International Journal of Consumer Studies

International Journal of Consumer Studies ISSN 1470-6423

Ethnicity, body shape differences and female consumers' apparel fit problems

Bukisile P. Makhanya[1], Helena M. de Klerk[1], Karien Adamski[2] and Anne Mastamet-Mason[3]

[1]Department of Consumer Science, University of Pretoria, Pretoria, South Africa
[2]Department of Statistics, University of Pretoria, Pretoria, South Africa
[3]Department of Fashion Design, Tshwane University of Technology, Pretoria, South Africa

Keywords
Body shape, fit problems, female, drop value, 3D body scanning, ethnicity.

Correspondence
Helena M. de Klerk, Department of Consumer Science, University of Pretoria, Pretoria 0001, South Africa.
E-mail: helena.deklerk@up.ac.za

doi: 10.1111/ijcs.12079

Abstract

This research compared body shapes, measurements, ratios and fit problems of 234 African (109) and Caucasian (125) women. A three-dimensional (3D) full-body scanner generated virtual body images from which circumferential, width, protrusion and height measurements were extracted. Thereafter, circumferential and height ratios were computed. Drop values of key circumferential measurements were used to classify participants' bodies that were later visually confirmed and adopted. Results revealed that triangle, hourglass and rectangle were the three most predominant shapes among African and Caucasian women. There was a significant association between the three most predominant body shapes and ethnicity. There were significant differences in some body measurements and ratios, most of which were observed between African and Caucasian triangle as well as some of the other body shapes and the Caucasian hourglass used in the apparel industry. The differences especially between Caucasian hourglass and the other body shapes may be resulting in the persistent fit problems reported by some of the predominant body shapes at some of the selected body parts. This study therefore concluded that multicultural markets need to identify characteristics of all prevalent shapes within a population in order to minimize apparel fit problems.

Introduction

Living in a consumer-driven era, the challenge to apparel industries is not only about giving customers extra choices, but rather to contain consumers and cater for various consumers' preferences as well. Female body shapes and proportions vary and change over time, as the result of, among others, nutritional changes, lifestyles and ethnicity. These differences have an impact on apparel fit (Hillestad, 1980, p. 121; Winks, 1997, p. 20; Ashdown, 1998; Simmons and Istook, 2003). Ready-to-wear apparel fit problems have gained a lot of attention as consumer demand for well-fitted apparel increases. Among consumers, dissatisfaction with fit is one of the most frequently stated problems with garment purchases. Women have been reported as the most dissatisfied consumers with fit (Delong *et al*., 1993; Alexander *et al*., 2005; Otieno *et al*., 2005).

Dimensions from the human body are the underpinning to an effective sizing system and consequently better fitting apparel items. Sizing systems originate from people's measurements and body shapes (Bye *et al*., 2006, p. 66; Petrova in Ashdown, 2007, p. 56). Ashdown (2000) sees sizing systems as the focus around which all factors concerning sizing and fit evolve. She has identified the main factors affecting sizing systems and consequently the fit of ready-to-wear apparel to be, the population measures (body measurements), the design features (construction of the apparel), the fit issues (fit quality management), and the communication of sizing and fit (size labelling). To improve apparel fit, body measurements and major body shape variations prevalent within a consumer population must therefore be considered (Devarajan and Istook, 2004; Bye *et al*., 2006; Petrova in Ashdown, 2007, p. 57). Worldwide apparel industries, nevertheless, still mainly manufacture women's apparel that could fit only the ideal body shape properly. Consumers who differ in body shape characteristics from the ideal figure are therefore likely to experience fit problems from the standard apparel. Studies by Simmons *et al*. (2004), Lee *et al*. (2007), and Shin and Istook (2007) confirm diversity of body shapes within and between populations. From a sample of 222 women, 40% were bottom heavy hourglass, 21.6% hourglass, 17.1% spoon and 15.8% of rectangular shape. Findings from Pisut and Connell (2007) revealed that women are becoming larger than the ideal figure and reflect different body shapes and sizes than in previous decades (Simmons *et al*., 2004). Another study by Lee *et al*. (2007) discovered that the most prevalent body shape among US and Korean women was the rectangle and not the ideal figure. Apparel manufacturers therefore need to understand body shape differences within populations in order to produce apparel with satisfactory fit.

In many Western countries, variations in female apparel consumers' body shape are to a large extent attributed to the diverse ethnic groups. Lee *et al*. (2007) recorded that body shapes, sizes and proportions differ between ethnic groups and emphasized the need to study them as a way to increase consumer fit satisfaction with standardized apparel across the diverse ethnic groups. In this study, the African and Caucasian ethnic groups form part of the varied South African ethnic groups. Findings of a study by Winks (1997) revealed that body dimensions of Black South African men were generally smaller than those of Caucasian South African men. This might also hold true for African and Caucasian South African women.

Categorizing body shapes and comparing body measurements and ratios of different ethnic groups are imperative to determine any differences. Moreover, differently shaped consumers require differently shaped apparel to accommodate figure variations (Anderson *et al*., 2001; Fan, 2004; Connell *et al*., 2006). According to Connell *et al*. (2006), the classification of female body shapes within a specific country is, however, a challenge due to variations within and across ethnically homogeneous and heterogeneous populations. Pisut and Connell (2007) therefore suggested that when constructing ready-to-wear apparel for a diverse target population, it is crucial that attention is directed at existing differences in figure shape characteristics to minimize fit problems.

As in most other countries the South African apparel industry still do not cater for figure shape variations (Strydom and De Klerk, 2006). As in many other countries the South African apparel industry continues to base apparel production on body shape and measurements of an ideal figure (Western hourglass) (Goldsberry *et al*., 1996; Anderson *et al*., 2001; Alexander *et al*., 2005). As a result, female consumers with different body proportions from the ideal figure may experience ready-to-wear apparel fit problems. Therefore, it is imperative to investigate how female body shapes and body shape characteristics of diverse populations such as the South African population compare with each other and differ from the ideal figure. This could help to determine if the use of standard apparel shape and measurements would still give satisfactory fit across all ethnic groups. Otherwise, ready-to-wear apparel fit problems currently experienced in South Africa will persist. This study therefore sought to identify and compare the most prevalent body shapes, body shape characteristics and apparel fit problems of young African and Caucasian women in South Africa.

Literature

Body shapes have in the past mostly been classified by drop of key circumferential measurements into the prevalent hourglass, triangle, rectangular, apple and inverted triangle shapes (Chun-Yoon and Jasper, 1996; Winks, 1997; Beazley, 1998; Gupta and Gangadhar, 2004; Yu, 2004, p. 185). According to Simmons *et al*. (2004), a typical hourglass shape has bust and hips that are almost equal with moderate waist indentation. The rectangular body shape has hip and bust that are fairly equal and almost aligned with little or no indentation at the waist and has low bust-to-waist and hip-to-waist ratios. The oval body shape has the stomach, waist and abdomen measurements larger than the bust with folds around the midsection compared with the rest of the body. The triangular shape has larger hip circumferences than bust with no defined waistline and a low hip-to-waist ratio. An inverted triangular shape has a larger bust circumference than hips with no defined waistline and a small bust-to-waist ratio. The extent to which a body deviates in shape and size from the ideal body shape used by the apparel industry in the manufacturing of women's apparel may result in fit problems for those consumers with different body shapes.

Connell *et al*. (2006) categorized body shapes using the relationship of the whole body to the front and side view perspectives, whereas Ashdown (2003) evaluated body protrusion from the front, side and back views of the body to enable the differentiation of bodies that have the same circumferential proportions but different widths and depth proportions. Simmons *et al*. (2004) undertook a study to come up with the Female Figure Identification Technique (FFIT) software (College of Textile, North Carolina State University, Raleigh, NC, USA). Literature was then used to identify body shapes as well as visual and descriptive information that helped to eventually also develop mathematical formula for the FFIT software. The studies by Connell *et al*. (2006) and Simmons *et al*. (2004) came up with body shape descriptors and not specific body shape parameters. Lee *et al*. (2007) utilized the FFIT software and also successfully came up with body shape defining parameters to classify US and Korean women. They further anticipated that the same parameters may be used successfully to classify other random US samples with no mentioning of how successful it would be in different populations.

Despite these research findings, apparel industries keep on failing to satisfy different female consumer populations with different body shapes using dimensions and shapes of the Western standard or ideal figure. Although body shape descriptors of different populations may be similar, defining parameters could be different and specific to each population. Populations and cultures differ with regard to how big or how small, how tall or how long they are. We therefore reason that, as body shapes, size and proportions of South African women most probably differ from those of US women, body shape parameters that classified US and Korean women cannot successfully be used to classify South African women. As a result in this study, parameters and mathematical formulae used by Lee *et al*. (2007) had to be modified based on the key dimensions of African and Caucasian women from South Africa. Moreover, Mastamet-Mason (2008) successfully modified the Western body shape parameters to determine ranges for the predominant Kenyan body shapes within maximum and minimum drop values (a drop value is the difference between the hip circumference and the bust circumference or the difference between the bust and the waist circumference) and alluded that the use of body shape descriptors alone does not take proportions into considerations. Mastamet-Mason *et al*. (2012) further suggested the use of also visual sensory evaluation that could adequately address the visual analysis of the body.

Methodology

Sampling

The targeted population of this study was African and Caucasian women aged 18–25 years. Large manufacturers and apparel retailers generally target this age group. They are young mature women with fully developed bodies and are considered to be fashion conscious. This consumer segment belongs to the Echo Boom or

Generation Y consumer segment, a group that is racially diverse and who seeks fashionable apparel that is flattering and will make them look attractive to show off their physical attributes to satisfy emotional needs, to impress and to be accepted by others (Frings, 2005; Olivier, 2007). They were students from two large universities in Tshwane, a major metropolitan city in South Africa. Purposive and snowball sampling techniques were used. Participants were recruited through e-mails, campus news, posters and word of mouth. A total sample of 234 was obtained from 109 African and 125 Caucasian women.

Data collection

A $(TC)^2$ NX-12 three-dimensional (3D) body scanner was used in this study. Body scanning is regarded as the most reliable and accurate body measurement method (Istook and Hwang, 2001; Xu *et al*., 2002; Ashdown, 2003, 2007, p. xix; Simmons and Istook, 2003; Devarajan and Istook, 2004; Yu in Fan, 2004:171; Wang *et al*., 2007). Participants wore two-piece scanning garments made from light grey stretchy single knit fabric with a fibre content of 95% cotton and 5% lycra over their everyday well-fitting undergarments. Subjects were scanned until a good quality image was obtained in the normal scanning posture, i.e. feet 35 cm apart, and arms hanging away from the torso as suggested in ISO/DIS 20685 (2004). Thereafter, circumferential, width, protrusion and height measurements were extracted at the bust, stomach, waist, abdomen, buttock, hip and thigh areas. The body measurements were automatically extracted following landmarks and description of where they were taken by the 3D body scanner. These are critical fit points crucial in the classification of body shapes. Thereafter, circumferential and height ratios were computed. Participants also completed questionnaires on, among others, apparel fit problems they experienced at each of the selected body parts.

Body shape classification procedure

Defining parameters within the maximum and minimum range values of drop values were calculated and used to identify distinctive body shapes in this study (refer to Table 1). The difference in hip and bust circumferences was used to first classify triangle and inverted triangle shapes. Once a body was classified, it was no longer subjected to further classification using bust and waist relationship that was used to classify hourglass, rectangle and apple shapes. Body shapes assigned from measurements were confirmed and adopted after visual analysis of scanned images by two trained and experienced fashion design researchers.

Data analysis

Descriptive statistics, e.g. frequencies, mean, median, standard deviation as well as percentages, were used to analyse measurement data. The chi-square test was conducted to determine if body shape prevalence varied by ethnic group at 5% level of significance. The Kruskal–Wallis test was also used to establish which body shapes recorded significant differences in body measurements and ratios at each of the selected body parts at 5% level of significance. Body shapes with body measurements and ratios that recorded significant differences were further subjected to post hoc tests for planned pairwise comparison to determine which body shape pairs had significantly different measurements and ratios at each body part. Comparisons of interest in this study were similar African ad Caucasian body shapes, e.g. African and Caucasian hourglass shapes as well as African and Caucasian triangle, African and Caucasian rectangle with the Caucasian (Western) hourglass shape that is currently used by the apparel industry. Thereafter, percentages were used to summarize ready-to-wear apparel fit problems reported by different body shapes at each of the selected body parts.

Results and discussion

Body shape classification

The most prevalent body shapes among the African group ($n = 109$) were the triangle (58.7%), followed by the hourglass (27.5%) and rectangular shape (12.8%). The least common was the apple shape (0.9%). Among Caucasian group ($n = 125$), the hourglass shape (40.8%) was the largest followed by triangle (33.6%) and rectangle (25.6%). There were no participants classified as apple among the Caucasian group. There were also no participants classified as inverted triangle among both ethnic groups (Table 2).

Table 1 Body shape categories and defining parameters

		Defining parameters			
		Mean	SD	Min–Max	
Drop values	Body shapes	12.6	5.7	0.09–29.8	Defining formulae
Hip – bust	Triangle	Mean to max			12.6 ≤ hip – bust ≤ 29.8
	Inverted triangle	Hip – bust < 0			Hip – bust < 0
		Mean	SD	Min–Max	
		18	4.1	–3.7–26.6	
Bust – waist	Hourglass	Mean ≤ bust – waist ≤ max			18 ≤ bust – waist ≤ 26.6
	Rectangular	Mean –3 × SD <bust – waist < mean			5.6 < bust – waist < 18
	Apple	Minimum ≤ bust – waist ≤ –3 × SD			–3.7 ≤ bust – waist ≤ 5.6

SD, standard deviation.
Adapted from Lee *et al.*, 2007; Mastamet-Mason, 2008. Measurements are in centimetres.

Table 2 Body shape classification by ethnic group

Body shape categories	Classification by ethnic group			
	African *n* (col. %)	Caucasian *n* (col. %)	Total *n* (col. %)	χ^2 *P*-value
Triangle	64 (58.7)	42 (33.6)	106 (45.3)	0.0004
Hourglass	30 (27.5)	51 (40.8)	81 (34.6)	
Rectangle	14 (12.8)	32 (25.6)	46 (19.7)	
Apple[a]	1 (0.9)	0 (0)	1 (0.4)	
Total	109 (47)	125 (53)	234 (100)	

[a]Least common body shape excluded in further discussions. Significant difference at $P < 0.05$.

Table 2 also shows that there was a significant association between body shape prevalence (of the three predominant shapes) and ethnicity ($P = 0.004$) as the order of predominant body shapes differed among African and Caucasian women.

Comparison of selected body measurements and ratios for similar African and Caucasian body shapes

The Kruskal–Wallis test of paired similar African and Caucasian body shapes (Table 3) revealed that:

African and Caucasian triangle: The thigh circumference of African triangle was 4.2 cm more than that of Caucasian triangle and total body-to-waist and total body-to-hip height ratios of Caucasian triangle were significantly higher than those of African triangle (indicated with #, #[1] and #, respectively).

African and Caucasian hourglass: The abdomen circumference, abdomen width and abdomen protrusion of African hourglass were significantly 5.0, 3.2 and 3.5 cm less than those of Caucasian hourglass, respectively (indicated with *, # and *). Furthermore, the Caucasian hourglass was significantly taller than the African hourglass as they recorded higher total body, bust and waist height measurements with 6.2, 4.8 and 3.5 cm mean differences, respectively, as indicated with *, # and *.

African and Caucasian rectangle: The African rectangle was significantly shorter (8 cm) and recorded significantly lower total body-to-waist height ratio than the Caucasian rectangular as indicated in Table 3 by #[3] and #[2], respectively.

Comparison of selected body measurements and ratios for Caucasian hourglass and the other body shapes

In order to predict any fit problems, selected body measurements and ratios of all other African and Caucasian shapes were compared with those of the Caucasian hourglass (mostly used by the apparel industry for sizing).

Caucasian hourglass and African and Caucasian triangle

The triangular African and Caucasian shapes had significantly smaller bust circumference (4.6 and 5.8 cm mean differences, respectively) and smaller bust protrusions (2.7 and 3.8 cm, respectively) as well as higher hip width (1.9 and 1.6 cm, respectively) and significantly lower bust-to-waist, lower bust-to-hip and higher hip-to-waist ratio than Caucasian hourglass (differences indicated by * and #). The African triangle also had significantly bigger hip, seat and thigh circumferences (6.2, 4.8 and 4.3 cm mean differences, respectively), smaller abdomen width (2 cm mean difference) than the Caucasian hourglass shape (as indicated by * and #). The African triangle was significantly shorter and recorded lower bust height than the Caucasian hourglass. Caucasian hourglass also had significantly higher bust-to-waist and bust-to-hip and lower hip-to-waist circumferential ratios than Caucasian and African triangle. These differences are also clearly visible from the scanned body images (Fig. 1).

Caucasian hourglass and African and Caucasian rectangle

Table 3 also shows that Caucasian rectangle had a significantly wider waist (2.5 cm mean difference), resulting in significantly lower bust-to-waist and hip-to-waist ratios than the Caucasian hourglass (as indicated by *, #[1], #[2] and #[3], respectively). The Caucasian rectangle also had a significantly higher total body-to-waist height ratio than the Caucasian hourglass. On the other hand, the African rectangle was significantly shorter and recorded significantly lower bust height as well as bust-to-waist ratios than the Caucasian hourglass (Table 3).

Perceived fit problems

Participants indicated their experiences of tight, loose or no problems with ready-to-wear apparel fit at the selected body parts. As there were three fit categories, 40% and above of participants in each fit category per body shape was regarded as a majority and were indicated by bold figures with superscript letters ([a]) and below 40% as a minority. Comparisons of reported fit problems were between similar African and Caucasian body shapes as well as between Caucasian hourglass and the other African and Caucasian body shapes (Table 4).

Comparison of fit problems of Caucasian hourglass and African and Caucasian triangle

Comparison of measurements revealed that both triangular shapes had significantly smaller busts than the Caucasian hourglass and were expected to have loose fit. Literature (Rasband and Liechty, 2006, p. 202) confirms that triangular shapes have smaller upper bodies, i.e. bust, stomach and waist than average and are therefore expected to experience loose fit at these body parts. However, findings of this study indicate that the two triangular shapes reported different fit problems at the bust as

Table 3 Multiple comparisons of body measurements and ratios of predominant African and Caucasian body shapes

Dimension	African triangle	Caucasian triangle	African hourglass	Caucasian hourglass	African rectangle	Caucasian rectangle	Mean difference	Kruskal–Wallis *P*-value
Bust circumference	87.7*	86.5#	90.6	92.3*#	91.7	90.6	4.6*, 5.8#	**0.0000**
Abdomen circumference	84.7	84.1	80.3*	85.3*	86.6	88.0	5*	**0.013**
Hip circumference	106.0*	102.7	99.1	99.8*	101.7	100.6	6.2*	**0.0000**
Buttocks circumference	101.7*	98.7	95.8	96.9*	97.4	97.6	4.8*	**0.0032**
Thigh circumference	61.4*#	57.2#	57.7	57.1*	59.4	56.9	4.2*, 4.3#	**0.0012**
Waist width	25.1	25.6	24.3	25.5*	24.5	28.0*	2.5*	**0.0000**
Abdomen width	29.8*	31.0	28.6#	31.8*#	29.9	32.6	2*, 3.2#	**0.0000**
Hip width	39.7*	39.4#	37.6	37.8*#	38.0	38.2	1.9*, 1.6#	**0.0004**
Bust protrusion	46.6*	45.5#	48.6	49.3*#	48.6	48.6	2.7*, 3.8#	**0.0002**
Abdomen protrusion	44.8	45.9	42.8*	46.3*	44.7	47.0	3.5*	**0.0102**
Total body height	161.0*	164.6	159.6#1	165.8*#1#2	157.4#2#3	165.4#3	4.8*, 6.2#1, 8.4#2, 8.0#3	**0.0000**
Bust height	116.0*	118.6	115.6#1	120.4*#1#2	113.7#2	118.3	4.4*, 4.8#1, 6.7#2	**0.0001**
Waist height	104.3	104.4	102.5*	106.0*	100.9	103.2	3.5*	**0.0087**
Bust-to-waist ratio	1.25*	1.25#1	1.31	1.30*#1#2#3	1.22#2	1.19#3	0.05*#1, 0.08#2, 0.11#3	**0.0000**
Hip-to-waist ratio	1.51*	1.49#1	1.43	1.41*#1#2	1.34	1.32#2	0.1*, 0.08#1, 0.09#2	**0.0000**
Bust to hip	0.82*	0.84#	0.91	0.92*#	0.91	0.90	0.1*, 0.07#	**0.0000**
Total body-to-waist height ratio	1.55#1	1.58#1	1.55	1.57*	1.56#2	1.61*#2	0.04*, 0.03#1, 0.05#2	**0.0000**
Total body-to-hip height	2.07*#1	2.13#	2.08	2.11*	2.07	2.12	0.04*, 0.06#	**0.0001**

Bold *P*-values indicate significant differences at 5%. *, #, #1, #2 and #3 denote body shape pairs significantly different at 5%. Measurements are in centimetres.

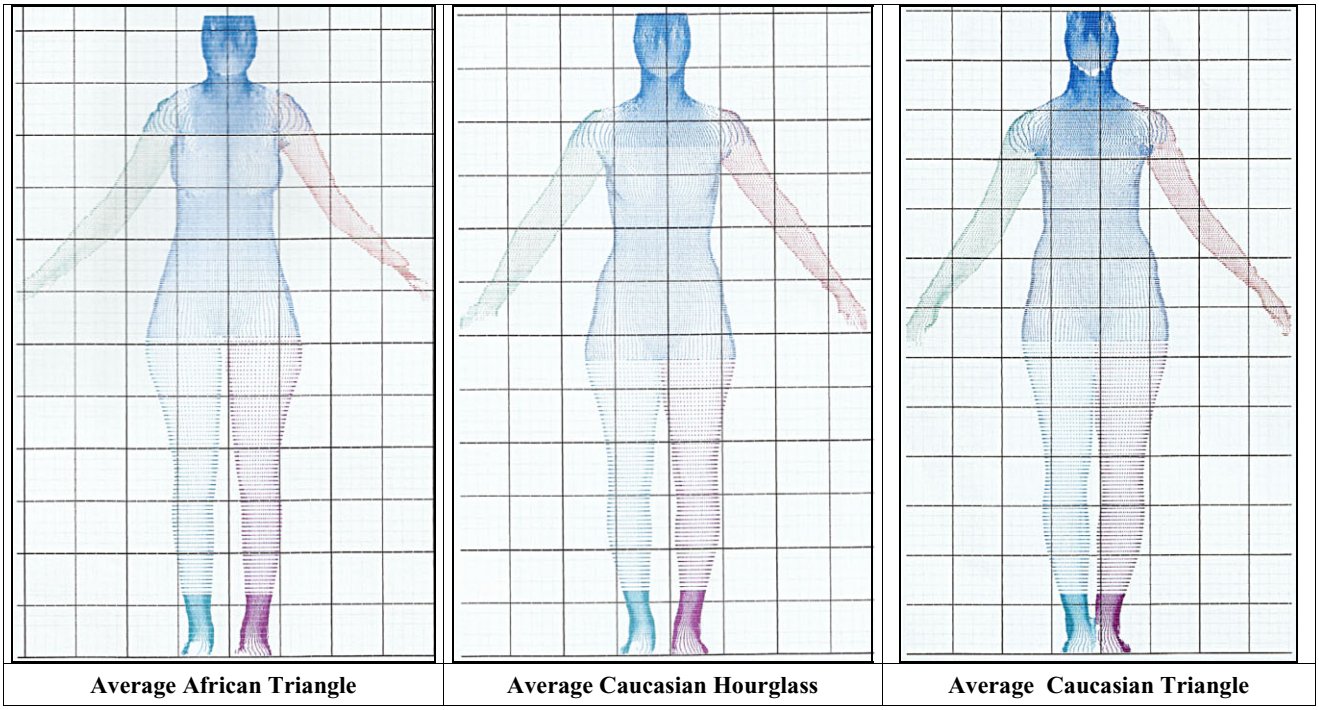

Figure 1 Comparison of African and Caucasian triangle and Caucasian hourglass body shapes.

48.4% African triangle reported good fit whereas 57.1% Caucasian triangle reported loose fit, the latter was as predicted in literature. Waist measurements of both African and Caucasian triangles recorded no significant difference from those of Caucasian hourglass as expected, 47.6% Caucasian triangle reported no fit problems. However, it was inconsistent with literature that 54.7% African triangle reported loose apparel fit at the waist and a majority that reported good fit at the bust and waist. This might be because of the wide thighs of the African triangle. Participants might have bought the garment to fit the widest part of the body, namely the thighs, resulting in a too loose fit at the waist. Muthambi (2012) who also used this research projects' data to develop proposed sizing for young African women with triangular-shaped bodies found that participants required a basic sheath dress that is commonly used in the industry that was two sizes larger to accommodate the large thighs, resulting in a loose fit around the waist, midriff and bust. Stomach and abdomen measurements of both triangles recorded no significant differences from those of Caucasian hourglass, and hence, good fit was to be expected as it was reported. However, this was inconsistent with literature as garments meant to fit wider hips, fit loosely at the smaller and tapering stomach, waist and abdomen (Rasband and Liechty, 2006, p. 210).

Literature records that triangular shapes also have larger lower bodies, i.e. hips, seat and thighs, and are expected to experience apparel tightness at these body parts (Rasband and Liechty, 2006, p. 24). These were confirmed by the finding from measurements as African triangular shapes recorded significantly larger hips and seat than Caucasian hourglass shapes. On the other hand, the Caucasian triangle had significantly larger thighs than the Caucasian hourglass. The findings on fit problems indicated that more than 50% African and Caucasian triangles reported apparel tightness at their lower bodies, which were in accordance with literature records.

Comparison of fit problems of Caucasian hourglass and African hourglass

The abdomen circumference, abdomen width and abdomen protrusion of the African hourglass were significantly less than those of the Caucasian hourglass. As the South African apparel industry still mainly base their sizing on the measurements of the Western hourglass, one would have expected that the Caucasian hourglass to report no fit problems, while the African hourglass might report loose fitting around the abdomen. Table 4 however shows that most African hourglass shapes reported no fit problems at the stomach (46.7%), abdomen (56.7%), seat (43.3%) and thighs (40%) and 40% reported loose fit at waist, seat and hips, whereas, a majority of Caucasian hourglass reported a too tight fit at the stomach (51%), waist (41.2%), abdomen (54.9%) and thighs (66.7%). It is worth noting that the tight apparel fit problems reported by a majority of Caucasian (Western) hourglass at all the other body parts were also unexpected as the industry is believed to be basting ready-to-wear apparel manufacturing on the standard or Western hourglass figure. Yet, the problems experienced by the Caucasian hourglass suggest that the standard figure or Western hourglass used by the apparel industry might also be different from the Caucasian hourglass identified in this study.

Table 4 Comparison of frequency and percentage distribution of fit problems by body shape

Body part	Fit problems	African triangle *n* (%)	Caucasian triangle *n* (%)	African hourglass *n* (%)	Caucasian hourglass *n* (%)	African rectangle *n* (%)	Caucasian rectangle *n* (%)	Total *n* (%)
Bust	Tight	14 (21.9)	13 (31.0)	10 (33.3)	19 (37.3)	2 (14.3)	**15 (46.9)**[a]	13 (31.0)
	Loose	19 (29.7)	**24 (57.1)**[a]	10 (33.3)	15 (29.4)	5 (35.7)	10 (31.3)	83 (36)
	Fits	**31 (48.4)**[a]	5 (11.9)	10 (33.3	17 (33.3)	**7 (50)**[a]	7 (21.9)	77 (33)
Stomach	Tight	19 (29.7)	13 (31.0)	8 (26.7)	**26 (51.0)**[a]	**7 (50)**[a]	**15 (46.9)**[a]	88 (38)
	Loose	19 (29.7)	6 (14.3)	8 (26.7)	3 (5.9)	3 (21.4)	6 (18.8)	45 (19)
	Fits	**26 (40.6)**[a]	**23 (54.8)**[a]	**14 (46.7)**[a]	22 (43.1)	4 (28.6)	11 (34.4)	100 (43)
Waist	Tight	14 (21.9)	12 (28.6)	7 (23.3)	**21 (41.2)**[a]	4 (28.6)	8 (25)	66 (28.3)
	Loose	**35 (54.7)**[a]	10 (23.8)	**12 (40)**[a]	10 (19.6)	3 (21.4)	**13 (40.6)**[a]	83 (35.6)
	Fits	15 (23.4)	**20 (47.6)**[a]	11 (36.7)	20 (39.2)	**7 (50)**[a]	11 (34.4)	84 (36.1)
Abdomen	Tight	20 (31.5)	13 (31.0)	7 (23.3)	**28 (54.9)**[a]	**6 (42.9)**[a]	**16 (50)**[a]	90 (39)
	Loose	18 (28.1)	5 (11.9)	6 (20)	4 (7.8)	3 (21.4)	3 (9.4)	39 (17)
	Fits	**26 (40.6)**[a]	**24 (57.1)**[a]	**17 (56.7)**[a]	19 (37.3)	5 (35.7)	13 (40.6)	104 (44)
Hips	Tight	**43 (67.2)**[a]	**33 (78.6)**[a]	**12 (40)**[a]	**33 (64.7)**[a]	3 (21.4)	**15 (46.9)**[a]	139 (60)
	Loose	9 (14.1)	4 (9.5)	**12 (40)**[a]	5 (9.8)	3 (21.4)	4 (12.5)	37 (16)
	Fits	12 (18.8)	5 (11.9)	6 (20)	13 (25.6)	**8 (57.1)**[a]	**13 (40.6)**[a]	57 (24)
Seat/buttocks	Tight	**37 (57.8)**[a]	**27 (64.3)**[a]	5 (16.7)	18 (35.3)	5 (35.7)	13 (40.6)	105 (45)
	Loose	8 (12.5)	6 (14.3)	**12 (40)**[a]	14 (27.5)	5 (35.7)	5 (15.6)	50 (21)
	Fits	19 (29.7)	9 (21.4)	**13 (43.3)**[a]	19 (37.3)	4 (28.6)	**14 (43.7)**[a]	78 (34)
Thighs	Tight	**41 (64.1)**[a]	**34 (81.0)**[a]	**12 (40)**[a]	**34 (66.7)**[a]	2 (14.3)	**19 (59.4)**[a]	142 (61)
	Loose	5 (7.8)	0 (0)	9 (30)	9 (17.7)	4 (28.6)	3 (9.4)	30 (13)
	Fits	18 (28.1)	8 (19.1)	9 (30)	8 (15.7)	**8 (57.1)**[a]	10 (31.3)	61 (26)
Total		64	42	30	51	14	32	233 (100)

[a]Bold figures with superscript letter indicate the majority of participants at each body part and fit category per body shape.

Comparison of fit problems of Caucasian hourglass and African and Caucasian rectangle

Literature (Rasband and Liechty, 2006, p. 25) states that a rectangular shape has an average to large bust, mid-section, namely stomach, waist and abdomen as well as hips, seat and thighs that are almost equal thus resembling a rectangle. This body shape is therefore expected to experience apparel tightness at all these body parts as they are larger than average. Findings of this study reveal no significant differences in all measurements of both African and Caucasian rectangular shapes and those of the Caucasian hourglass, except at the waist where the Caucasian rectangular shape had significantly wider waist than the Caucasian hourglass (Table 4). This is the main difference between hourglass and rectangular shape recorded in literature and as a result the latter is expected to have apparel tightness at the waist. On the contrary, Table 4 shows that 46.9% Caucasian rectangle reported loose apparel and 50% African rectangle reported good fit at the waist, which was inconsistent with literature (Rasband and Liechty, 2006, p. 206). However, as can be expected both African and Caucasian rectangles reported tight fit around the stomach (50% and 51%, respectively) and abdomen (42.9% and 54.9%, respectively).

Conclusions and implications

In this study, the bust, waist and hip drop values and visual verification were successfully used to classify body shapes of young African and Caucasian women between the ages of 18 and 25 years. As literature suggests, this study confirmed that body shape prevalence, body measurements and body shape characteristics differ between ethnic groups. Differences in body dimensions as well as body shape characteristics were also observed between similar African and Caucasian body shapes.

It can be concluded that by far the most prevalent body shape among the African group was the triangular shape (58.7%), followed by the hourglass shape (27.5%) and the rectangular shape (12.8%). Among the Caucasian group, the most prevalent body shape was the hourglass shape (40.8%), followed by the triangular shape (33.6%) and the rectangular shape (25.6%). This is contrary to what was found in other Western and non-Western studies. Lee *et al*. (2007) discovered that the most prevalent shape among US and Korean women was the rectangle, Mastamet-Mason *et al*. (2012) also found that the distinctive body shape in Kenya was the rectangle, although with distinct differences between the Kenyan and Western rectangular shapes. Considering that ready-made apparel items in South Africa are still mainly designed and sized based on the ideal (hourglass) Western body shape, this means that by far most African and Caucasian young female consumers' bodies differ from what is still seen by industry as the ideal and most common body shape. They are therefore likely to have difficulties in finding apparel items that fit well.

It can further be concluded that body shape characteristics differ between African and Caucasian women with the same body shapes – expectedly due to ethnic differences. The so-called ideal Caucasian hourglass' abdomen circumference, abdomen width and abdomen protrusion were, for example, significantly wider than those of the African hourglass, while the thigh circumference of the most prevalent African triangle was significantly more than that of the Caucasian triangle. This confirms the studies of Lee *et al*. (2007) and Mastamet-Mason *et al*. (2012) who concluded that body shape characteristics of the same shape differ between ethnic groups. In constructing apparel for a diverse target market, it is therefore crucial that the apparel industry pays attention to these existing differences in body shape characteristics. If not, the apparel industry will keep struggling to supply consumers with well-fitting clothes and as a result consumers will continue having difficulty finding well-fitting garments.

In order to predict any fit problems, selected body measurements and ratios of all other African and Caucasian shapes were further compared with those of the Caucasian hourglass (mostly used by industry for sizing and fit evaluation). This study confirms results from previous studies (Simmons *et al*., 2004; Connell *et al*., 2006; Lee *et al*., 2007) as significant differences were found between both the African and Caucasian triangular and rectangular shapes and the Western hourglass shape. In most cases, predicted fit problems were therefore confirmed by the African and Caucasian respondents' perceived fit problems. Specifically, the Caucasian rectangle reported fit problems at all body parts while both the Caucasian and African triangle reported tight fit around the hips, buttocks and thighs. There were, however, in some cases discrepancies between expected fit problems and perceived fit problems as reported by the respondents. It should however be noted that perceived fit problems are subjective as it may also be influenced by other factors, such as fit preferences and body cathexis.

Apparel manufacturers and retailers who would like to target diverse multicultural markets need to be cognizant of the differences between the body shapes and body shape characteristics of different consumer groups. Furthermore, it would be unrealistic for apparel industries to continue manufacturing styles that are suitable for the hourglass body shape and expect them to fit all other body shapes. The quality of apparel in respect of its fit can only be determined collectively, through dress forms, fit models and sizing systems, which all have to represent the target population's sizes and body shapes. Understanding the underlying differences in body shape could help designers to translate the distinct body characteristics into better fitting apparel items. Fit models as well as dress forms chosen for fit testing and modelling in the apparel industry should reflect the characteristics of all the most prevalent shapes. One reason for so many female consumers being not satisfied with their bodies is that fashionable clothing is manufactured based on an ideal figure and therefore reflects a standard body shape. When women do not fit that particular standard, they blame their bodies for the improper fit and view them as imperfect rather than the clothes. If clothes do not fit well consumer's attitude and ultimately their self-concept will reflect those feelings, especially if ill fit is a consistent problem in all their shopping experiences. Finally, if all components of an effective sizing system could be taken into consideration and be based on body shapes and measurements of target markets, in this case young female African and Caucasian consumers, an effective sizing system could be achieved and apparel fit satisfaction could be enhanced.

Limitations and recommendations

This study was limited to a South African sample of only university students from a specific region, but can serve as positive base

for other comparative studies. Studies of larger women, older women and men could be conducted for comparative data.

References

Alexander, M., Connell, L.J. & Presley, A.B. (2005) Clothing fit preferences of young female consumers. *International Journal of clothing Science and Technology*, **17**, 52–64.

Anderson, L.J., Brannon, L.E., Ulrich, P.V., Presley, A.B., Waronka, D., Grasso, M. & Stevenson, D. (2001) *Understanding Fitting Preferences of Female Consumers: Development an Expert System to Enhance Accurate Sizing Selection*, National Textile Centre Annual Report, 198-A08.

Ashdown, S.P. (1998) An investigation of the structure of sizing systems: a comparison of three multidimensional optimized sizing systems generated from anthropometric data with the ASMT standard D5585-9. *International Journal of Clothing Science and Technology*, **10**, 324–341.

Ashdown, S.P. (2000) Introduction to sizing and fit research. RESEARCH FIT. The Fit symposium: Clemson Apparel Research Centre. Clemson. SC. [WWW document]. URL http://car .clemson.edu/fit2000/ (accessed on 6 March 2009).

Ashdown, S.P. (2003) The three-dimensional scanner: ready-to-wear. [WWW document]. URL http://www.explore.cornell.edu/ scene=the%203d%20body%scanner (accessed on 28 August 2009).

Ashdown, S.P. (ed.) (2007) *Sizing in Clothing: Developing Effective Sizing Systems for Ready to Wear Clothing*. Wood Head Publishing Limited, New York.

Beazley, A. (1998) Size and fit: the development of size charts for clothing. Part 3. *Journal of Fashion Marketing and Management*, **3**, 66–84.

Bye, E.K., LaBat, K.L. & DeLong, M.R. (2006) Analysis of body measurement systems for apparel. *Clothing and Textiles Research Journal in International Textile and Apparel Association*, **24**, 66–79.

Chun-Yoon, J. & Jasper, C.R. (1996) Key dimensions of women's ready-to-wear apparel: developing consumer size-labelling system. *Clothing and Textile Research Journal*, **14**, 89–95.

Connell, L.J., Ulrich, P.V., Brannon, E.L., Alexander, M. & Presley, A.B. (2006) Body shape assessment scale: instrument development for analysing female figures. *Clothing and Textiles Research Journal*, **24**, 80–95.

Delong, M., Ashdown, S., Butterfield, L. & Turnbladh, K.F. (1993) Data specifications needed for apparel production using computers. *Clothing Textiles Research Journal*, **11**, 1–7.

Devarajan, P. & Istook, K. (2004) Validation of female figure identification technique (FFIT) for apparel software. *Journal of Textile and Apparel, Technology and Management*, **4**, 1–23.

Fan, J. (2004) Perception of body appearance and its relation to clothing. In *Clothing Appearance and Fit: Science and Technology* (ed. by J. Fan, W. Yu & L. Hunter), pp. 72–87. Wood Head Publishing Ltd, New York.

Frings, G.S. (2005) *Fashion from Concept to Consumer*, 8th edn Prentice Hall, Upper Saddle River, NJ.

Goldsberry, E., Shim, M. & Reich, N. (1996) Women 55 and older: part II. Overall satisfaction and dissatisfaction with fit of ready-to-wear. *Clothing and Textiles Research Journal*, **10**, 37–45.

Gupta, D. & Gangadhar, B.R. (2004) A statistical model for developing body size charts for garments. *International Journal of Clothing Science and Technology*, **16**, 458–469.

Hillestad, R. (1980) Underlying structure of appearance. *Dress*, **6**, 117–125.

ISO/DIS 20685 (2004) 3D scanning methodologies for internationally compatible anthropometric databases.

Istook, C.L. & Hwang, S. (2001) Body scanning systems with application to the apparel industry. *Journal of Fashion Marketing and Management*, **5**, 120–132.

Lee, Y.M., Istook, C.L., Nam, Y.J. & Park, S.M. (2007) Comparison of body shape between USA and Korean women. *International Journal of Clothing Service and Technology*, **19**, 374–391.

Mastamet-Mason, A. (2008) An explication of the problems with apparel fit experienced by female Kenyan consumers in terms of their unique body shape characteristics. PhD Consumer Science, Thesis, University of Pretoria.

Mastamet-Mason, A., De Klerk, H.M. & Ashdown, S.P. (2012) Identification of a unique African female body shape. *International Journal of Fashion Design, Technology and Education*, **5**, 105–116.

Muthambi, A. (2012) Proposed sizing for young South African women of African descent with triangular shaped bodies. Masters Consumer Science, Dissertation, University of Pretoria.

Olivier, D. (2007) South Africa poised to become a loyalty marketing gem. *Journal of Consumer Marketing*, **24**, 180–181.

Otieno, R., Harrow, C. & Lea-greenwood, G. (2005) The unhappy shopper, a retail experience: exploring fashion, fit and affordability. *International Journal of Retail and Distribution Management*, **33**, 289–309.

Pisut, G. & Connell, L.J. (2007) Fit preferences of female consumers in USA. *Journal of Fashion Marketing*, **11**, 366–379.

Rasband, J. & Liechty, E. (2006) *Fabulous Fit*, 2nd edn Fairchild Publications, New York.

Shin, S.H. & Istook, C. (2007) Importance of understanding the shape of diverse ethnic female consumers for developing jeans sizing systems. *International Journal of Consumer Studies*, **31**, 135–143.

Simmons, K. & Istook, C.L. (2003) Body measurement techniques, comparing 3-D body-scanning and anthropometric methods of apparel applications. *Journal of Fashion Marketing and Management*, **7**, 306–332.

Simmons, K., Istook, C.L. & Devarajan, P. (2004) Female figure identification technique (FFIT) for apparel. Part 1: describing female shapes. *Journal of Textile and Apparel, Technology and Management*, **4**, 1–5.

Strydom, M. & De Klerk, H.M. (2006) The South African clothing industry: problems experienced with body measurements. *Journal of Family Ecology and Consumer Sciences*, **34**, 80–89.

Wang, M.J., Wu, W.Y., Lin, K.C., Yang, S.H. & Lu, J.M. (2007) Automated anthropometric data collection from three-dimensional digital human models. *International Journal of Advanced Manufacturing Technology*, **32**, 109–115.

Winks, J.M. (1997) *Clothing Sizing, International Standardization*. The Textile Institute, Redwood Books, London.

Xu, B., Huang, Y., Yu, W. & Chen, T. (2002) Three-dimensional body scanning system for apparel mass customization. *Society of Photo-Optical Instrumentation Engineers*, **41**, 1475–1479.

Yu, W. (2004) Subjective assessment of clothing. In *Clothing Appearance and Fit: Science and Technology* (ed. by J. Fan, W. Yu & L. Hunter), pp. 239–240. Wood Head Publishing Ltd, New York.