circumference / under-bust circumference 42. front abdominal circumference / back abdominal circumference 43. front hip circumference / back hip circumference 44. hip circumference / maximum hip circumference 45. front waistline→shoulder line length / shoulder line→back waistline length
Indirect measurement	Different value between measurements	46. S.N.P.→B.P.→front waistline length - S.N.P.→B.P. length 47. bust circumference - under-bust circumference *48. back abdominal circumference *49. front hip circumference 50. maximum hip circumference - hip circumference
	Angle	51. upper abdomen angle 52. lower abdomen angle 53. upper buttock angle

*3~*6 were measured with a rectangular template.

*12. front abdominal circumference: the front circumference between 2 cross points of abdominal level and the vertical level of the projected point of thigh (Kim, 1990)

*14. back hip circumference: the back circumference between 2 cross points of hip level and the vertical level of the projected point of thigh (Kim, 1990)

*16. maximum hip circumference: the horizontal hip circumference with celluloid plate on the projected point of abdomen (Park et al., 1998)

*17. back shoulder length: the length between both shoulder points on back

*18. back interscye breadth: the length between left armpit point and right armpit point on back

*20. S.N.P.: side neck point

*21. back diagonal length: the length between S.N.P. and center back point on waistline

*22. chest shoulder length: the length between both shoulder points on front

*23. front interscye breadth: the length between left armpit point and right armpit point on front

*26. B.P.: bust point

*27. front diagonal length: the length that S.N.P. to B.P. to center front point on waistline

*28. front waistline → shoulder line length: the length that front waistline to front armpit point to the point which is 2.5cm moved from shoulder point

*29. shoulder line → back waistline length: the length that the point which is 2.5cm moved from shoulder point to back armpit point to back waistline

*35. Rohrer index = (weight / height³) × 10⁵

*48. back abdominal circumference = abdominal circumference - front abdominal circumference

*49. front hip circumference = hip circumference - back hip circumference

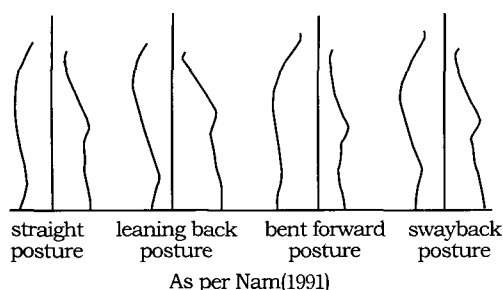


Fig. 1. Upper body somatotypes

was bust development, i.e., small bust, medium bust and large bust. Like brassiere sizing system, the difference value of *bust circumference* and *under-bust circumference* was going to be used as a criterion. But there seem to be a problem using this difference value. Suppose a woman's *bust circumference* is very big or very small. There will be a big difference between the difference value 10 cm of *bust circumference* 100 cm and that of *bust circumference* 75 cm. In this case the index of *bust circumference/under-bust circumference* can be more reasonable than the difference value of *bust circumference* and *under-bust circumference*. Consequently the index was used as a criterion for bust development.

Bust development was classified into three groups: large, medium, and small. When the index of *bust circumference/under-bust circumference* is generally distributed, if the index is over 75% of the index distribution, she has *large bust*. Also if the index is below 25% of the index distribution, she has *small bust*. And the rest, between 25-75% has *medium bust*. Therefore, a large bust is when the index of *bust circumference/under-bust circumference* is above 1.15 (Table 2).

However, apparently small bust dose not cause a serious fitting problem for middle-aged women according to the survey (Kim, 2001). Therefore, *medium bust* and *small bust* can be combined into

the same group.

Suppose to do the combination of three criteria of lateral view and two criteria of bust development, there are six somatotypes for the upper body. However, the frequency of *leaning back posture - large bust* was very low, so this group was eliminated. In the end, somatotypes of the upper body were classified into five groups as follows.

1. straight posture - medium/small bust
2. straight posture - large bust
3. leaning back posture - medium/small bust
4. bent forward/swayback posture - medium/small bust
5. bent forward/swayback posture - large bust

2) Lower body

The somatotype classification for the lower body was also based on previous studies (Nam & Lee, 1984; Cho, 1992) and the survey for production of made-to-measure clothes for middle-aged women (Kim, 2001). For well-fitting lower body clothes, accurate data of abdominal prominence and buttock prominence are very important. So the somatotypes of the lower body were classified into four groups as follows.

1. normal abdomen - normal buttocks
2. normal abdomen - prominent buttocks
3. prominent abdomen - normal buttocks
4. prominent abdomen - prominent buttocks

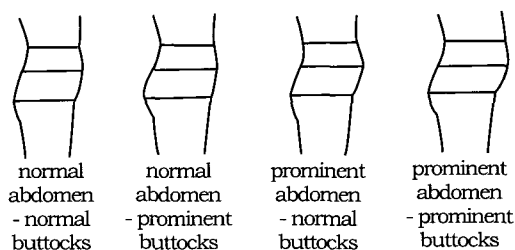


Fig. 2. Lower body somatotypes

The criterion of *prominent abdomen* is upper abdomen angle or under abdomen angle. If the angle is located over 75% of the generalized distribution of the same measurement, she

Table 2. Descriptive statistics of anthropometric data

unit: cm

Method	Item	Measurement	Mean	S.D.	Quartile					
					0%(Min)	25%	50%	75%	100%(Max)	
Direct measure- ment	Height	1. stature	154.28	4.90	140.00	151.35	154.30	157.00	171.70	
		2. neck height posterior	129.87	8.68	117.70	127.38	130.50	133.13	148.40	
	Breadth	3. back neck breadth	6.27	0.75	2.40	5.80	6.30	6.80	8.20	
		4. front neck breadth	5.78	0.83	2.30	5.30	5.70	6.20	9.40	
		5. back neck depth	4.91	1.16	1.80	4.00	4.80	5.75	9.80	
		6. front neck depth	7.44	1.11	4.30	6.50	7.50	8.30	10.50	
		7. nipple to nipple breadth	17.25	1.74	13.30	16.10	17.20	18.10	23.00	
	Circum- ference	8. chest circumference	89.04	5.42	76.60	85.08	89.00	89.53	107.00	
		9. bust circumference	91.34	6.27	75.00	86.78	91.50	95.83	407.40	
		10. under-bust circumference	81.05	6.03	67.30	77.40	81.00	84.90	100.00	
		11. waist circumference	76.92	7.04	61.20	71.45	76.50	81.23	99.90	
		12. front abdominal circumference	43.95	3.44	35.00	41.50	43.50	46.50	53.00	
		13. abdominal circumference	91.55	5.83	77.80	87.05	90.95	96.00	107.00	
		14. back hip circumference	51.78	3.40	40.50	49.75	52.00	54.00	62.10	
	15. hip circumference	93.60	4.48	82.00	90.35	93.45	97.05	108.50		
	16. maximum hip circumference	96.40	4.92	93.30	93.00	96.10	100.00	112.00		
	Length	17. back shoulder length	39.23	2.11	32.20	37.65	39.50	40.85	43.70	
		18. back interscye breadth	37.20	2.64	30.00	35.50	37.40	39.00	47.50	
		19. back length	39.11	2.28	30.20	37.70	39.20	40.50	45.40	
		20. S.N.P.→scapular→back waistline length	42.95	2.14	36.70	41.60	43.00	44.50	49.00	
		21. back diagonal length	41.50	2.58	30.50	40.00	41.50	43.15	47.80	
		22. chest shoulder length	37.63	2.50	17.20	36.55	37.55	39.00	42.00	
		23. front interscye breadth	32.83	2.25	28.00	31.30	32.65	34.40	40.50	
		24. waist front length	33.31	2.52	27.20	31.60	33.00	34.65	48.50	
		25. S.N.P.→B.P. length	26.14	2.26	20.30	24.95	26.00	27.20	37.20	
		26. S.N.P.→B.P.→front waistline length	40.44	2.48	30.80	38.95	40.30	42.00	52.00	
		27. front diagonal length	40.54	2.44	34.00	38.90	40.50	42.00	49.50	
		28. front waistline→shoulder line length	36.07	2.26	31.00	34.70	36.00	37.50	42.20	
		29. shoulder line→back waistline length	37.70	2.16	32.00	36.45	37.50	39.20	45.00	
		30. shoulder length	12.62	0.92	10.20	12.00	12.60	13.25	15.00	
		31. abdominal length	10.45	1.97	4.10	9.20	10.30	11.50	18.50	
		32. hip length	18.34	1.83	13.50	17.30	18.30	19.50	24.60	
		33. crotch length	26.50	2.05	22.00	25.10	26.50	27.50	33.50	
	Others	34. weight (kg)	58.02	6.71	43.00	53.25	57.75	62.85	80.00	
	Index	35. Rohrer index	1.58	0.18	1.20	1.46	1.56	1.69	2.12	
		36. chest shoulder length/back shoulder length	0.96	0.06	0.44	0.94	0.97	0.99	1.10	
		37. front interscye breadth/back interscye breadth	0.89	0.07	0.66	0.84	0.88	0.94	1.08	
		38. waist front length/back length	0.85	0.06	0.70	0.82	0.85	0.88	1.24	
		39. S.N.P.→B.P.→front waistline length/ S.N.P.→scapular→back waistline length	0.94	0.05	0.70	0.91	0.95	0.98	1.19	
		40. front diagonal length/back diagonal length	0.98	0.06	0.82	0.94	0.98	1.01	1.28	
		41. bust circumference/under-bust circumference	1.13	0.03	1.05	1.11	1.13	1.15	1.26	
		42. front abdominal circumference/ back abdominal circumference	0.93	0.09	0.73	0.88	0.92	0.97	1.32	
		43. front hip circumference/back hip circumference	0.81	0.08	0.54	0.76	0.81	0.86	1.19	
		44. hip circumference/maximum hip circumference	0.97	0.01	0.89	0.96	0.97	0.98	1.00	
		45. front waistline→shoulder line length/ shoulder line→back waistline length	0.96	0.04	0.78	0.94	0.96	0.98	1.09	
		Difference value of measure- ments	46. S.N.P.→B.P.→front waistline length - S.N.P.→B.P. length	14.30	2.52	2.80	12.70	14.30	16.10	22.30
			47. bust circumference - under-bust circumference	10.29	2.62	4.20	8.60	10.50	12.00	21.90
	48. back abdominal circumference		47.60	3.71	37.00	45.40	47.50	50.05	57.10	
	49. front hip circumference		41.83	2.96	29.60	40.00	41.70	43.35	50.60	
	50. maximum hip circumference - hip circumference		2.79	1.46	0.20	1.85	2.60	3.50	11.50	
Indirect measure- ment	Angle	51. upper abdomen angle (°)	10.61	4.32	-6.50	8.00	10.50	13.50	22.50	
		52. lower abdomen angle (°)	16.92	6.81	1.00	12.00	16.00	21.00	38.00	
		53. upper buttock angle (°)	14.09	4.25	1.00	11.50	14.00	16.50	28.00	

belongs to a prominent abdomen. The criterion of *prominent buttocks* is upper buttock angle. Therefore according to the result, prominent abdomen is when upper abdomen angle is above 13.5° or when lower abdomen angle is above 21°. If upper buttock angle is above 16.5°, she is classified into prominent buttocks (Table 2).

Only 50% of the people didn't have a fitting problem wearing ready-to-wear, 25% of them had the problem but could wear, and the other 25% could not wear ready-to-wear (Preiss et al., 1996; incited by Kim, 1998). Therefore, in this study 75% was set up as the criterion of somatotype classification for bust development, abdomen prominence, and buttock prominence, because small bust, flat abdomen, and flat buttocks do not cause a serious fitting problem.

3. Statistical analysis

In order to find out somatotype differences and the structure of the differences, GLM (General Linear Models) procedure and SNK (Student - Newman - Keuls) tests were done. For the discriminant criteria of somatotypes, stepwise discriminant analysis was done. Discriminant functions were created and the hit ratios were also calculated. The package for statistics was SASWIN.

III. Results and Discussion

1. Anthropometric data

The mean, S.D., and quartile of the anthropometric data of this study are shown in Table 2.

2. Somatotype difference

1) Upper body

The distribution of subjects for the upper body somatotypes is shown in Table 3. The frequency of *leaning back posture - large bust* was too low (8,

Table 3. Distribution of subjects for somatotypes of the upper body

Somatotype		N	Percentage(%)
Posture	Bust		
straight	medium/small	94	37.30
	large	28	11.11
leaning back	medium/small	23	9.13
	large	8	3.17
bent forward/ swayback	medium/small	72	28.57
	large	27	10.71
Total		252	100.00

3.17%), so it was appropriate to eliminate the somatotype from the somatotype groups of this study.

The measurement items which had big differences among the upper body somatotypes were 1) six direct measurements: *back interscye breadth*, *front interscye breadth*, *S.N.P.→scapular→back waistline length*, *waist front length*, *S.N.P.→B.P.→front waistline length*, and *front diagonal length*; 2) seven indexes: *chest shoulder length/back shoulder length*, *front interscye breadth/back interscye breadth*, *waist front length/back length*, *S.N.P.→B.P.→front waistline length/S.N.P.→scapular→back waistline length*, *front diagonal length/back diagonal length*, *bust circumference/under-bust circumference*, and *front waistline→shoulder line length/shoulder line→back waistline length*; 3) two difference value of measurements: *S.N.P.→B.P.→front waistline length - S.N.P.→B.P. length* and *bust circumference - under-bust circumference*; 4) one angle: *upper abdomen angle* (Table 4).

Stature, *weight*, *Rohrer index*, *bust circumference*, *waist circumference*, *hip circumference* etc. didn't have significant differences among somatotypes. This means that the somatotype differences of the upper body are just from somatotype, not from build or obesity.

Table 4. Somatotype differences & difference structures of measurement items for the upper body

Item		Somatotype	1. straight posture- medium /small bust	2. straight posture - large bust	3. leaning back posture- medium /small bust	4. bent forward /swayback posture- medium/ small bust	5. bent forward/ swayback posture- large bust	F-value	Difference structures (No.: Somatotype)
Height	1. stature		154.32	154.58	152.75	154.04	156.00	1.51	
	2. neck height posterior		130.23	130.29	129.33	130.25	132.12	1.36	
Breadth	3. back neck breadth		6.29	6.28	6.01	6.42	6.03	2.13	3 / (2 1) 4 5
	4. front neck breadth		5.70	5.60	5.86	5.91	5.92	1.22	
	5. back neck depth		4.75	4.80	4.68	5.19	5.13	1.99	
	6. front neck depth		7.55	7.66	7.90	7.20	7.04	3.39*	
	7. nipple to nipple breadth		17.13	17.48	17.53	17.19	17.24	0.39	
Circumference	8. chest circumference		88.97	88.94	90.25	89.02	89.12	0.28	3/(4 1)/2 5
	9. bust circumference		90.85	92.33	93.32	91.04	91.60	0.95	
	10. under-bust circumference		81.52	79.05	83.64	82.01	78.13	4.19**	
	11. waist circumference		76.85	75.24	78.99	78.12	74.78	2.05	
	12. front abdominal circumference		44.01	43.79	44.65	44.24	42.94	0.95	
	13. abdominal circumference		91.77	91.30	92.64	91.78	90.59	0.43	
	14. back hip circumference		51.74	52.44	51.41	51.89	51.77	0.34	
	15. hip circumference		93.67	94.16	93.58	93.70	93.37	0.12	
	16. maximum hip circumference		96.32	96.99	97.14	96.56	95.85	0.32	
Length	17. back shoulder length		39.08	39.95	38.55	39.25	39.87	2.26	5 / (4 2) 1 / 3
	18. back interscye breadth		36.76	37.00	35.91	38.11	38.47	6.38***	
	19. back length		38.75	38.87	39.18	39.58	39.72	1.94	
	20. S.N.P.→scapular→back waistline length		42.49	42.65	42.30	43.82	43.80	6.58***	
	21. back diagonal length		41.52	41.36	41.48	41.75	41.19	0.28	
	22. chest shoulder length		37.44	38.08	38.57	37.64	36.93	1.70	
	23. front interscye breadth		33.12	32.95	35.63	31.86	31.69	18.69***	
	24. waist front length		33.31	33.90	34.67	32.39	33.62	5.64***	
	25. S.N.P.→B.P. length		26.08	27.10	26.66	25.69	25.76	2.75*	
	26. S.N.P.→B.P.→front waistline length		40.51	41.40	42.56	39.19	40.54	11.55***	
	27. front diagonal length		40.38	41.04	42.45	39.93	40.53	5.58***	
	28. front waistline→shoulder line length		36.26	35.84	37.45	35.45	35.89	4.23**	
	29. shoulder line→back waistline length		37.65	37.68	37.04	37.95	38.21	1.17	
	30. shoulder length		12.53	13.01	12.82	12.49	12.70	2.15	
	31. abdominal length		10.52	10.61	9.97	10.66	10.16	0.74	
	32. hip length		18.35	18.40	18.49	18.19	18.21	0.19	
Others	34. weight (kg)		57.99	58.61	59.10	57.97	57.73	0.20	
Index	35. Rohrer index		1.58	1.59	1.66	1.59	1.53	1.71	3 / 4 1 2 5
	36. chest shoulder length/back shoulder length		0.96	0.96	1.00	0.96	0.93	4.96***	
	37. front interscye breadth/back interscye breadth		0.90	0.89	0.99	0.84	0.83	49.86***	
	38. waist front length / back length		0.86	0.87	0.88	0.82	0.85	12.37***	
	39. S.N.P.→B.P.→front waistline length / S.N.P.→scapular→back waistline length		0.95	0.97	1.01	0.90	0.93	50.13***	
	40. front diagonal length/back diagonal length		0.97	0.99	1.02	0.96	0.99	6.31***	
	41. bust circumference/under-bust circumference		1.12	1.17	1.12	1.11	1.17	61.69***	
	42. front abdominal circumference / back abdominal circumference		0.93	0.93	0.94	0.93	0.91	0.51	
	43. front hip circumference / back hip circumference		0.81	0.80	0.83	0.81	0.81	0.45	
	44. hip circumference / maximum hip circumference		0.97	0.97	0.96	0.97	0.97	2.23	
	45. front waistline→shoulder line length / shoulder line→back waistline length		0.96	0.95	1.01	0.94	0.94	32.93***	
Difference Value	46. S.N.P.→B.P.→front waistline length - S.N.P.→B.P. length		14.43	14.30	15.90	13.50	14.78	5.17***	3 / 5 1 2 4
	47. bust circumference-under-bust circumference		9.34	13.28	9.69	9.04	13.46	50.51***	5 2 / 3 1 4
	48. back abdominal circumference		47.76	47.51	47.99	47.54	47.65	0.09	
	49. front hip circumference		41.93	41.72	42.17	41.82	41.60	0.14	
	50. maximum hip circumference-hip circumference		2.65	2.83	3.57	2.86	2.49	2.16	
Angle	51. upper abdomen angle (°)		10.27	10.46	7.33	11.47	12.63	6.13***	5 4 2 1 / 3
	52. lower abdomen angle (°)		16.79	17.88	17.50	17.72	13.46	2.18	
	53. upper buttock angle (°)		13.89	14.43	16.41	14.13	12.61	2.66*	3 / (2 4 1) / 5

* The numbers of the columns of somatotypes represent mean (cm).

* p<0.05, ** p<0.01, *** p<0.001

/: / separates groups which have differences

(): the group inside parentheses could be outside parentheses

Therefore the measurement items, which had differences, can be used for pattern making for each somatotype.

S.N.P. → B.P. → front waistline length / S.N.P. → scapular → back waistline length, front interscye breadth / back interscye breadth, waist front length / back length, and front waistline → shoulder line length / shoulder line → back waistline length had the differences among *leaning back posture, straight posture, and bent forward / swayback posture* in order. *Leaning back posture* had a longer and wider front body than *straight posture* had, and *bent forward / swayback posture* had a longer and wider back body than *straight posture* had. The measurements of *bust circumference / under-bust circumference* and *bust circumference - under-bust circumference* represent bust developments. *Bent forward / swayback posture - large bust* and *straight posture - large bust* were in the same group for *bust circumference / under-bust circumference*. *Leaning back posture - medium / small bust, straight posture - medium / small bust, and bent forward / swayback posture - medium / small bust* were in the same group for *bust circumference / under-bust circumference*.

2) Lower body

The distribution of subjects for the lower body somatotypes is shown in Table 5.

The measurement items which had big differences among the lower body somatotypes were 1) four circumferences: *waist circumference, front abdominal circumference, abdominal circumference, and hip circumference*; 2) two indexes: *Rohrer index* and *hip circumference / maximum hip circumference*; 3) three angles: *upper abdomen angle, under abdomen angle, and upper buttock angle. Front abdominal circumference / back abdominal circumference*, which was expected to

Table 5. Distribution of subjects for the lower body somatotypes

Somatotype		N	Percentage (%)
Abdomen	Buttocks		
normal	normal	106	42.06
normal	prominent	34	13.49
prominent	normal	77	30.56
prominent	prominent	35	13.89
Total		252	100.00

have difference as for the somatotype *prominent abdomen*, didn't have the difference because the item is related to build or obesity (Table 6).

Prominent abdomen - normal buttocks and *prominent abdomen - prominent buttocks* had longer *front abdominal circumferences* than others had. For *upper abdomen angle, prominent abdomen - normal buttocks* had a big value and for *under abdomen angle, prominent abdomen - prominent buttocks* had a big value. *Normal abdomen - prominent buttocks* and *prominent abdomen - prominent buttocks* had longer *back buttocks circumference* and larger *upper buttock angle* than the others had. *Prominent abdomen - prominent buttocks* especially had big measurements of *Rohrer index, waist circumference, abdominal circumference, maximum hip circumference, and maximum hip circumference - hip circumference*. This means the somatotype is deeply related to obesity.

2. Somatotype discrimination

1) Upper body

The discriminant variables of the upper body were four items: *front interscye breadth / back interscye breadth, bust circumference / under-bust circumference, S.N.P. → B.P. → front waistline length / side neck point → scapular → back waistline length, and front waistline → shoulder line length / shoulder line → back waistline length*.

The discriminant coefficients through these four

Table 6. Somatotype differences & difference structures of measurement items for the lower body

Somatotype		1. normal abdomen -normal buttocks	2. normal abdomen- prominent buttocks	3. prominent abdomen -normal buttocks	4. prominent abdomen- prominent buttocks	F-value	Difference structures (No.: Somatotype)
Height	1. stature	154.83	155.69	153.54	153.19	2.21	
	2. neck height posterior	130.36	131.36	129.81	129.69	1.27	
Circum- ference	11. waist circumference	75.90	74.43	77.57	80.99	6.69***	4 / 3 1 2
	12. front abdominal circumference	43.18	42.82	44.69	45.75	7.97***	4 3 / 1 2
	13. abdominal circumference	90.17	90.85	92.32	94.73	6.45***	4 / 3 2 1
	14. back hip circumference	51.04	52.68	51.80	53.07	4.31**	4 2 / (3) / 1
	15. hip circumference	92.72	93.80	94.10	94.99	2.91	
	16. maximum hip circumference	95.11	96.19	97.03	99.13	6.92***	4 / 3 2 1
Length	31. abdominal length	10.44	10.11	10.68	10.31	0.77	
	32. hip length	18.56	17.59	18.46	18.15	2.69*	1 3 / (4) / 2
	33. crotch length	26.49	25.73	26.96	25.73	3.16*	3 / (1 4) / 2
Others	34. weight (kg)	56.92	58.29	58.21	60.65	2.84*	4 / (2 3) / 1
Index	35. Rohrer index	1.54	1.55	1.61	1.66	7.99***	4 / 3 2 1
	42. front abdominal circumference/ back abdominal circumference	0.92	0.90	0.94	0.94	2.63	
	43. front hip circumference / back hip circumference	0.82	0.78	0.82	0.79	2.57	
	44. hip circumference / maximum hip circumference	0.98	0.98	0.97	0.96	14.20***	2 1 3 / 4
Difference Value	48. back abdominal circumference	46.99	48.04	47.63	48.98	2.78*	4 / (2 3) / 1
	49. front hip circumference	41.68	41.12	42.30	41.92	1.42	
	50. maximum hip circumference - hip circumference	2.39	2.39	2.92	4.13	16.06***	4 / 3 2 1
Angle	51. upper abdomen angle(°)	9.24	8.52	13.69	10.00	25.10***	3 / 4 1 2
	52. lower abdomen angle(°)	13.69	14.22	19.16	24.39	38.36***	4 / 3 / 2 1
	53. upper buttock angle(°)	12.38	19.00	11.78	19.57	110.58***	4 2 / 1 3

* The numbers of the columns of somatotypes represent mean (cm).

*p<0.05, **p<0.01, ***p<0.001

/: / separates groups which have differences

(): the group inside parentheses could be outside parentheses

valuables are shown in Table 7.

The best discriminant function for the upper body through those discriminant coefficients was as follows:

Discriminant function 1

$$=12.335 \times A - 7.071 \times B + 12.876 \times C + 15.607 \times D$$

A: front interscye breadth/back interscye breadth,

B: bust circumference/under-bust circumference,

C: S.N.P.→B.P.→front waistline length/S.N.P.→
scapular→back waistline length,

D: front waistline→shoulder line length/ shoulder line
→ back waistline length

The centroid of the function is shown in Table 8.

The hit ratios of discriminant functions for the upper body are shown in Table 9. The hit ratio of *straight posture - medium/small bust* was 87.23%, that of *straight posture - large bust* was 82.14%, that of *leaning back posture - medium/small bust* was 82.61%, that of *bent forward/swayback posture - medium/small bust* was 79.17%, and that of *bent forward/swayback posture - large bust* was 88.89%. The hit ratios of all the upper body somatotypes were over 70%, which has high discriminant probability.

Table 7. Discriminant coefficients for the upper body

Discriminant coefficient Discriminant variable	Discriminant function 1	Discriminant function 2	Discriminant function 3	Discriminant function 4
front interscye breadth/ back interscye breadth	12.335	-1.199	-1.192	-14.560
bust circumference/ under-bust circumference	-7.071	39.851	9.110	-8.291
S.N.P.→B.P.→front waistline length/ S.N.P.→scapular→back waistline length	12.876	9.429	-16.161	13.556
front waistline→shoulder line length/ shoulder line→back waistline length	15.607	-3.104	28.826	10.177

Table 8. Centroid of discriminant function 1 for the upper body

Somatotype	Mean of discriminant score	Discriminant function 1
straight posture - medium/small bust		0.628
straight posture - large bust		0.152
leaning back posture - medium/small bust		3.139
bent forward/swayback posture - medium/small bust		-1.451
bent forward/swayback posture - large bust		-1.338

Table 9. Hit ratios of discriminant functions for the upper body

Discriminant somatotype Real somatotype	straight posture -medium /small bust	straight posture - large bust	leaning back posture -medium /small bust	bent forward /swayback posture -medium /small bust	bent forward /swayback posture - large bust
straight posture - medium/small bust	82 87.23	2 2.13	2 2.13	8 8.51	0 0.00
straight posture - large bust	3 10.71	23 82.14	0 0.00	0 0.00	2 7.14
leaning back posture - medium/small bust	4 17.39	0 0.00	19 82.61	0 0.00	0 0.00
bent forward/swayback posture - medium/small bust	14 19.44	0 0.00	1 1.39	57 79.17	0 0.00
bent forward/swayback posture - large bust	0 0.00	3 11.11	0 0.00	0 0.00	24 88.89
Total	103 42.21	28 11.48	22 9.02	65 26.64	26 10.66
Previous probability	0.385	0.115	0.094	0.295	0.111
Hit ratio	0.128	0.179	0.174	0.208	0.111

※ The numbers of the table represent 'N' and 'Percentage (%)'.

2) Lower body

The discriminant variables of the lower body were five items: *upper buttock angle, upper abdomen angle, under abdomen angle, hip circumference/*

maximum hip circumference, and back hip circumference.

The discriminant coefficients through these five valuables are shown in Table 10.

The best discriminant function for the lower body through those discriminant coefficients was as follows:

Discriminant function 1
 $=0.035 \times E+0.023 \times F+0.066 \times G-18.404 \times H+0.018 \times I$
 E: upper buttock angle, F: lower abdomen angle,
 G: upper abdomen angle,
 H: hip circumference/maximum hip circumference,
 I: back hip circumference

The centroid of the function is shown in Table 11.

The hit ratios of discriminant functions for the lower body are shown in Table 12. The hit ratio of *normal abdomen - normal buttocks* was 93.40%,

that of *normal abdomen - prominent buttocks* was 73.53%, that of *prominent abdomen - normal buttocks* was 83.12%, and that of *prominent abdomen - prominent buttocks* was 77.14%. The hit ratios of all the lower body somatotypes were over 70%, which has high discriminant probability. The items of angles, however, were not easy to measure, so the diagram of 4 somatotypes was suggested instead of the angle items (Fig. 2). Each somatotype had a representative value of an angle, which was the mean of anthropometric measurement of this study (Table 6).

Table 10. Discriminant coefficients for the lower body

Discriminant variable	Discriminant coefficient	Discriminant function 1'	Discriminant function 2'	Discriminant function 3'
upper buttock angle		0.035	-0.091	0.077
lower abdomen angle		0.023	0.155	-0.045
upper abdomen angle		0.066	0.223	0.156
hip circumference / maximum hip circumference		-18.404	-7.542	37.586
back hip circumference		0.018	0.042	0.106

Table 11. Centroid of discriminant function 1 for the lower body

Somatotype	Mean of discriminant score	Discriminant function 1'
normal abdomen - normal buttocks		-0.840
normal abdomen - prominent buttocks		1.455
prominent abdomen - normal buttocks		-0.528
prominent abdomen - prominent buttocks		2.291

Table 12. Hit ratios of discriminant functions for the lower body

Discriminant somatotype Real somatotype	normal abdomen - normal buttocks	normal abdomen - prominent buttocks	prominent abdomen - normal buttocks	prominent abdomen - prominent buttocks
normal abdomen - normal buttocks	99 93.40	1 0.94	6 5.66	0 0.00
normal abdomen - prominent buttocks	5 14.71	25 73.53	0 0.00	4 11.76
prominent abdomen - normal buttocks	12 15.58	0 0.00	64 83.12	1 1.30
prominent abdomen - prominent buttocks	0 0.00	3 8.57	5 14.29	27 77.14
Total	116 46.03	29 11.51	75 29.76	32 12.70
Previous probability	0.421	0.135	0.306	0.139
Hit ratio	0.066	0.265	0.169	0.229

* The numbers of the table represent N' and 'Percentage (%)'.

IV. Conclusions

The purpose of the study was to develop a somatotype discriminating system. The research procedures and results were as follows:

1. The criteria for the upper body somatotypes were lateral view and bust development. The upper body somatotypes were classified into five types: *straight posture - medium/small bust*, *straight posture - large bust*, *leaning back posture - medium/small bust*, *bent forward/swayback posture - medium/small bust*, and *bent forward/swayback posture - large bust*.

2. The criteria for the lower body somatotypes were abdominal prominence and buttock prominence. The lower body somatotypes were classified into four types: *normal abdomen - normal buttocks*, *normal abdomen - prominent buttocks*, *prominent abdomen - normal buttocks*, and *prominent abdomen - prominent buttocks*.

3. The discriminant variables for the upper body were four items: *bust circumference/under-bust circumference*, *front interscye breadth/back interscye breadth*, *S.N.P.→B.P.→front waistline length/S.N.P.→scapular→back waistline length*, and *front waistline→shoulder line length/shoulder line→back waistline length*.

4. The discriminant variables for the lower body were five items: *upper buttock angle*, *under abdomen angle*, *upper abdomen angle*, *hip circumference/maximum hip circumference*, and *back hip circumference*. However, those angle items were difficult to measure, so the diagram for the 4 somatotypes was suggested instead of the angle items.

5. The hit ratios of discriminant functions for the upper and lower body were all over 70%.

This study has limitations about the places of

measurement and the numbers of subjects, so it is needful to be cautious when applying the result of this study to the entire population of middle-aged women in Korea.

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