A Comparison of Chinese Women's Lower Body Features in Shanghai and Hong Kong

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Abstract

In this study, we analyzed the figure type and lower-body size of Shanghai and Hong Kong adult women in their early twenties using the data obtained from 3D whole body scanners. We also provided concrete information related to women's lower bodies, in terms of crotch width, crotch length, inseam, outseam, slope of waist, etc., among women in Shanghai and Hong Kong. The result may be useful to the Chinese apparel industry when designing trouser pants for adult women.

According to the results of the factor analysis for categorizing the body shape of the lower half, 5 factors were obtained: obesity of the lower half factor, height of the lower half factor, length from waist to the crotch factor, factor related to legs, and shape of the abdomen factor. After performing a cluster analysis according to the factor analysis, three clusters were set: Cluster 1 was represented as the lower half growth type, which has a high value in height of the lower half factor and grows in the abdomen part. Cluster 2 was represented as thin legs type, which has a low value in most part compared to the length of leg bones and factors about legs that have high value. Cluster 3 was represented as the obesity type having a high value in the obesity of the lower half factor. Overall, thin legs type achieved a high rate in Shanghai adult women and obesity type received a high rate in adult women living in Hong Kong.

Key words : body shape, China, Hong Kong, Lower body, 3D

1. Introduction

To design dress with outstanding fit, acknowledging body of human is needed to be preceded. Body shape is the most outer shape

that is composed of skeleton, muscle, thickness and position of panniculus, and pose. Body shape is different depending on sex, age, race and so on. Since individual difference is very large though sex, age, and race are same, study of body shape according to sex, age,

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race is essential to design dress with outstanding formativeness and wearability.

Human body measurements are important for an exact analysis of body figure type, and obviously lead to advances in quality of fit. In the past, the length of the human body and its circumference were obtained using a measuring tape, yielding 2D data from 3D measurements. These data provide information on body size in a static situation, but do not provide 3D data on body shape. Two-dimensional methods are inaccurate because the 3D data differ for each person and circumstance. We have thus come to use a 3D whole body scanner for body measurements. Such scanners obtain a 3D figure, providing measurements for the body size and appearance without direct body measurements. In addition, highly authentic sampling information can be used repeatedly. This removes some of the obstacles to human body measurement (Choi, 2008; Dong, 2001; Kim, 2006).

A number of domestic and overseas projects, such as the launch of a spaceship in 2003, distributive liberalization in 2005, and the Beijing Olympics in 2008, have seen China gain the attention of the world as a large consumer market. The inflow of varied information, rise in fashion standards, and intellectual elevation of socioeconomic activity on the development of mass media and high educational backgrounds mean that Chinese consumers are increasingly interested in imperial products and improved quality in their fashion surroundings. A preference for fashion products, the actual condition of wearing and purchasing, and information about Chinese body types have become necessary to develop clothing goods that cater to such consumer requests (Cha, 2008).

Hong Kong plays an important role as a global consumption market that every world fashion is gathered. Since Hong Kong had gotten effects a lot from British, they represent other consumption aspect compared to China. For these consumption market of China and Hong Kong, information such as body shape, wearing and purchasing status, and preference about clothing goods of consumers of China and Hong Kong.

In this study, we analyzed the figure type and lower-body size of Shanghai and Hong Kong adult women in their early 20's using data obtained from 3D whole body scanners. We also provide concrete information related to Shanghai and Hong Kong women's lower bodies in terms of crotch width, crotch length, inseam, outseam, slope of waist that may be useful to the Chinese apparel industry when designing trouser pants for adult women.

II. Method and Procedure of Research

1. Subjects

A total of 210 women from Donghua University, China and 100 women from Hong Kong Polytechnic University, Hong Kong were selected by simple random sampling. The women were aged from 18 to 24 years old.

2. Period and place of measurement

In China, a preliminary measuring test was conducted from 21–24 January, 2008, in the Human Engineering room, Clothes College, Donghua University, Shanghai. The main

measurement was carried out from 20 February to 30 March, 2008. In Hong Kong, the main measurement was carried out from 15 September to 30 October, 2010.

3. Posture of 3D body measurement

The subjects were asked to stand with their feet 30 cm apart and their legs straight. To prevent the loss of data from the crotch and armpit areas, they were also required to hold handles and look forward briefly without upper wear to ensure they were physically comfortable for the test, and wore a hat on their head after tying their hair.

4. Measurement instruments and garments

The 3D Whole Body Scanner (TC²Corporation) was used for measurements (Figure 2). The subjects wore only a thin pair of prevent the loss of data from the crotch and armpit areas, they were also required to hold handles and look forward briefly without upper wear to ensure they were physically comfortable for the test, and wore a hat on their head after tying their hair.

Figure 1. 3D Anthropometry Posture and Process of Body Scanning

Figure 2. Whole Body Scanner of TC² Corporation

5. Measurement items and analysis of 3D data

These data were analyzed using TC²Corporation's analysis program at the Hong Kong Polytechnic University. A total of 39 items were determined using the under body auto-extract program (Jung & Lee, 1998; Park, 2006; Lee & Lyu, 2007), (Table 1). These opened and analyzed an Excel program after conversion from ORD (OMAX Routed Data) files. The DC Suite program of the Digital Clothing Center at Seoul National University was used to make 3D forms.

6. Analysis program and methods

The data obtained were processed using the SPSSWIN 18.0 software. The average and standard deviation of the measurements were calculated to determine the lower body characteristics of Chinese adult women, and an exploratory factor analysis was used to draw measurement item factors of the lower body. A nonhierarchical K-means cluster analysis was performed on the basis of the factor loadings for lower-body grouping. A one-way ANOVA test was then used to verify the difference between lower-body measurement items derived from the clusters of lower-body measurements. Post-verification was completed using Duncan's multiple range test. The statistical significance was examined at a level of $\alpha = 0.05$.

Table 1. Measurement Parts

Division	Part		
Circumference	Waist Full	Hips Full	Abdomen Full
	Waist Front	Hips Front	Abdomen Front
	Waist Back	Hips Back	Abdomen Back
	Knee Left	Calf Left	Thigh Left
	Knee Right	Calf Right	Thigh Right
	Seat Full		
Height	Waist Height	Abdomen Height	Calf Height
	Hips Height	Knee Height	Thigh Height
	Seat Height	Height	
Width	Waist Width	Hips Width	Abdomen Width
	Seat Width		
Length	Crotch Length Full	Crotch Length Front	Crotch Length Back
	Waist to Hips	Knee Knock Left	Knee Knock Right
	Thigh Length	Outseam	Inseam
	Waist to Seat		
Other	Weight		

III. Results

After 3D scanning body of 210 Shanghai and 100 women of Hong Kong and analyzing data, results of Shanghai early-20s is like following. Average of circumference is 74.0cm for waist, 94.2cm for hip, and 83.4cm for abdomen. Average of height is 161.1cm for height, 96.7cm for waist, 90.6cm for abdomen, 75.9cm for hip, 66.6cm for thigh, 43.3cm for knee, and 31.1cm for calf. Average of width is 26.6cm for waist, 30.3cm for abdomen, and 34.8cm for hip. Average of length is 65.4cm for full crotch, 21.6cm for hip, 99.5cm for knee knock, 28.9cm for thigh, 97.4cm for outseam, and 71.6cm for inseam. Weight was shown 52.4kg for average. In case of data of Hong Kong is like following. Average of circumference is 73.0cm for waist, 94.6cm for hip, and 82.7cm for abdomen. Average of height is 158.4cm for height, 94.0cm for waist, 75.4cm for hip, 68.3cm for thigh, 43.5cm for knee, and 32.7cm for calf. Average of width is 26.3cm for waist, 30.0cm for abdomen, and 35.6cm for hip. Average of length is 61.5cm for full crotch, 21.1cm for hip, 99.6cm for knee knock, 30.8cm for thigh, 95.7cm for outseam, and 75.2cm for inseam. Weight was shown 52.3kg for average. There were meaningful differences in height: waist, abdomen, thigh, and so on, and length: full crotch, thigh, outseam, inseam, and so on. In case of height, compared to Shanghai women is 161.1cm for average, Hong Kong women is a little bit shorter as 158.4cm (Table 2). Body shape of lower half and sectional diagram by part of Shanghai and Hong Kong early 20s women are shown like Figure 3 and Figure 4. Rather than Shanghai women, Hong Kong women are more slim, but Hong Kong women have protruded abdomen and thick thigh.

In order to classify 39 lower half measurement factors to several body configuration factors, exploratory factor analysis was conducted. After factor analysis, five factors that eigenvalue is over 1 were extracted and variance explanation power of five factors was shown as about 82.3%. Factor 1 was shown that has eigenvalue as about 14.6 and explains 37.3% of total variations. Since it is consisted of hip circumference, hip width, weight, waist circumference, waist width, and so on, it was named 'Obesity of lower half factor.' Factor 2 was shown that has eigenvalue as about 7.2 and explains about 18.4% of total variations. Since it is consisted of height, waist height, hip height, thigh height, abdomen height, calf height, length of outseam and inseam, and so on, it was named 'Height of lower half factor.' Factor 3 was shown that has eigenvalue as about 5.9 and explains about 15.2% of total variations. Since it is consisted of crotch length, front crotch length, back crotch length, hip length, and so on, it was named 'Length from waist to the crotch factor.' Factor 4 was shown that has eigenvalue as about 2.6 and explains about 6.7% of total variations. Since it is consisted of leg bone length, knee circumference, calf circumference, thigh circumference, and so on, it was named 'Factor related to legs.' Factor 5 was shown that has eigenvalue as about 1.8 and explains about 4.3% of total variations. Since it is consisted of abdomen width, abdomen circumference, front abdomen circumference, back abdomen circumference, and so on, it was named 'Shape of abdomen factor.' (Table 3, 4).

Table 2. Differences in the Body Index Between Shanghai and Hong Kong

(unit: cm/kg)

Division	Shanghai(n=210)		Hong Kong(n=100)		t
	Average	SD	Average	SD	
Waist Full	74.0	6.5	73.0	7.9	1.16
Waist Front	35.7	3.3	35.2	4.0	1.23
Waist Back	38.3	3.2	37.8	4.0	1.11
Waist Height	96.7	4.9	94.0	4.7	4.64***
Waist Width	26.6	2.3	26.3	2.6	0.83
Hips Full	94.2	4.9	94.6	6.4	-0.60
Hips Front	46.5	2.5	48.6	4.3	-4.37***
Hips Back	47.7	3.4	46.1	5.1	2.92**
Hips Height	75.9	4.2	75.3	6.1	0.90
Hips Width	34.8	1.8	35.6	2.4	-3.22**
Abdomen Full	83.4	6.8	82.7	9.0	0.66
Abdomen Front	40.7	3.4	40.3	4.7	0.70
Abdomen Back	42.7	3.6	42.1	4.7	1.13
Abdomen Height	90.6	5.2	89.1	5.6	2.33*
Abdomen Width	30.3	2.4	30.0	3.2	0.66
Crotch Length Full	65.4	5.8	61.5	7.4	4.97***
Crotch Length Front	32.4	2.9	30.5	3.2	5.10***
Crotch Length Back	33.0	3.2	31.0	4.5	4.47***
Waist to Hips	21.6	3.3	21.1	4.8	0.97
Knee Left	37.9	2.3	36.9	3.3	2.85**
Knee Right	37.8	2.3	37.0	3.4	2.07*
Knee Height	43.3	2.2	43.5	4.7	-0.57
Knee Knock Left	99.7	0.9	99.6	1.3	0.50
Knee Knock Right	99.5	0.8	99.6	1.3	-0.63
Calf Left	37.3	2.5	36.0	3.1	3.87***
Calf Right	37.0	2.2	36.5	2.8	1.48
Calf Height	31.1	2.2	32.7	5.7	-2.74**
Thigh Left	52.6	3.6	54.9	6.9	-3.07**
Thigh Right	52.9	3.6	55.1	7.2	-2.92**
Thigh Height	66.6	3.9	68.3	6.1	-2.44*
Thigh Length	28.9	2.4	30.8	4.5	-3.88***
Outseam	97.4	5.0	95.7	4.6	2.80**
Inseam	71.6	3.9	75.2	6.5	-5.06***
Seat Full	92.7	4.7	91.7	6.3	1.33
Seat Height	80.2	4.0	79.4	4.5	1.42
Seat Width	33.7	1.7	33.8	2.1	-0.44
Waist to Seat	17.2	2.5	16.0	3.0	3.51*
Height	161.1	5.9	158.4	6.3	3.68***
Weight	52.4	6.7	52.3	8.8	0.07

*p<0.05, **p<0.01, ***p<.001

	Shanghai	Hong Kong
0°
45°
90°
135°
180°

Figure 3. Differences in Lower Body Shape Between Shanghai and Hong Kong

Figure 4. Sectioned Diagram of Lower Body Between Shanghai and Hong Kong

Table 3. Factor Analysis Contributory Rate of Lower Body Index and Factor Name

Factor	Contents	Eigen-value	Contributory rate (%)	Accumulated contributory rate (%)
1	Obesity of lower body	14.57	37.35	37.35
2	Height of lower body	7.18	18.42	55.76
3	Length from waist to crotch	5.93	15.21	70.97
4	Related leg	2.63	6.74	77.71
5	Shape of abdomen	1.77	4.54	82.25

Table 4. Factor Analysis Results of Related Lower Body Index

Division	Factor loadage					Community (h ²)
	factor 1	factor 2	factor 3	factor 4	factor 5	
Hips Full	0.93	0.04	0.25	0.11	0.13	0.95
Seat Width	0.91	0.08	0.25	0.02	0.10	0.90
Seat Full	0.91	0.05	0.25	0.17	0.20	0.95
Hips Width	0.88	0.02	0.26	-0.15	-0.02	0.86
Weight	0.80	0.24	0.16	0.36	0.22	0.90
Waist Back	0.79	-0.02	-0.09	0.31	0.34	0.84
Waist Full	0.79	-0.02	-0.09	0.31	0.34	0.84
Waist Front	0.79	-0.02	-0.09	0.31	0.35	0.55
Waist Width	0.77	0.03	-0.15	0.21	0.38	0.81
Hips Front	0.71	0.05	0.09	-0.20	-0.06	0.84
Hips Back	0.66	0.01	0.26	0.31	0.23	0.65
Seat Height	0.08	0.94	0.08	0.11	0.12	0.92
Thigh Height	-0.05	0.93	-0.30	0.12	-0.03	0.97
Inseam	-0.00	0.90	-0.34	0.12	-0.08	0.94
Hips Height	0.07	0.87	-0.06	0.28	0.21	0.88
Outseam	0.10	0.85	0.48	-0.04	0.04	0.97
Waist Height	0.10	0.82	0.52	-0.01	0.06	0.96
Height	0.25	0.78	0.29	-0.10	0.12	0.78
Knee Height	-0.05	0.78	0.03	0.36	-0.07	0.74
Abdomen Height	0.20	0.69	0.30	0.06	-0.45	0.81
Thigh Length	-0.03	0.60	-0.42	-0.19	-0.00	0.66
Calf Height	-0.07	0.59	-0.10	0.48	-0.08	0.60
Crotch Length Full	0.18	0.03	0.94	0.06	0.09	0.92
Crotch Length Back	0.18	-0.03	0.91	0.04	0.07	0.86
Crotch Length Front	0.17	0.11	0.89	0.09	0.10	0.85
Waist to Seat	0.06	0.09	0.84	-0.24	-0.13	0.79
Waist to Hips	0.04	-0.02	0.68	-0.43	-0.25	0.71

Table 4. Continued

Division	Factor loadage					Community (h ²)
	factor 1	factor 2	factor 3	factor 4	factor 5	
Knee Knock Left	-0.01	0.01	-0.04	0.76	0.13	0.60
Knee Left	0.45	0.21	0.12	0.76	0.03	0.84
Knee Right	0.44	0.26	0.09	0.74	-0.00	0.81
Knee Knock Right	-0.04	0.08	-0.12	0.71	0.14	0.55
Calf Left	0.50	0.06	0.09	0.65	0.13	0.70
Calf Right	0.62	0.10	0.05	0.62	0.11	0.80
Thigh Right	0.48	0.29	-0.36	0.59	-0.02	0.79
Thigh Left	0.41	0.27	-0.35	0.58	-0.01	0.79
Abdomen Width	0.44	0.07	0.02	0.09	0.78	0.90
Abdomen Front	0.46	0.07	-0.00	0.12	0.77	0.93
Abdomen Full	0.51	0.03	0.05	0.17	0.76	0.96
Abdomen Back	0.52	-0.01	0.09	0.21	0.74	0.92

Table 5. Cluster Analysis of Lower Body Figure

Division	Cluster			F
	cluster 1 (N=108)	cluster 2 (N=124)	cluster3 (N=74)	
Obesity of lower body	0.028	-0.408	0.664	32.51***
Height of lower body	0.804	-0.730	0.090	125.01***
Length from waist to crotch	0.614	0.123	-1.109	116.99***
Related leg	-0.236	0.285	-0.150	9.54***
Shape of abdomen	0.245	-0.110	-0.167	5.20**

p<0.01, *p<0.001

Cluster analysis was done to categorize shapes of lower half of women in two regions according to factors from factor analysis. As a result, three clusters that people were distributed the best were set Cluster 1 was represented as long lower half type (N=108) which has high value in most of height values including length of waist to crotch and shape of abdomen. Cluster 2 was represented as thin legs type (N=124) that has low value in most parts compared to length of leg bones and factors about legs that have high value. Cluster 3 was represented as obesity type (N=29) that has

high value in obesity of the lower half factor. Therefore, clusters were named lower half growth type, thin legs type, and obesity type in order of cluster 1, 2, 3 (Table 5, 6). Sectional diagram by parts and shapes of lower half by clusters is like Figure 5 and Figure 6.

There were relatively high ratio in thin legs type (44.3%) and lower half growth type (41.9%), but obesity type (13.8%) was relatively low. In contrast, there was the highest percentage in obesity type (45.0%) and followed thin legs type (35.0%) and lower half growth type (20.0%) (Table 7, 8, 9).

Table 6. Difference of Lower Body Items on Cluster (Total)

(unit: cm/kg)

Division	Cluster 1 Development (N=108)		Cluster 2 Slim legs (N=124)		Cluster 3 Obesity (N=29)		F	Duncan test		
	average	SD	average	SD	average	SD				
Waist Full	73.6	7.6	71.6	5.2	77.2	7.5	16.62***	b	c	a
Waist Front	35.5	3.8	34.5	2.6	37.3	3.7	16.56***	b	c	a
Waist Back	38.1	3.8	37.1	2.6	39.9	3.7	16.68***	b	c	a
Waist Height	100.9	3.7	92.9	2.7	93.6	3.9	188.13***	a	b	b
Waist Width	26.5	2.5	25.7	1.9	27.9	2.5	23.08***	b	b	a
Hips Full	95.5	5.3	92.5	4.7	95.9	5.9	13.78***	a	b	a
Hips Front	47.5	2.8	45.9	2.8	48.9	4.1	21.01***	b	c	a
Hips Back	48.0	3.9	46.6	3.3	47.0	5.2	3.60*	a	b	ab
Hips Height	79.0	4.0	72.5	3.5	76.3	4.9	77.11***	a	c	b
Hips Width	35.4	1.7	34.3	1.9	35.7	2.3	15.12***	a	b	a
Abdomen Full	84.7	8.4	80.9	6.9	84.7	6.4	9.89***	a	b	a
Abdomen Front	41.3	4.3	39.4	3.5	41.6	3.3	10.97***	a	b	a
Abdomen Back	43.3	4.5	41.5	3.7	42.9	3.3	7.37***	a	b	a
Abdomen Height	93.5	5.5	87.4	3.8	89.7	4.8	50.76***	a	c	b
Abdomen Width	30.8	2.9	29.4	2.5	30.8	2.3	11.17***	a	b	a
Crotch Length Full	68.3	5.3	64.2	3.9	57.8	7.1	85.64***	a	b	c
Crotch Length Front	33.8	2.6	31.7	2.0	28.9	2.9	88.04***	a	b	c
Crotch Length Back	34.5	2.9	32.6	2.3	29.0	4.5	67.66***	a	b	c
Waist to Hips	23.1	3.7	21.5	3.2	19.0	3.8	30.15***	a	b	c
Knee Left	37.8	2.6	37.2	2.5	37.8	3.0	1.60			
Knee Right	37.8	2.5	37.1	2.6	38.1	3.1	3.87*	ab	b	a
Knee Height	44.9	2.0	42.1	3.1	43.4	3.7	25.86***	a	c	a
Knee Knock Left	99.4	1.0	99.9	0.8	99.5	1.3	5.63**	b	a	b
Knee Knock Right	99.4	1.0	99.7	0.8	99.4	1.2	2.58			
Calf Left	36.9	2.9	36.6	2.5	37.2	3.1	1.16			
Calf Right	36.9	2.6	36.4	2.0	37.6	2.5	5.50**	ab	b	a
Calf Height	32.5	2.1	30.7	4.1	31.9	4.7	6.85**	a	b	a
Thigh Left	52.9	3.8	52.0	3.9	56.4	6.8	21.12***	b	b	a
Thigh Right	53.0	3.7	52.3	3.9	56.8	7.2	21.95***	b	b	a
Thigh Height	69.7	3.4	64.0	3.7	68.8	5.1	67.95***	a	c	b
Thigh Length	30.5	2.3	27.6	1.9	31.4	4.7	48.13***	a	b	a
Outseam	101.7	3.6	93.8	2.7	94.9	3.7	189.65***	a	b	b
Inseam	75.1	3.6	69.5	3.9	75.1	5.9	61.82***	a	c	a
Seat Full	93.6	5.0	90.5	4.5	93.7	6.1	14.04***	a	b	a
Seat Height	83.3	3.2	77.0	2.8	80.1	3.7	115.39***	a	c	b
Seat Width	34.1	1.6	33.0	1.6	34.3	2.1	18.31***	a	b	a
Waist to Seat	18.5	2.0	16.7	2.2	14.5	2.7	67.16***	a	b	c
Height	165.5	5.0	156.0	4.0	159.8	4.9	125.81***	a	c	b
Weight	54.8	8.0	49.3	5.0	54.0	8.2	20.27***	a	b	a

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

*a, b, c: Duncan's multiple range test (a>b>c).

	Cluster 1	Cluster 2	Cluster 3
0°
45°
90°
135°
180°

Figure 5. Difference of Lower Body Shapes on Cluster

Figure 6. Sectioned Diagram of Lower Body on Cluster

Table 7. Comparison of Lower Body Figure Between Shanghai and Hong Kong

Division	Shanghai	Hong Kong		χ^2 df
	N (%)	N (%)	N (%)	
Development	88 (41.9)	20	(20.0)	38.35***
Slim legs	93 (44.3)	35	(35.0)	
Obesity	29 (13.8)	45	(45.0)	
Total	210 (100.0)	100	(100.0)	

***p<0.001

Table 8. Difference of Lower Body Items on Cluster (Shanghai)

(unit: cm/kg)

Division	cluster 1 Development (N=88)		cluster 2 Slim legs (N=93)		cluster 3 Obesity (N=24)		F	Duncan test		
	average	SD	average	SD	average	SD				
Waist Full	73.6	6.3	72.3	5.4	80.7	6.4	22.71***	b	b	a
Waist Front	35.5	3.1	34.9	2.7	39.1	3.2	22.77***	b	b	a
Waist Back	38.1	3.1	37.4	2.7	41.6	3.2	22.78***	b	b	a
Waist Height	101.2	3.4	93.5	2.7	93.7	3.3	158.05***	a	b	b
Waist Width	26.5	2.2	25.8	1.9	29.2	2.3	28.83***	b	b	a
Hips Full	95.3	4.7	92.4	4.4	96.9	5.1	14.58***	a	b	a
Hips Front	47.2	2.5	45.4	2.1	48.1	2.4	20.70***	a	b	a
Hips Back	48.1	3.8	47.0	2.8	48.8	3.0	4.52*	ab	b	a
Hips Height	79.1	3.7	72.9	2.7	75.7	2.6	88.63***	a	c	b
Hips Width	35.2	1.6	34.0	1.5	35.8	1.8	18.13***	a	b	a
Abdomen Full	84.4	6.8	81.7	6.9	85.4	5.6	5.23**	a	b	a
Abdomen Front	41.1	3.4	39.9	3.5	42.0	2.8	5.57**	ab	b	a
Abdomen Back	43.3	3.6	41.8	3.6	43.4	3.0	4.56*	a	b	a
Abdomen Height	94.0	5.2	87.5	3.5	90.1	3.4	51.92***	a	c	b
Abdomen Width	30.7	2.4	29.6	2.4	31.1	2.0	6.92**	a	b	a
Crotch Length Full	68.6	5.2	64.4	4.0	58.8	5.9	48.23***	a	b	c
Crotch Length Front	33.9	2.6	31.9	2.0	29.1	3.2	45.98***	a	b	c
Crotch Length Back	34.7	2.9	32.5	2.5	29.7	2.9	39.29***	a	b	c
Waist to Hips	23.0	3.5	21.2	2.3	18.4	2.8	29.16***	a	b	c
Knee Left	38.3	2.4	37.4	2.1	38.6	2.1	4.81**	a	b	a
Knee Right	38.2	2.3	37.2	2.2	38.5	2.2	6.73**	a	b	a
Knee Height	44.9	1.8	41.7	1.4	43.3	1.9	85.41***	a	b	a
Knee Knock Left	99.5	0.8	99.8	0.9	99.5	1.0	3.24*	b	a	b
Knee Knock Right	99.4	0.8	99.6	0.8	99.4	0.9	1.91			
Calf Left	37.4	2.5	36.8	2.5	38.3	2.5	4.55**	ab	b	a
Calf Right	37.3	2.3	36.5	1.9	38.0	2.1	6.71**	ab	b	a
Calf Height	32.4	2.1	29.9	1.6	31.0	1.5	45.24***	a	c	b
Thigh Left	53.2	3.6	51.5	3.2	54.6	3.9	11.32***	b	c	a
Thigh Right	53.3	3.5	51.8	3.2	54.9	3.9	10.07***	b	c	a
Thigh Height	69.6	2.9	63.7	2.5	67.0	2.9	108.50***	a	c	b
Thigh Length	30.3	2.1	27.4	1.9	29.3	2.2	46.88***	a	c	b
Outseam	101.9	3.4	94.1	2.8	94.1	3.4	158.62***	a	b	b
Inseam	74.6	2.9	68.7	2.5	72.0	2.9	108.53***	a	c	b
Seat Full	93.6	4.4	91.0	4.3	95.3	5.1	13.53***	a	b	a
Seat Height	83.4	2.8	77.1	2.6	80.0	2.9	121.18***	a	c	b
Seat Width	34.1	1.6	33.0	1.5	34.6	1.7	16.02***	a	b	a
Waist to Seat	18.5	1.9	16.9	1.8	14.1	2.7	54.60***	a	b	c
Height	165.6	5.0	156.9	3.8	160.7	3.6	91.38***	a	c	b
Weight	54.7	6.9	49.5	5.4	54.4	6.6	17.34***	a	b	a

*p<.05, **p<.01, ***p<.001

*a, b, c: Duncan's multiple range test (a>b>c).

Table 9. Difference of Lower Body Items on Cluster (Hong Kong)

(unit: cm/kg)

Division	Cluster 1 Development (N=20)		Cluster 2 Slim legs (N=35)		Cluster 3 Obesity (N=45)		F	Duncan test		
	average	SD	average	SD	average	SD				
Waist Full	73.7	12.0	69.9	4.2	75.0	7.4	4.42*	ab	b	a
Waist Front	35.6	6.0	33.7	2.1	36.2	3.7	4.49*	ab	b	a
Waist Back	38.1	6.0	36.3	2.1	38.8	3.7	4.32*	ab	b	a
Waist Height	99.5	4.4	91.5	2.1	93.5	4.3	30.58***	a	c	b
Waist Width	26.6	3.6	25.2	1.7	27.1	2.4	5.78**	a	b	a
Hips Full	96.4	7.6	92.8	5.3	95.2	6.4	2.35			
Hips Front	48.9	3.4	47.3	3.7	49.4	4.9	2.32			
Hips Back	47.4	4.5	45.5	4.2	45.9	5.9	0.95			
Hips Height	78.6	5.0	71.5	5.1	76.7	5.9	13.60***	a	b	a
Hips Width	36.3	1.5	35.1	2.4	35.7	2.6	1.55			
Abdomen Full	86.2	13.7	78.8	6.6	84.2	6.9	5.97**	a	b	a
Abdomen Front	42.3	7.1	38.1	3.2	41.3	3.6	7.59**	a	b	a
Abdomen Back	43.4	7.3	40.5	3.8	42.7	3.6	3.38*	a	b	a
Abdomen Height	91.6	6.5	87.2	4.4	89.4	5.6	4.53*	a	b	ab
Abdomen Width	31.1	4.6	28.7	2.6	30.6	2.4	5.36**	a	b	a
Crotch Length Full	67.3	5.8	63.8	3.7	57.2	7.8	21.50***	a	b	c
Crotch Length Front	33.5	3.0	31.1	2.1	28.7	2.8	24.72***	a	b	c
Crotch Length Back	33.8	2.9	32.7	1.9	28.5	5.2	17.45***	a	a	b
Waist to Hips	23.3	4.8	22.1	4.8	19.3	4.3	6.55**	a	a	b
Knee Left	35.7	2.8	36.9	3.4	37.4	3.4	1.82			
Knee Right	35.8	2.4	36.7	3.6	37.8	3.6	2.68			
Knee Height	44.7	3.0	43.0	5.5	43.4	4.6	0.89			
Knee Knock Left	99.0	1.5	100.0	0.8	99.6	1.5	3.76*	ab	b	a
Knee Knock Right	99.4	1.7	99.8	0.9	99.5	1.4	0.96			
Calf Left	34.5	3.5	36.1	2.3	36.5	3.2	3.31*	b	a	a
Calf Right	35.4	3.4	36.3	2.3	37.3	2.7	3.63*	b	ab	a
Calf Height	32.7	1.9	33.0	6.9	32.4	5.9	0.10			
Thigh Left	51.3	4.3	53.5	5.1	57.6	8.0	7.67**	b	b	a
Thigh Right	51.4	4.2	53.5	5.2	58.1	8.5	8.27***	b	b	a
Thigh Height	70.0	5.2	65.0	5.7	70.0	5.9	8.64***	a	b	a
Thigh Length	31.1	3.0	28.0	2.0	32.7	5.3	13.47***	a	b	a
Outseam	101.1	4.5	93.0	2.2	95.4	3.9	34.65***	a	c	b
Inseam	76.8	5.4	71.7	5.8	77.1	6.4	8.81***	a	b	a
Seat Full	93.5	7.3	89.4	4.9	92.8	6.5	3.98**	a	b	a
Seat Height	82.7	4.6	76.7	3.4	80.1	4.1	15.69***	a	c	b
Seat Width	34.4	1.9	33.0	1.9	34.2	2.2	4.26*	a	b	a
Waist to Seat	18.4	2.1	16.1	3.0	14.8	2.6	12.22***	a	b	b
Height	165.0	5.0	153.6	3.7	159.2	5.4	36.67***	a	c	b
Weight	55.2	12.0	48.9	3.9	53.7	9.2	4.63*	a	b	a

*p<.05,**p<.01, ***p<.001

*a, b, c: Duncan's multiple range test (a>b>c).

IV. Conclusion and Suggestion

In this study, we analyzed the figure type and lower-body size of Shanghai and Hong Kong adult women in their early twenties using data obtained from 3D whole body scanners. We also provided concrete information related to Shanghai and Hong Kong women's lower bodies in terms of crotch width, crotch length, inseam, outseam, slope of waist, and so on. That may be useful to the Chinese apparel industry when designing trouser pants for adult women.

According to results of factor analysis for categorizing the body shape of lower half, 5 factors were set: obesity of the lower half factor, height of the lower half factor, length from waist to the crotch factor, factor related to legs, and shape of abdomen factor. After doing cluster analysis according to factor analysis, three clusters were set: Cluster 1 was represented as lower half growth type which has high value in height of the lower half factor and grows in abdomen part. Cluster 2 was represented as thin legs type that has low value in most part compared to length of leg bones and factors about legs that have high value. Cluster 3 was represented as obesity type that has high value in obesity of the lower half factor. As the results, thin legs type got a high rate in Shanghai women and obesity type got a high rate in Hong Kong women.

However, since this study targeted just part of early-20s women in Shanghai and Hong Kong, generalization of these data must be exercised caution and in-depth research into various region and ages of Shanghai and Hong Kong will be needed. As it came out in comparison study, data of 3D whole body scanner and data of direct measurement is different: 4.9mm in minimum to 62.2mm in maximum in

circumference, 0.6mm in minimum to 51mm in maximum in height, 3.8mm in minimum to 21.9mm in maximum in width, and 0.3mm in minimum to 41.8mm in maximum in length (Cha, 2012). As the result, consideration of difference is needed. However, this study has a significance of comparison of lower body features between Shanghai and Hong Kong in China.

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