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Analysis of body shape and anthropometric measurements of US middle-aged women using 3D body scan data

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Abstract

The apparel industry has recently been recognizing the important target market of middle-aged women. The aim of this study was to examine the anthropometric characteristics of US women of 46 to 65 years of age and identify distinctive body shape characteristics of US middle-aged women. A total of 1915 middle-aged women whose ages ranged from 46 to 65 were selected from the SizeUSA database. The age range was divided into two groups: 46-55 and 56-65. Twenty-four body measurements important for apparel development were chosen. Four factors－Girth Factor, Height Factor, Hip Drop Factor, and Bust Drop Factor－accounted for the US middle-aged women's body measurements. The body shapes were classified into four body shapes, which were Y-Shape in the overweight range, S-Shape in the overweight range, H-Shape in the overweight range, and the A-Shape in obese range. H-Shape, which was the least-defined waist in relation to the bust and hips with a short height, existed more in older middle-aged women than in younger middle-aged women. Y-Shape, S-Shape, and A-Shape existed more in the group of younger middle-aged women than in the group of older middle-aged women. In addition, compared with the younger middle-aged women, older middle-aged women had narrower shoulders, a larger waist, thinner legs, and a longer distance between side neck to bust point. The findings from the current study may be applied in the apparel industry for developing clothing sizing systems for US middle-aged women.

Keywords: middle-aged, US women, body scan, size, body shape

I. Introduction

Middle-age is defined as from mid-40s to mid-60s by US Census Bureau (Middle Age, n.d.). The apparel industry has recently been recognizing the important target market of middle-aged women. Middle-aged women have more financial security than young women and are willing to spend more money on clothes than young women. To serve the big baby boomer middle-aged market, many US apparel companies are opening new brands targeting more mature women, providing better quality products which fit them better with comfort and yet still stylish (Garfinkel, 2008; Veciana-Suarez, 2011). This business focusing on the middle age women is not a strategy just among the US companies. In Japan, many fashion related business and big department stores are targeting women in their 40s and 50s for the success of their business and actively developing products and promotion plans (Tokuda, 2013). They recognized that middle-aged Japanese women are active consumers, still fashion conscious and paying attention to cosmetics. In Korea, high-priced as well as mid- and low-priced brands are starting clothing brands targeting middle-aged women,

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who would like to look stylish and slim as they were in their 20s and 30s (The Chosun Ilbo, 2010). Also, Korean lingerie companies are launching brands exclusively for the middle-aged women. However, some companies aiming this market such as Gap Inc.'s Forth & Towne, Janeville and Liz Claiborne Inc.'s Sigrid Olsen have not been able to keep their brands successfully (Agins, 2008). One key for the success of this apparel business is to develop size standards based on anthropometric studies of the body characteristics of the middle-aged women and provide clothes that fit them well.

The aim of this study was to examine the anthropometric characteristics of US women of 46 to 65 years of age and identify distinctive body shape characteristics of US middle-aged women. The detailed research goals were as follows.

1. To identify the factors that affect body shapes of the US women 46 to 65 years of age.
2. To classify the body shapes of the US women 46 to 65 years of age and examine their body shape characteristics.
3. To identify the relationships of age groups and body shape classifications.
4. To examine the differences in anthropometric data between the 46 to 55 years of age group and the 56 to 65 years of age group.

II. Background

1. Body change of middle-aged women

Women's body changes significantly as they age. Many women in their 30s go through pregnancy and childbirth, which result in changes in their body proportions. As women reach 40s and 50s, the changes accelerate as they go through menopause and experience hormone and metabolism change (Somers, 2014). Many studies reported that as women get older, circumference measurements and weight increase, bust line and shoulder droop, leg and arm become thinner and height decreases due to gradual bone loss (Garn, 1975; Hughes et al., 2004; Richards, 1981; Williamson, 1993). Such changes affect how clothing fit on their body, and clothes that were made to fit younger consumers will fit differently on middle-aged consumers. Studies on the body size and shape characteristics of middle-aged women are needed to better resolve the fit problems.

Ashdown and Na (2008) reported overall posture difference in upper body between the younger women aged 19-35 and older women aged 55+ in the US. Compared to the younger women, older women had increased back curvature, more rounded back shape, more forwarded neck and head position, lower and fuller bust, and an asymmetrical body configuration. To accommodate these changes, recommendations were made for older women's clothes to adjust the hem length of center front and center back of the upper garments and to change bust dart depth, location and length.

A study based on the UK National Sizing Survey using a 3D body scanner analyzed the 3D body shapes of 9614 participants aged 16-91 years based on their age and gender using BMI and other body measurements (Wells, Treleaven, & Cole, 2007). As women aged, there were tendencies that the fat was distributed around the waist area in the upper body. More women were in the overweight or obese range as age increased, which indicates that older women had heavier weight. Men showed relatively stable waist circumference across the age groups, whereas women had the waist circumference increased in relation to hip, chest and bust as age increased. Height, thigh, and head measurements decreased as age increased in both men and women.

Goldsberry, Shim, and Reich (1996) conducted a large scale anthropometric study collecting the body measurements of 6657 women aged 55 years and older in the US. The body measurements of the participants were analyzed as contrast to the body measurements of the PS 42-70 database developed in 1971. The results showed that as women aged, they had tendencies to have larger central and lower areas of torso with larger waist and abdomen, flatter buttocks, lower bustline,

broader back shoulder, enlarged armscye area and tilted head and neck due to changes in bone structure, muscle mass, and body frame. Recommendation was to create clothes that will fit on the more relaxed body frame in contrast to the erect body frame that young women have.

Park (1998) studied the characteristics of Korean women's body types according to age differences. Body characteristics were analyzed using important circumference measurements including chest circumference, bust circumference, under bust circumference, waist circumference and hip circumference. Women in their 20s and 30s had defined waist curve lines from bust level to hip level. Women in their 40s started to have smaller drop value of bust circumference minus waist circumference due to breast beginning to sag. Women in their 50s and 60s started to have larger upper body with fat accumulating around waist and abdomen areas resulting in O-shape.

2. Clothing preference and fit problems of middle-aged women

Apparel industry has generally focused on offering merchandises for young consumers as their main target market. More fashion retailers are recognizing the financial power and security of middle-aged women and providing products and service targeting the middle aged-group. However, several studies showed middle-aged women expressing their difficulties finding clothes with a good fit. Birtwistle and Tsim (2005) examined the purchasing behavior of the UK middle-aged women. The middle-aged women were interested in purchasing trendy and stylish clothes, but not too fashion forward that is likely to be worn by young consumers. They were looking for products that last long. Comfort and quality were also important factors when selecting clothing. They felt that many clothes do not reflect the body changes with aging of middle-aged women and were dissatisfied with fit of clothes that are currently available. They found pants that have good fit on both hip and waist areas were especially hard to find. They preferred skirts and pants with generous fit at the waist. Holmlund, Hagman, and Polsa, (2011) reported similar findings. They explored the purchase behavior of the middle-aged women aged from 50 to 63 in Finland. The Finnish middle-aged women considered stylish and fashionable clothes to give them more self-assurance and confidence. They especially paid attention to selecting the right color of clothes for them, and comfortable clothes that last a long time were important as well. Finding clothes with a good fit on them was a challenge. In general, clothes were too small for their body type and they would have to select larger sizes than normal for certain international brands. Pants were especially difficult to fit at the waist and thigh as they were too tight at the waist and thigh or too low at the waist.

Risius, Thelwell, Wagstaff, and Scurr (2012) studied the factors that middle-aged women considered when purchasing bras. Women aged 45-65 years stated that choosing bras that appropriate for each person's body type was the most important factor. Participants were most concerned with sagging breasts developed by ageing. Participants expressed the needs to purchase bras that give more support and uplift to the sagging breasts. Nam, Choi, and Kim (2013) investigated the clothing purchase behavior and preferences of Korean middle-aged women in their 40s and 50s. Women in their 40s were most dissatisfied with the fit of suit pants, blouse and shirts, and women in their 50s were most dissatisfied with the fit of one-piece dress and suit pants. They expressed the needs of better clothing sizing system for middle-aged women. Majority of them had experiences of alteration after purchasing clothes and felt it like wasting of their money.

III. Methods

1. Sample and procedures

SizeUSA is the largest national sizing study using 3D body scanning technology in the US conducted from 2002 to 2003 (Devarajan & Istook, 2004). [TC]^2

body scanner was used for SizeUSA study and more than 200 measurements were automatically extracted from the scanner software. The participants were from 12 cities across the US including age groups of 18-25, 26-35, 36-45, 46-55, 56-65 and over 60. For the current study purpose, a total of 1915 middle-aged women whose ages ranged from 46 to 65 were selected from the SizeUSA database. The age range was divided into two groups: 46-55 (n=1246, 65.07%) and 56-65 (n=669, 34.93%).

Twenty-four body measurements important for apparel development and sizing systems were chosen to analyze the anthropometric characteristics of the US middle-age women. Among 24 body measurement, 19 measurements were selected from the raw data extracted from the body scanner and 5 measurements were calculated measurements using the raw data. The 19 measurements were: Bust Girth, Waist Girth, Hip Girth, Neck Base Girth, Bust Point Distance, Side Neck to Bust Point Distance, Across Front Width, Back Shoulder Width (Contoured), Upper Arm Girth, Arm Length, Thigh Girth, Knee Girth, Height, Bust Height, Waist Height, Hip Height, Crotch Height, Thigh Height, and Knee Height. The 5 calculated measurements were: BMI, Waist Height/Height, Hip Girth - Waist Girth, Hip Girth - Bust Girth, and Bust Girth - Waist Girth. BMI was calculated based on height and weight to quantify body fat to categorize into underweight, normal weight, overweight and obese (NIH, n.d.). BMI of under 18.5 is underweight, from 18.5 to 24.9 is normal weight, from 25 to 29.9 is overweight, and of 30 or greater is obesity.

2. Data analysis

The data were analyzed by descriptive statistics, factor analysis, cluster analysis, chi-square test, one-way ANOVA, Duncan's post-hoc test, and *t*-test using SPSS program. Factor analysis was used to identify the factors that affect body shapes of the US women 46 to 65 years of age (Research Goal 1). Cluster analysis and one-way ANOVA were conducted to classify the body shapes of the US women 46 to 65 years of age and examine the body shape characteristics of the US middle-aged women (Research Goal 2). Chi-square test was used to identify the relationships of age groups and body shape classifications (Research Goal 3). *T*-test was used to examine the differences in anthropometric data between the 46 to 55 years of age group and the 56 to 65 years of age group (Research Goal 4).

IV. Results and Discussion

1. Factor analysis

The factor analysis results identified four factors accounting for the US middle-aged women's body measurements (reliability from .829 to .948) (Table 1). Principal component factor analysis with varimax rotation determined the optimal number of factors. The 12 measurements in Factor 1 were relevant to body girth: BMI, bust girth, waist girth, hip girth, upper arm girth, back shoulder width (contoured), across front width, neck base girth, side neck to bust point distance, bust point distance, thigh girth, and knee girth. Therefore, Factor 1 was labeled as Girth Factor, which accounted for 36.11% of the total variance (Eigenvalue =8.67). The 9 measurements in Factor 2 were relevant to body height: height, bust height, waist height, hip height, crotch height, knee height, arm length, thigh height, waist height/height. Therefore, Factor 2 was labeled as Height Factor, which accounted for 28.98% of the total variance (Eigenvalue = 6.96). The 2 measurements in Factor 3 were relevant to hip drop value: hip girth minus waist girth and hip girth minus bust girth. Therefore, Factor 3 was labeled as Hip Drop Factor, which accounted for 9.70% of the total variance (Eigenvalue =2.33). One measurement in Factor 4 was relevant to bust drop value: bust girth minus waist girth. Therefore, Factor 4 was labeled as Bust Drop Factor, which accounted for 7.17% of the total variance (Eigenvalue =1.72).

〈Table 1〉 Factor analysis of body measurements

Factor 1. Girth factor	Factor loading
BMI	.957
Bust girth	.952
Waist girth	.945
Hip girth	.924
Upper arm girth	.876
Bust point distance	.807
Back shoulder width (contoured)	.806
Thigh girth	.802
Side neck to bust point distance	.795
Neck base girth	.776
Knee girth	.743
Across front width	.506
Eigenvalue=8.67, % of variance=36.11% Cumulative %=36.11%, α=.924	
Factor 2. Height factor	Factor loading
Crotch height	.971
Thigh height	.971
Bust height	.936
Waist height	.929
Hip height	.918
Height	.884
Knee height	.862
Arm length	.793
Waist height/height	.428
Eigenvalue=6.96, % of variance=28.98% Cumulative %=65.09%, α=.948	
Factor 3. Hip drop factor	Factor loading
Hip girth – waist girth	.903
Hip girth – bust girth	.864
Eigenvalue=2.33, % of Variance=9.70% Cumulative%=74.79%, α =.829	
Factor 4. Bust drop factor	Factor loading
Bust girth - waist girth	.886
Eigenvalue=1.72, % of variance=7.17 % Cumulative %=81.96% α= -	

2. Body shape classifications of middle-aged women

The cluster analysis was performed to classify the US middle-aged women into different groups according to body shape and measurement characteristics. The results of a cluster analysis using factor scores from factor analysis revealed four clusters as optimal to classify the US middle-aged women's body shapes (Table 2). The numbers of women were evenly distributed between four groups. Group 1 had 511 women (26.68%), Group 2 had 588 women (30.70%), Group 3 had 487 women (25.43%), and Group 4 had 329 women (17.18%). From the analysis of one-way ANOVA and Duncan's post-hoc test, the mean measurements between four groups were compared (Table 3) to get a detailed account of body shape characteristics.

Group 1 had women with the highest factor score for Height Factor and the low factor score for Hip Drop Factor. More specifically, one-way ANOVA showed that all of the measurements in Height Factor including Crotch Height, Thigh Height, Bust Height, Waist Height, Hip Height, Height, Knee Height, Arm Length, Waist Height/Height were the largest in Group 1. Hip Girth minus Bust Girth was the smallest and Bust Girth and Back Shoulder Width (contoured) were large. Therefore, Group 1 was named as Y-Shape Group for the women were tall with large upper body with relatively smaller lower body with tall height. In addition, mean BMI of women in Group 1 was 27.06, which was in the overweight range.

Group 2 had women with the lowest factor score for Girth Factor, the highest factor score for Bust Drop Factor and the moderate factor score for Hip Drop Factor. More specifically, one-way ANOVA showed that Bust Girth minus Waist Girth and Hip Girth minus Waist Girth was the largest in Group 2 and the waist girth was the smallest in Group 2. Therefore, Group 2 was named as S-Shape Group for the women had the defined waist in relation to the bust and hip. In addition, mean BMI of women in Group 2 was 25.24, which was in the overweight range. BMI score in Group 2 was the smallest, therefore, women in Group 2 was the lightest among all 4 groups.

〈Table 2〉 Cluster analysis for body shape classification (N=1,915)

Factor	Cluster group				*F*-Value
	Cluster 1 (*n*=511)	Cluster 2 (*n*=588)	Cluster 3 (*n*=487)	Cluster 4 (*n*=329)	
Girth factor	−.019 (b)	−.560 (d)	−.167 (c)	1.279 (a)	398.03**
Height factor	1.060 (a)	−.348 (c)	−.646 (d)	−.069 (b)	509.22**
Hip drop factor	−.497 (c)	.348 (b)	−.542 (c)	.952 (a)	319.07**
Bust drop factor	.120 (b)	.677 (a)	−.849 (d)	−.140 (c)	315.77**

**p<.01, a~d: Duncan's multiple range test (a>b>c>d)
Cluster 1: Y-Shape group
Cluster 2: S-Shape group
Cluster 3: H-Shape group
Cluster 4: A-Shape group

〈Table 3〉 Body shape classification differences in anthropometric measurements (Unit: cm)

Anthropometric measurement		Cluster group				*F*-Value
		Y-Shape group (*n*=511)	S-Shape group (*n*=588)	H-Shape group (*n*=487)	A-Shape group (*n*=329)	
Girth factor	BMI	27.06 (b)	25.24 (c)	27.46 (b)	36.51 (a)	442.46**
	Bust girth	108.81 (b)	100.46 (d)	104.57 (c)	119.71 (a)	245.88**
	Waist girth	94.69 (b)	83.01 (c)	94.82 (b)	108.71 (a)	390.84**
	Hip girth	109.25 (b)	103.89 (d)	106.96 (c)	129.34 (a)	583.27**
	Upper arm girth	32.11 (b)	29.59 (d)	31.45 (c)	38.23 (a)	339.65**
	Bust point distance	21.87 (b)	20.55 (c)	20.80 (c)	23.47 (a)	151.23**
	Back shoulder width (contoured)	40.94 (b)	38.56 (d)	39.09 (c)	42.75 (a)	168.18**
	Thigh girth	61.75 (b)	59.39 (c)	59.11 (c)	74.42 (a)	524.85**
	Side neck to bust point distance	29.39 (b)	27.66 (d)	28.30 (c)	31.42 (a)	155.88**
	Neck base girth	39.67 (b)	37.08 (c)	39.50 (b)	41.91 (a)	227.35**
	Knee girth	39.45 (b)	37.69 (d)	38.43 (c)	44.53 (a)	395.16**
	Across front width	38.96 (b)	38.02 (c)	35.64 (d)	40.26 (a)	67.17**
Height factor	Crotch height	76.40 (a)	70.28 (b)	67.97 (c)	70.59 (b)	487.24**
	Thigh height	73.41 (a)	67.26 (b)	64.97 (c)	67.59 (b)	488.07**
	Bust height	121.08 (a)	113.26 (c)	111.02 (d)	115.14 (b)	397.88**
	Waist height	103.73 (a)	96.65 (c)	93.62 (d)	100.33 (b)	546.59**
	Hip height	87.66 (a)	80.37 (c)	78.94 (d)	84.18 (b)	499.52**
	Height	168.17 (a)	158.72 (c)	157.71 (d)	162.31 (b)	333.79**
	Knee height	46.94 (a)	43.03 (c)	42.32 (d)	43.54 (b)	286.70**
	Arm length	57.12 (a)	52.35 (c)	52.30 (c)	54.64 (b)	260.38**
	Waist height/height	.62 (a)	.61(b)	.59 (c)	.62 (a)	180.67**
Hip drop factor	Hip girth - waist girth	14.55 (b)	20.88 (a)	12.17 (c)	20.57 (a)	311.89**
	Hip girth - bust girth	0.43 (d)	3.43 (b)	2.41 (c)	9.63 (a)	141.31**
Bust drop factor	Bust girth - waist girth	14.12 (b)	17.45 (a)	9.75 (d)	10.95 (c)	330.05**

**p<.01, a~d: Duncan's multiple range test (a>b>c>d)
BMI unit: kg/m^2

Group 3 had women with the low factor score for Hip Drop Factor and the lowest factor score for Bust Drop Factor. More specifically, one-way ANOVA showed that Hip Girth minus Waist Girth and Hip Girth minus Bust Girth were small and Bust Girth minus Waist Girth was the smallest. All of the measurements in Height Factor including Crotch Height, Thigh Height, Bust Height, Waist Height, Hip Height, Height, Knee Height, Arm Length, Waist Height/ Height were the smallest in Group 3. Therefore, Group 3 was named as H-Shape Group for the women had the least-defined waist in relation to the bust and hip with short height. Mean BMI of women in Group 3 was 27.46, which was in the overweight range.

Group 4 had the highest factor score for Hip Drop Factor and the low factor score for Bust Drop Factor. More specifically, one-way ANOVA showed that Hip Girth minus Waist Girth and Hip Girth minus Bust Girth were the largest and Bust Girth minus Waist Girth was low. Therefore, Group 4 was named as A-Shape Group for the women had large lower body with relatively smaller upper body. In addition, mean BMI of women in Group 4 was 36.51, which was in the obese range. BMI score in Group 4 was the largest, therefore, women in Group 4 was the heaviest among all 4 groups.

3. Age groups and body shape classification

The current study investigated the body shape characteristics of the US women aged from 46 to 65. The body shape differences between the younger middle-aged women aged from 46 to 55 and older middle-aged women aged from 56 to 65 were examined to further analyze the body shape characteristics of the US middle-aged women. Body shapes were evenly distributed between Y-Shape (26.68%), S-Shape (30.70%), H-Shape (25.43%) and A-Shape (17.18%) groups, which indicated that the US middle- aged women had diverse body types.

When compared between two age groups by Chi-Square analysis, greater percentages (32.0%) of women aged from 56 to 65 had more H-Shape while 21.9% of women aged from 46 to 55 had H-Shape. That is, there were tendencies that H-Shape exists more in older middle-aged women than in younger middle-age women. The characteristics of H-Shape is the least-defined waist in relation to the bust and hip with short height. Therefore, the results imply that as middle-aged women enter into the older age, their waistline becomes less defined and less curvy, resulting in straighter body shape. In addition, as middle-aged women enter into the older age, there are tendencies that their height and height related body measurements become shorter.

Greater percentages of women aged from 46 to 55 had more Y-Shape (28.1%), S-Shape (31.8%), and A-Shape (18.2%) than the women aged from 56 to 65 had Y-Shape (24.1%), S-Shape (28.7%), and A-Shape (15.2%). This may indicate the younger middle-aged women had more diverse body shapes than the older middle-aged women. More specifically, more number of younger middle aged women had tall

〈Table 4〉 Body shape classification by age group (N=1915) ( )=col.%

Age group	Cluster group				Total *n* (%)
	Y-Shape group *n* (%)	S-Shape group *n* (%)	H-Shape group *n* (%)	A-Shape group *n* (%)	
46-55	350 (28.1)	396 (31.8)	273 (21.9)	227 (18.2)	1,246 (100.0)
56-65	161 (24.1)	192 (28.7)	214 (32.0)	102 (15.2)	669 (100.0)
Total	511 (26.7)	588 (30.7)	487 (25.4)	329 (17.2)	1,915 (100.0)
χ^2=23.61**, *df*=3					

**p<.01

height and large upper body (Y-Shape), defined waist in relation to the bust and hip (S-Shape), and a large lower body with a relatively smaller upper body (A-Shape).

4. Age groups and body measurements

T-test was used to examine the differences in anthropometric data between 46-55 age group and 56-65 age group. Significant differences existed in 14 out of 24 body measurements between the two age groups.

Among 12 measurements in Girth Factor, 4 measurements were significantly different between the two age groups. Back Shoulder Width (Contoured), Thigh Girth and Across Front Width were significantly larger in 46-55 age group than in 56-65 age group. Neck Base Girth was significantly larger in 56-65 age group than in 46-55 age group. Although not statistically significant, Waist Girth and Side Neck to Bust Point Distance were larger in 56-65 age group than in 46-55 age group. The results showed that younger

〈Table 5〉 Age groups differences in anthropometric measurements (Unit: cm)

Anthropometric measurement		Age group		*t*-Value
		46-55 (*n*=1,246)	56-65 (*n*=669)	
Girth factor	BMI	28.31	28.13	.64
	Bust girth	107.06	107.09	−.03
	Waist girth	93.24	94.23	−1.47
	Hip girth	110.64	110.29	.56
	Upper arm girth	32.18	32.39	−.87
	Bust point distance	21.44	21.51	−.63
	Back shoulder width (contoured)	40.21	39.75	2.76**
	Thigh girth	62.64	61.09	4.74**
	Side neck to bust point distance	28.85	29.11	−1.80
	Neck base girth	39.09	39.47	−2.42**
	Knee girth	39.52	39.55	−.10
	Across front width	38.30	37.59	2.79**
Height factor	Crotch height	71.78	70.64	5.03**
	Thigh height	68.73	67.61	4.61**
	Bust height	115.70	114.00	5.82**
	Waist height	98.65	97.92	2.70**
	Hip height	82.93	81.99	3.68**
	Height	162.08	160.73	3.88**
	Knee height	44.12	43.66	2.88**
	Arm length	54.08	53.85	1.35
	Waist height/height	0.58	0.59	−2.85**
Hip drop factor	Hip girth - waist girth	17.40	16.05	4.21**
	Hip girth - bust girth	3.58	3.23	1.06
Bust drop factor	Bust girth - waist girth	13.82	12.85	3.84**

**$p<.01$ BMI unit: kg/m^2

middle-aged women have broader shoulders, smaller waist, thicker legs, and a shorter distance between side neck to bust points while older middle-aged women have narrower shoulders, larger waist, thinner legs, and a longer distance between side neck to bust point.

Almost all measurements in Height Factor, 8 out of 9 measurements, were significantly different between the two age groups. Crotch Height, Thigh Height, Bust Height, Waist Height, Hip Height, Height, Knee Height, and Waist Height/Height were significantly larger in 46-55 age group than in 56-65 age group. The results showed that younger middle-aged women are taller and older middle-aged women are shorter.

Among 2 measurements in Hip Drop Factor, 1 measurement was significantly different between the two age groups. Hip Girth minus Waist Girth was significantly larger in 46-55 age group than in 56-65 age group. One measurement in Bust Drop Factor was significantly different between the two age groups. Bust Girth minus Waist Girth was significantly larger in 46-55 age group than in 56-65 age group. The results were confirming that due to weight gain with age increase, younger middle-aged women have thinner waist and older middle-aged women have larger waist in comparison to the bust girth and hip girth.

V. Conclusion

This study examined the anthropometric characteristics of the US middle-aged women 46 to 65 years of age and identified body shape characteristics of the US middle-aged women. Four factors－Girth Factor, Height Factor, Hip Drop Factor, and Bust Drop Factor－accounted for the US middle-aged women's body measurements. The body shapes of the US middle-aged women were classified into four body shapes, which were Y-Shape in the overweight range, S-Shape in the overweight range, H-Shape in the overweight range, and A-Shape in the obese range. The body shapes were evenly distributed between the four shapes. Three groups of Y-Shape, S-Shape and H-Shape were in the overweight range and one group of A-Shape was in the obese range. No groups were in underweight or normal weight range. The results implied that as the US women become middle-aged, their weight increase resulting in the overweight and obese BMI ranges. The SizeUK study also reported that more women were in the overweight or obese range as age increased (Wells et al., 2007).

The relationships of age groups and body shape classifications were analyzed. H-Shape, which were the least-defined waist in relation to the bust and hip with short height, existed more in older middle-aged women than in younger middle-age women. Therefore, as middle-aged women enter into the older age, their waistline becomes less defined and less curvy, resulting in straighter body shape. The results are in agreement with Wells et al.'s (2007) study based on SizeUK data that as women aged, there were tendencies that the fat was distributed around the waist area in the upper body. In addition, as age increased, there were tendencies that the middle-aged women's height and height related body measurements become shorter, which reflect the same results from previous studies that gradual bone loss causes height decrease with older women (Garn, 1975; Hughes et al., 2004; Richards, 1981; Williamson, 1993). Y-Shape, S-Shape, and A-Shape exited more in younger middle-aged women group than in older middle-aged women group. Younger middle-aged women had more diverse body shapes than the older middle-aged women. A previous study (Kim, 2014) on the body shape analysis of the US women aged from 26 to 45 showed that, S-Shape was the most common body shape in 26-35 age group, and A-Shape, Y-Shape, and H-Shape existed more in 36-45 age group. This previous study and the current study suggest that women tend to have S-Shape in their 20s, and then, they starts to have various body shapes from mid-30s to mid-50s. Finally women tend to have more H-Shape from mid-50s.

Differences in anthropometric data between 46-55 age group and 56-65 age group were examined. Older middle-aged women had narrower shoulder than the younger middle-aged women. As older women have increase back curvature and rounded back shape (Ashdown & Na, 2008), this may have caused the narrower shoulder with older middle-aged women. Older middle-aged women had longer distance between side neck to bust points than the younger middle-aged women. Goldsberry et al. (1996) reported that as women aged, they have tendencies to have lower bustline. Likewise, sagging breast due to aging may have caused longer distance between side neck to bust points with older middle-aged women. Older middle-aged women had thinner leg than young middle-aged women, which could be the results of bone loss (Garn, 1975; Hughes et al., 2004; Richards, 1981; Williamson, 1993). Older middle-aged women had larger neck base girth than the younger middle-aged women. The results showed that when the middle aged women gains weight with age increase, their fat also distributes around the neck.

The findings from the current study may be applied in the apparel industry for developing clothing sizing systems for US middle-aged women. Apparel manufacturers and brands targeting US middle-aged women are recommended to develop products reflecting the characteristics of these body shape and size of middle-aged women.

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