

AN EMPIRICAL STUDY EXPLORING BODY PERCEPTION AND APPAREL FIT PREFERENCES FOR SOUTH AFRICAN WOMEN

Reena Pandarum*, Simon C Harlock & Lawrance Hunter

ABSTRACT

This empirical study examines the body shapes and apparel fit incongruities experienced by a convenience sample of South African women (n=155), aged 20 to 65 years. Also examined was the extent to which apparel manufactured using the currently-available/in-use sizing systems accommodate the women's ready-to-wear apparel sizing and fit requirements.

The findings are that the most prevalent body shapes assessed by a panel of experts, from a 3D rotational point cloud surface image derived from 3D body scans taken of the subjects were triangular/pear and rectangular. Conversely, this contrasted with the same perceived body shape in which the majority of subjects saw themselves as an hourglass, followed by the rectangular and triangular body shapes.

Furthermore, the subjects' perceptions of their ready-to-wear apparel sizes differed markedly from those derived from their under-bust and hip girths using a current published size chart developed using anthropometric data from a previous study of South African women. In terms of apparel fit, subjects reported particular problems with bust fit (too tight) and waist (too loose), all of which point to deficiencies in currently used size charts.

From these data, the authors argue that there is a need for revision and updating of the South African apparel-sizing system and thus providing the apparel retail and manufacturing sectors with current and up-to-date body shape and body dimension statistics for the South African women's-wear market.

— **Ms R Pandarum***

Department of Life and Consumer Science
University of South Africa
Florida
South Africa

Tel: +27 (0)11 471 2550

Email: pandak@unisa.ac.za

*Corresponding author

— **Prof SC Harlock**

Department of Life and Consumer Science
University of South Africa
Florida

South Africa

Tel: +27 (0)11 471 2550

Email: simonharlock@hotmail.com

— **Prof L Hunter**

CSIR and Department of Textile Science
Nelson Mandela University
Port Elizabeth

South Africa

Tel: +27 (0)41 5083260

Email: lhunter@csir.co.za

ARTICLE INFO

Article history

Received 11 January 2017

Final review submitted 27 October 2017

Accepted 24 November 2017

Keywords

3D body women scan, self-perceived body shapes, ready-to-wear, sizing-systems, South Africa, apparel retail and manufacturing

INTRODUCTION

The apparel manufacturing and retail sector in South Africa is said to be very small when compared to the other manufacturing sectors in the country, and accounted for only 3% of the country's manufacturing output in the year 2012 (Watson & Watson, 2013). Hence, there is a substantial influx of international clothing brands (Kasambala et al., 2014) to meet the current

needs for fashionable women's apparel in retail stores. As there are no reported apparel sizing and fit studies comparing South Africa and other countries, the assumption is that the apparel is not necessarily manufactured for the current body shapes and sizes of South African women. Even though the women's body shapes are gradually evolving towards a more westernised silhouette, apparel sizing and fit is still an everyday reality for many women today (John, 2007; Kasambala et.al. 2014; Milliam, 2017; Mac Duff & Smith., n.d).

Furthermore, recent advances in technology, such as 3D body scanners, virtual fitting rooms and online shopping, have now placed additional demands on South African apparel retailers and manufacturers as customers seek not only quality products but also instant product gratification. There is now a need for apparel manufacturers and retailers to reconsider their retailing strategies to provide the local women customers with, not only convenient on-line apparel shopping, but also with better fitting and appropriately labelled apparel in retail stores that reflect the current body shapes and sizes of South African women.

Currently, there are no up-to-date and, accessible apparel sizing or body dimension charts available that has been developed for the body shapes and dimensions of South African women of today. Mac Duff and Smith, (n.d) mentioned that there is a large database of body measurements in the country, collected largely from military personnel, but this is not in the public domain, and is therefore not accessible for comparison in this paper. Furthermore, the South African clothing manufacturers and retailers' apparel size charts are proprietary and target market driven (Milliam, 2017). Therefore, the only apparel size charts currently available to the public are those published on different retailer online shopping websites and, less easily accessible, within academic dissertations. For the purposes of this paper, the online clothing retailer websites size charts are deemed unreliable, as their origin/dataset cannot be verified. Hence, the comparative analysis reported, in this paper, is from that published from an academic study by Winks (1990) in Port Elizabeth, South Africa. Winks' (1990) study is widely referenced as the International Organisation Technical Report ISO/TR 10652.

To address some of the concerns mentioned above, this paper reports, for a convenience sample of South African women, their self-perceived body shapes, the analysis of an expert panel's assessment of the same subject's body shape from 3D-point cloud surface images and, the sizing and fit concerns of every subject. The aim of the paper is to provide the South African apparel industry with a better perspective on the sizing and fit concerns currently encountered by South African consumers, and a greater insight into why these occur. This is an initial report from on-going longer-term research project to provide up-to-date sizing and fit data for consumers and the apparel sector.

LITERATURE REVIEW

An overview of reported sizing and fit studies conducted in South Africa

Since the 1990s, published studies on sizing and fit in South Africa have attempted to develop body size charts reflecting body size and body shape variability taken from manual anthropometric studies and, more recently, using a 3D body scanner.

Winks' (1990) study defined body types extracted by bust girth and body height control dimensions for the Black (14%), White (69%) and Coloured (17%) but not the Indian (0%) populations. This study defined three body types. The "A" body type, which had a mean drop (the difference between the hip and bust girth measurements) value of 12cm. The "M" body type with a mean drop value of 6cms and the "H" body type with a mean drop value of 0cm respectively. In 1998, Defty published size charts for pattern drafting for women based on body height and five girth and four length control dimensions. However, Winks' (1990) study excluded the Indian population from his analysis due to the limited sample size, whilst Defty's (1998) book focused on size charts for the average, tall and short women's body dimensions, with and without shoes. Both these sizing and fit charts and tables of South African origin, conducted in academic environments, are now 19 and 27 years old respectively. However, Wink's (1990) data is still widely used and referenced both nationally and internationally in apparel sizing and fit studies as the technical report ISO/TR10652 (1990) - standards sizing

for clothes. Nonetheless, Winks' study highlighted the differences in body shapes of the Black, White and Coloured populations. This in turn influenced apparel sizing, sizing charts or tables and hence fit.

Apparel manufacturers and retailers are also said to adapt sizing charts for manufacturing apparel for their target markets, as Strydom's (2006) study noted that the control dimensions and the body landmark identifications used by different South African retailers vary. The qualitative data from Strydom's study indicated that the sizing systems currently used by South African retailers and manufacturers are based on averages rather than figure types. However, the primary focus of Strydom's study was a general overview of the clothing-related population measures used by South African manufacturing companies and retailers, and not an examination of body shape classification or of the customer's perception of ready-to-wear apparel.

A further sizing and fit collaborative initiative reported by Mac Duff and Smith (n.d) stated that Ergonomics Technologies is the custodian of the South African National Defence Force (SANDF) manual anthropometric database in South Africa. This means that the largest manual anthropometric database in the country is not in the public domain and was, therefore, not accessible for comparison in this paper.

Recent body sizing and fit studies published from within South African universities by Ola-Afolayan et al., (2013) using a dressmaker's tape measure on (n=50) African women, and by Makhanya et al., (2014) using a (TC) 2-NX12-3D-full body scanner indicated that, amongst the student population, the most prevalent body shapes of (n=234) females (125 Caucasian and 109 African) aged 18-25 years were triangular, hourglass and rectangular. Ola-Afolayan et al's (2013) study identified the women in her sample as being pear body shaped and wearing ready-to-wear dress sizes from 16 to 24. This study, however, did not indicate whether the African women sampled were Black South African or they were referring to all women residing in South Africa.

Similarly, Makhanya et al's., 2014 study focused on Caucasian and African students on campus and, therefore, within a fairly limited age group;

it was also unclear whether the "African" women classification were only Black women of South African descent. Makhanya et al's., (2014) study also classified body shapes on the commonly-used control dimensions of drop values and the differences between the minimum and maximum hip to bust girth measurements to classify the triangle and inverted body shapes, and the bust to waist drop values to classify the hourglass, rectangular and apple body shapes of the n=234 subjects.

A further analysis of the 3D scanned data collected by Makhanya et al., (2014) was by Muthambi et al., (2015), who used data for the African triangular body shaped women wearing apparel sizes 30 to 38 to develop an experimental size specification for a basic sheath dress. The fit trials were however, conducted on a non-representative sample of women that were not 3D scanned and the study concluded that the methodology used required improvement, as the experimental size specification did not offer the anticipated fit in all areas of the test apparel arising from the size chart.

In 2016, Kasambala et al. conducted a perception study on the emotional aspects of apparel sizing of women when rated against their value system for fit, using the laddering interview technique. This study included a psychographic question illustrating six body shapes, adapted from Liddelow (2011), to (n=59) women who, subsequently, perceived their body shapes as being triangle, oval, rectangle, inverted triangle, hourglass and diamond.

However, none of the studies reviewed above explored the ready-to-wear apparel fit preferences, apparel sizing, make any evaluation of the women's perception of their body shape, or compare these with an expert panel's assessment of the same subject's 3D rotational point cloud surface images of their scanned bodies in order to gain insight into sizing and fit.

Sizing system/s currently used in South Africa

Gribbin (2014) mentions that apparel manufacturers and retailers still manufacture apparel for the hourglass figure type using data

adapted from the 1940s and that the South African apparel manufacturers and retailers, at any given time, are not aware of the changing body shapes and sizes of the South African women (John, 2007; Khan, 2008; Milliam, 2017).

To establish the true source of the sizing systems used in South Africa, Strydom's (2006) study claims that the current sizing system used by manufacturers and retailers is British in origin. However, the author further argues that one manufacturer thought it was European; another said that it was South African with, a further five unsure as to where the apparel sizing system originated. Conversely, Pandarum and Yu (2015) maintain that the apparel sizing systems used in South Africa have been adapted, over time, from the British, mainland European and American systems. Pandarum and Yu (2015), also contend that the lack of a uniquely South African or African apparel sizing system, and the global village concept of free trade with world-wide clothing imports into South Africa, are also contributing factors in the current ready-to-wear apparel sizing and fit incongruities experienced by women shopping in South Africa today. Therefore, in the absence of reported studies conducted on how the sizing and fit of apparel manufactured both locally and internationally, and the women's concomitant fitting concerns, there are now well-founded reasons to investigate the suitability of these apparel-sizing systems used in ready-to-wear clothing for the South African women consumer.

PURPOSE AND SCOPE OF THE STUDY

This research sought to establish the extent to which South African women were aware of their current body shape and sizes and how they translated this into a ready-to-wear apparel label-size purchased in retail stores, irrespective of the brand, and the resulting apparel fit difficulties they typically experienced.

The comparisons conducted were between the women subjects' self-assessed body shape and those rated from 3D-point cloud surface images obtained from body scans of the same subjects. The purpose was to assess this finding against the notion that clothing retailers still manufacture for the hourglass figure type, as previous studies have indicated that individuals have different and unrealistic perceptions/misconceptions of

their body shape (Bee, 2006; Venter, 2009; Liddy, 2011).

This study answered the following research questions:

1. what were the most prevalent body shapes within the sample of subjects as assessed by a panel of experts from 3D point cloud images of body scans of each subject, and how do the subjects' perceptions of their own body shape differ from these;
2. what are the limitations, if any, of the current apparel sizing systems used by South African apparel retailers and manufacturers and;
3. what are the apparel sizing and fit preferences and incongruities experienced by the women when purchasing retail-bought ready-to-wear apparel.

METHODOLOGY

Research design

Using participants from the authors' previous and current 3D body scanner studies, this mixed-method study used random sampling to select (n=155) female subjects 20 to 65 years old, and from all 'walks of life'. Data collection took place on the UNISA, Science Campus in Florida, Johannesburg, where every subject completed a consent form and a demographic questionnaire, and was provided with an information flyer to explain the purpose of the study. Participation was voluntary and all procedures conformed with UNISA and Nelson Mandela University Ethical Clearance approvals [2011/CAES/044] and [H15-SCI-TEX- 001].

To assess each subject's body shape, and to derive 3D anthropometric data for body shape analysis, each subject's body dimensions were measured using either a (TC)2-NX12 or a (TC)2-NX16 full body scanners based on the ISO/DIS 20685 and ISO 7250-1 international

standards protocols. Measurements of body height and body weight was recorded manually, using an Adam® medical scale, as the (TC)2-NX12 nor the (TC)2-NX16 full body scanners do not take the actual height and the body weight of the subject automatically.

Every subject completed a psychographic question, pertaining to perceptions of their body shape from a supplied list of illustrations for the most common westernized geometric body shape classifications (adapted from Liddelow, 2011). Additionally, there were questions on the apparel sizes that they typically purchased in retail outlets, irrespective of the brand, and the fit problems they encountered with ready-to-wear apparel. These were presented in the questionnaire as open-ended, closed, and Likert scale type questions.

A panel of experts, comprising two of the authors and a postgraduate fashion student, with cumulatively, over 50 years' experience in textile, apparel/fashion research and skills acquired in the apparel industry and academia, subsequently assessed every subject's body shape, by reviewing the 3D-point cloud surface images generated from the scans.

The authors also took into consideration that Liddelow's (2011), horizontal figure types/shape classifications were flat geometric representations and the scanned images were in 3D-point- cloud. The panel also interrogated the written explanations of the different horizontal geometric body types/shapes to reach a final decision. These 3D body shapes were compared with each subject's self-assessment of her body shape. The subjects' self-reported ready-to-wear apparel sizes were assessed against Winks' (1990) apparel size chart according to the bust and hip girths derived from their 3D scanned data. Finally, both the 3D scan data and body shape classifications formed the basis for evaluating and reporting on the most prevalent apparel fit incongruities the subject experienced.

3D anthropometric data acquisition

The position that each subject adopted in the 3D scanner was to stand erect, with the head in the Frankfurt position and with the feet 350mm apart and parallel to each other, as indicated by floor markings inside the (TC) 2-NX 12 and the (TC) 2-NX 16 scanning booths. The arms were outstretched with the subject holding onto the fixed handrails 1100mm apart, and their right hand thumb hovering over the right handle on a button to activate the 3D scan generating process. This position optimises the automatic body measurement of both the height and

circumferences of the upper body. Studies conducted by Chi and Kennon (2006) indicate that the results of the 3D measurement data extracted by scanners is optimised for this natural anatomical position. The subjects were instructed to breathe normally, as similar studies conducted by Mckinnon and Istook (2002) had indicated that levels of breathing have a significant effect on the body scan and can affect the upper torso measurements, with maximum inhalation or exhalation either increasing or decreasing the breadth measurements. Therefore, every subject was scanned thrice to minimize this effect. The panel assessed every subject's body shape by viewing the front and side rotational views of the 3D-point cloud surface image taking into consideration the primary body dimensions, principally the shoulder, bust, waist and hip girth measurements.

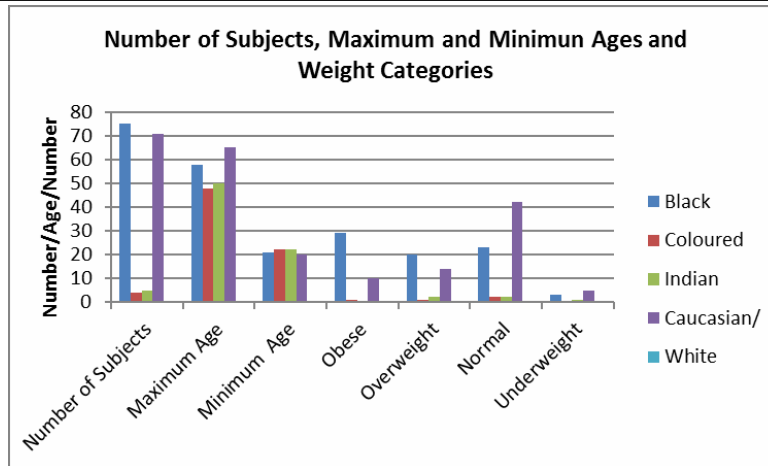
Sample

The majority of the subjects in this study were either Black (75) or White (71) women between 20 and 65 years old. Those volunteering for the study determined the sample population, and the sample is not intended to reflect the demographical composition of South African society. In Figure 1 it is noteworthy that 34% of the White and 65% of Black South-African subjects were in the overweight or obese body weight category.

RESULTS

Subjects self-perceived body shapes

For the psychographic question, subjects chose from six body-shape illustrations the shape that they considered most representative of themselves (see Figure 2, adapted from Liddelow, 2011). Of the n=155 subjects, n=131 answered the question on their self-perceived body shape, n=18 did not have a perception of their own body shape, and six declined to answer this question. The panel's visual assessment of the body shapes was conducted on the 3D rotational side and front views of the 3D point cloud of every subject scanned (see Figure 3).



Note: * Based on Body Mass Index (BMI) obese: BMI >30; Overweight: 25<BMI<30; Normal: 18.5 <BMI<25; Underweight: BMI <18.5.

FIGURE 1: AGE AND BODY WEIGHT CATEGORIES OF THE WOMEN SUBJECTS

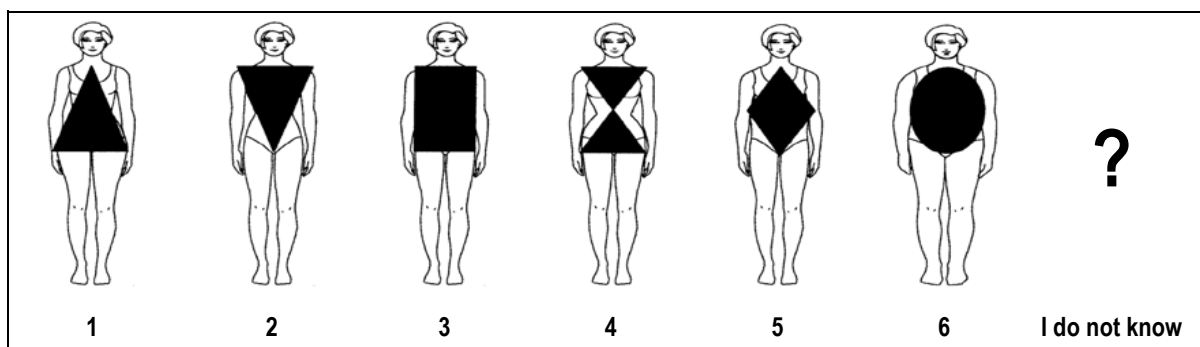


FIGURE 2: ADAPTED FROM LIDDELOW (2011)

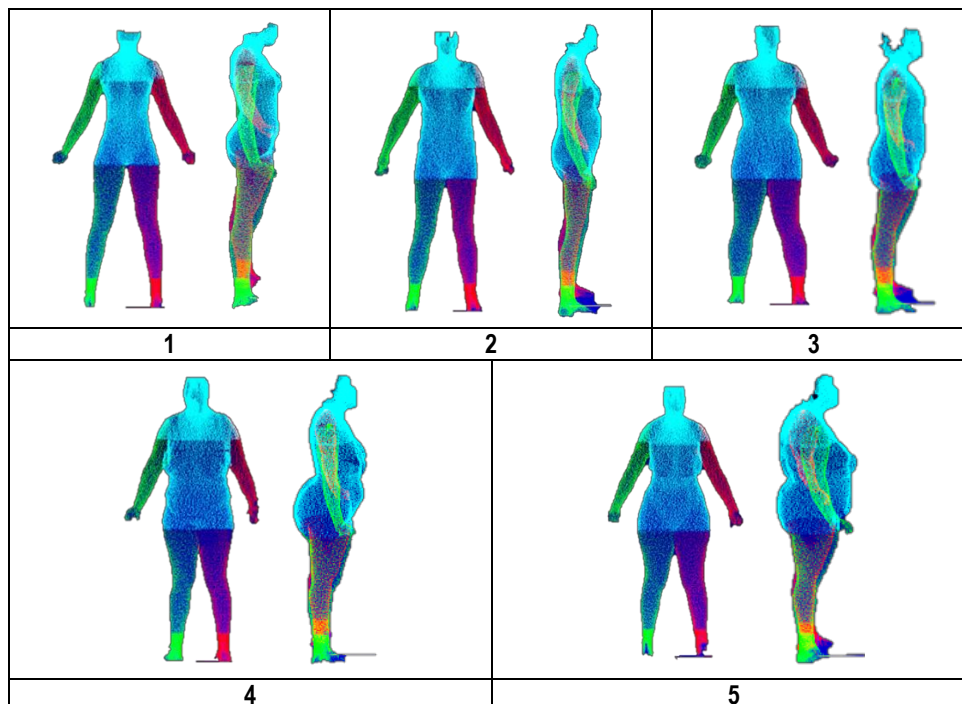


FIGURE 3: EXAMPLES OF DIFFERENT 3D POINT CLOUD BODY SHAPES (FRONT AND SIDE VIEWS)

TABLE 1: COMPARISON OF SUBJECTS' SELF-PERCEIVED AND PANEL ASSESSED BODY SHAPES (N=131)

Panel assessed body shape		Hourglass	Bottom Hourglass	Spoon	Triangle	Inverted Triangle	Diamond	Rectangle	Oval	Total
Subject's perceived body shape	Hourglass	3	6	25	1	0	0	6	0	41
	Triangle	2	1	21	2	0	0	2	0	28
	Inverted Triangle	1	2	4	0	0	0	6	0	13
	Diamond	0	0	3	0	0	0	2	0	5
	Rectangle	1	1	11	3	0	0	15	0	31
	Oval	1	0	5	1	0	0	6	0	13
	Total	8	10	69	7	0	0	37	0	31

Body shapes as assessed by the panel of subjects sampled in this study

Table 1 shows that the panel assessed the majority of body shapes as spoon/pear shaped (n=69), followed by rectangular (n=37). Only eight subjects assessed as having an hourglass shape. This contrasted with the same subject's self-perceived body shape in which the majority of the subjects (n=41) saw themselves as having an hourglass body shapes, followed by rectangular (n=31) and triangular (n=28). The range of body shapes options used by the panel was extended to include bottom hourglass and spoon/pear shapes, as these have been defined Simmons et al., (2004a) as distinctively different from the triangle body shape. However, to enable a more meaningful comparison, the assessed spoon/pear, bottom hourglass and triangle body shapes were grouped together as triangular.

On this basis, the panel assessed n=86 of the subjects as being predominantly triangular in shape, the corresponding number for the self-assessed triangular shape being only n=28. One explanation for these different perceptions is that the subjects who thought of their body shapes as "hourglass" might have perceived the shape that they wished to have, rather than their actual shape.

As Marshal et al., (2012:16) commented, the "psychological and physical image that one has of oneself and one's apparel choices expresses one's self-image." This may not be realistic.

Another explanation might be that, in the absence of a spoon or pear shaped classification to choose from, the subjects felt that the hourglass better represented their shape than the triangle. To evaluate the comparability further, the authors used the Hit Ratio where the number of body shape assessments for which there was agreement was calculated as a percentage of the total number of assessments. None of the subjects assessed by the panel had inverted triangle, diamond or oval body shape; hence, the only shapes where there could be some agreement were the hourglass, triangle (bottom hourglass + spoon + triangle combined) and the rectangle body shapes. This gave a Hit Ratio of $((2+24+15)/131)*100 = 31\%$.

A further analysis was conducted on those subjects with bottom hourglass figure types who may have considered that their shape being best represented by the hourglass body shape. Combining the panel-assessed hourglass with the bottom hourglass shapes, the spoon/pear with the triangle shapes and subject-perceived diamond, rectangle and oval shapes combined as rectangles gave a Hit rate of 42% (see Table 2).

The panel assessed the hourglass and bottom hourglass body shapes as hourglass; the spoon/pear and triangle shapes were combined into the triangle body shape classification and the self-perceived diamond, rectangle and oval shapes combined as rectangles. Therefore, even with, notionally, the most favourable

TABLE 2: PANEL ASSESSED AND SELF- PERCEIVED, COMBINED BODY SHAPES

Panel assessed body shapes		Hourglass	Triangle	Inverted Triangle	Rectangle	Total
Subject's perceived body shape	Hourglass	9	26	0	6	41
	Triangle	3	23	0	2	28
	Inverted Triangle	3	4	0	6	13
	Rectangle	3	23	0	23	49
	Total	18	76	0	37	131

TABLE 3: APPAREL SIZES AND THE CORRESPONDING BUST AND HIP GIRTH-MEASUREMENTS (CM.)

Garment Size	6	8	10	12	14	16	18	20	22	24	26
Bust girth	80	84	88	92	96	100	104	110	116	N/A	N/A
Hip girth	88	92	96	100	104	108	112	116	120	124	128

Source: Winks (1990). [N/A = not available].

comparison combination, there was disagreement between the panel and the subjects themselves in approximately 60% of the cases. The best agreements between the expert panel's and subjects' assessment for the combined shapes were for the triangular and rectangular body shapes, at 58% and 28% respectively, which were the predominant assessed body shapes of the n=131 subjects who responded.

By comparison, Kasambala et al's., (2016) perception study on the emotional aspects of apparel sizing and fit, found the (n=59) women's self-perceived body shapes to be triangle (42%) followed by oval (25%), rectangle (14%), inverted triangle (8%), hourglass (7%) and diamond (3%).

The conclusion drawn from the above is that subjects had significantly different views of their own body shape when compared with the expert panel's 3D assessment of the same subjects' scanned 3D body shapes. Such a large disagreement in shape perception clearly exemplifies the problems in subjectively assessing body shapes. It also serves to highlight the difficulties that manufacturers and retailers would encounter in deciding the most appropriate body shape to design and manufacture ready-made apparel in order to fit the majority of South African women, and that

the traditionally used hourglass body shape may not be relevant today.

Subject's upper and lower body apparel size perceptions compared with Winks' size chart as designated by ISO/TR 10652(1990) [E]

In the questionnaire, the subjects completed a question on what they thought their upper body and lower body apparel sizes were. Apparel sizes provided by the subjects were compared with the upper and lower body apparel sizes derived from ISO/TR 10652(1990) [E] Winks (1990),

(see Table 3), size charts according to their bust and hip girths, respectively, as extracted from the 3D point cloud images.

Figures 4 and 5 show the distribution of subject-perceived apparel sizes for the upper body and lower body ready-to-wear apparel, and those derived from Winks' size charts.

It is evident from Figures 4 and 5 that the subjects had very different perceptions of their ready- to-wear apparel sizes for the upper and lower body when compared with those derived from Winks' size charts according to their bust and hip girths. The mean subject-perceived upper body apparel size (11.7) was significantly smaller than the Winks' size chart derived upper body apparel size (13.7). Likewise, the mean

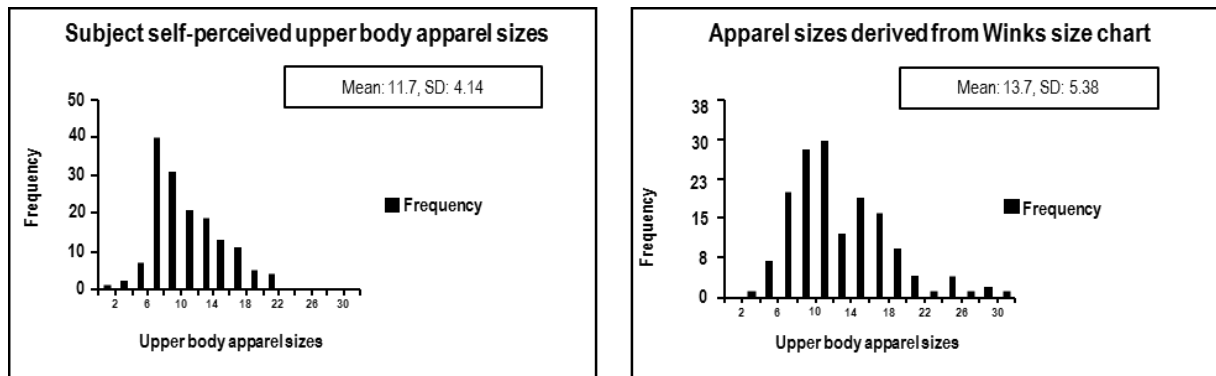


FIGURE 4: DISTRIBUTION OF UPPER BODY APPAREL SIZES: A) SUBJECTS SELF-PERCEIVED B) THOSE DERIVED FROM WINKS' SIZE CHART

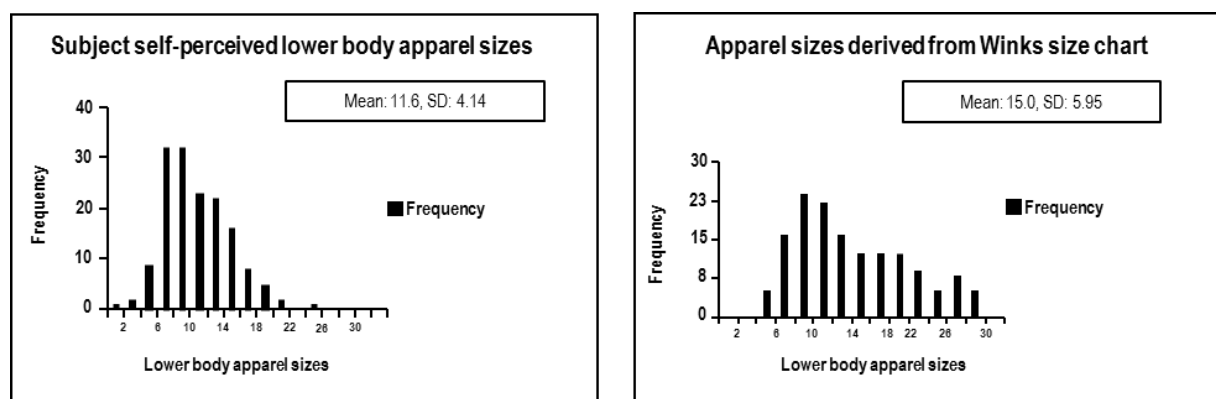


FIGURE 5: DISTRIBUTION OF LOWER BODY APPAREL SIZES A) SUBJECT'S SELF-PERCEIVED B) THOSE DERIVED FROM WINKS' SIZE CHART

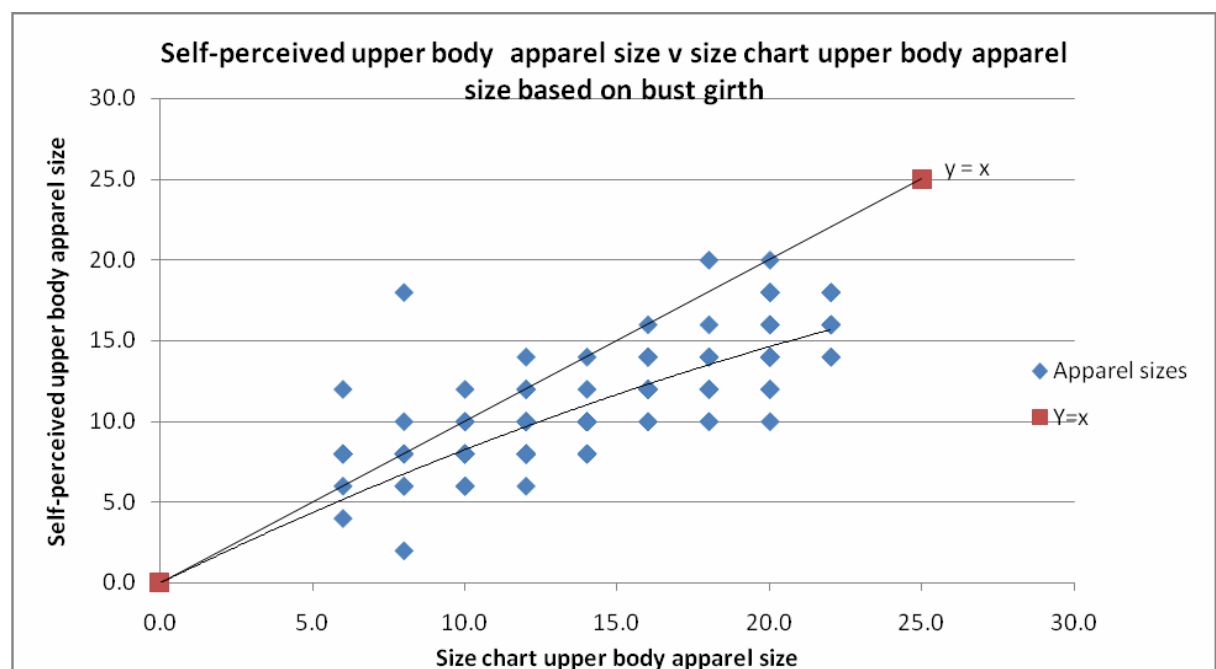


FIGURE 6: SELF-PERCEIVED UPPER BODY APPAREL SIZE VS. WINKS' (1990) SIZE CHART DERIVED UPPER BODY APPAREL SIZE

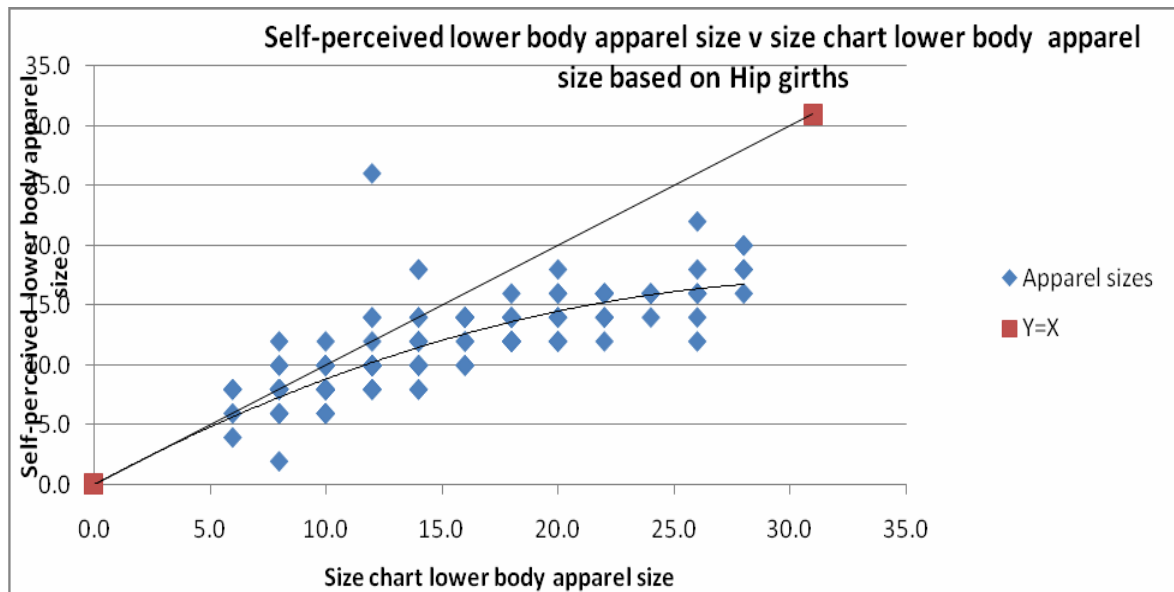


FIGURE 7: SELF-PERCEIVED LOWER BODY APPAREL SIZE VS. WINKS' (1990) SIZE CHART DERIVED LOWER BODY APPAREL SIZE

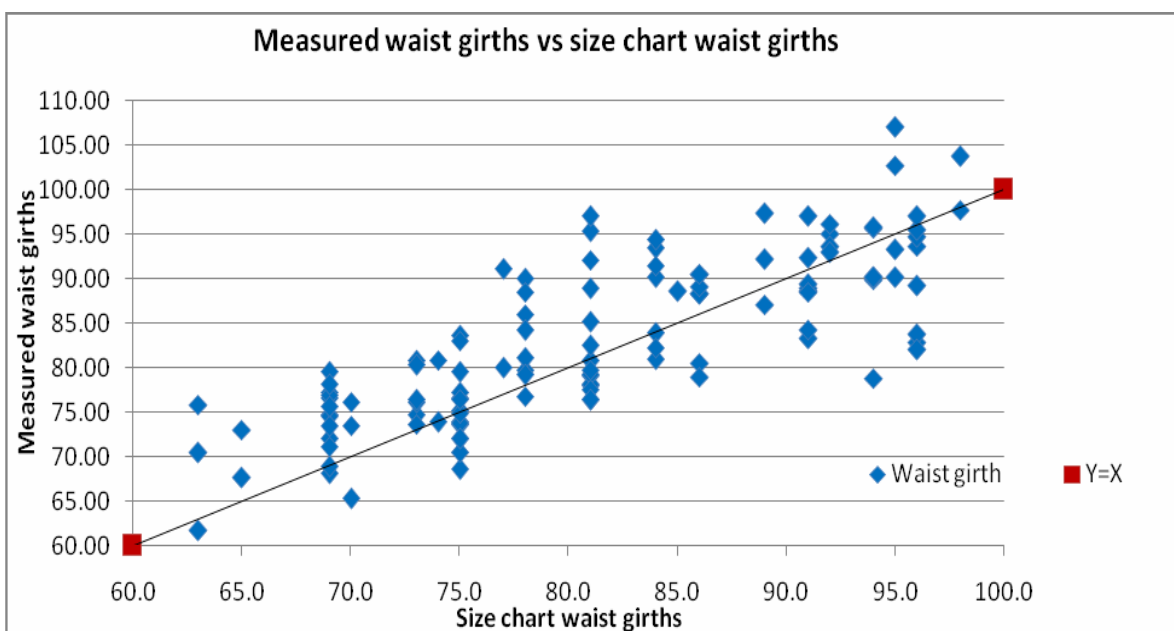


FIGURE 8: MEASURED WAIST GIRTHS VS. WINKS' (1990) SIZE CHART, WAIST GIRTHS

subject-perceived lower body apparel size (11.7) was significantly smaller than the lower body apparel size derived from Winks' size chart (15.0). Both the above differences were significant at the 95% confidence level based on t-tests for significant differences between the means. This implies that, collectively, subjects perceived their ready-to-wear apparel sizes to be smaller than those derived from Winks' size-chart did. To explore the correlation more fully, the individual values of each subject's self-

perceived upper and lower body apparels size were plotted (see Figures 6 and 7) against the apparel sizes derived from Winks' size chart based on their bust and hip girths respectively.

This graph shows the range of subject perceived upper body apparel sizes corresponding to each Winks' size chart derived upper body apparel sizes. The agreement was somewhat better for the Winks' size chart derived sizes 6-12, the difference getting larger as the derived size

TABLE 4: FIT PREFERENCES FOR DIFFERENT TYPES OF READY-TO-WEAR APPAREL PURCHASED

	Tops	Blouses	Jackets	Dresses	Skirts	Trousers	Total
Figure Hugging	14	1	5	27	24	28	99
Close fitting	49	47	38	46	53	62	295
Semi-fitted	49	61	52	53	46	38	299
Loose fitting	41	40	51	28	27	23	210
Very Loose fitting	4	2	4	3	1	1	15
Total	157*	151	150	157*	151	152	

* Some subjects registered preferences in more than one category

chart derived apparel size increased. A similar trend (Figure 7) is evident for the subject-perceived lower body apparel sizes plotted against the lower body apparel sizes derived from the size chart corresponding to each subject's hip girth measurement. In this case, the difference between the derived and subject-perceived lower body apparel sizes increases noticeably for sizes larger than 14.

Inferences drawn from the above observations are that for apparel labelled for body sizes 14 and larger, the Winks' Technical Report ISO/TR 10652(1990) [E] size chart may not reflect the size charts currently in use by manufacturers, or Winks' size chart data for apparel sizes larger than 14 may no longer be relevant today.

Waist girth comparisons

In a further assessment of the validity/accuracy of the Winks' size chart for use today, the measured waist girths extracted from the 3D scanned images were compared with those derived from the Winks' size charts corresponding to the measured hip girths. The waist girths were derived from the respective size charts according to the range of body heights viz. 160, 168 and 176 cm of the subjects see Figure 8 below, as indicated by Winks.

Figure 8 shows there is a correlation between the respective waist girths, although there is a large scatter of data points, which indicate that the fit of apparel, depending on their style, produced according to the waist girth measurement predicted by the size chart, is unlikely to be particularly good. The conclusion that may be drawn from this is that women consumers are likely to encounter fit problems, particularly with ready-to-wear retail apparel sizes to fit size 14 and larger in apparel

purchased from retailers/manufacturers using Winks' size charts, or any adapted versions thereof. These results also point to the need for further studies into female anthropometric data and the development of new size charts to further test the validity of Winks' and other size charts used by manufacturers of apparel for South African women.

Apparel styles and fit preferences

Subject responses about their preferred fit for the different styles of ready-to-wear apparel they purchased are summarised in Table 4.

The reason that some of these numbers exceed the total number of participants in the study (n=155) is that some subjects (n=157) indicated preferences in both categories, e.g. figure hugging and close fitting for tops and dresses. There was a strong preference for close, semi-fitted and loosely fitting apparel as opposed to figure hugging and very loose fitting apparel. It was also evident that younger women mostly preferred close to semi-fitted apparel, whereas the older women mostly preferred loosely fitting apparel. In general, fit preferences in the figure hugging category, were higher for the skirts and trousers, with very few preferring their blouses and jackets to be figure hugging. Table 4 also shows that the apparel in the close and semi-fitting

categories were popular choices, with the very loose fitting category being the least popular fitting choice for the subjects in this study.

Clearly, with such a strong preference for close and semi-fitted apparel, issues of fit will be critical and worth noting by any apparel manufacturer or retailer of ready-to-wear women apparel.

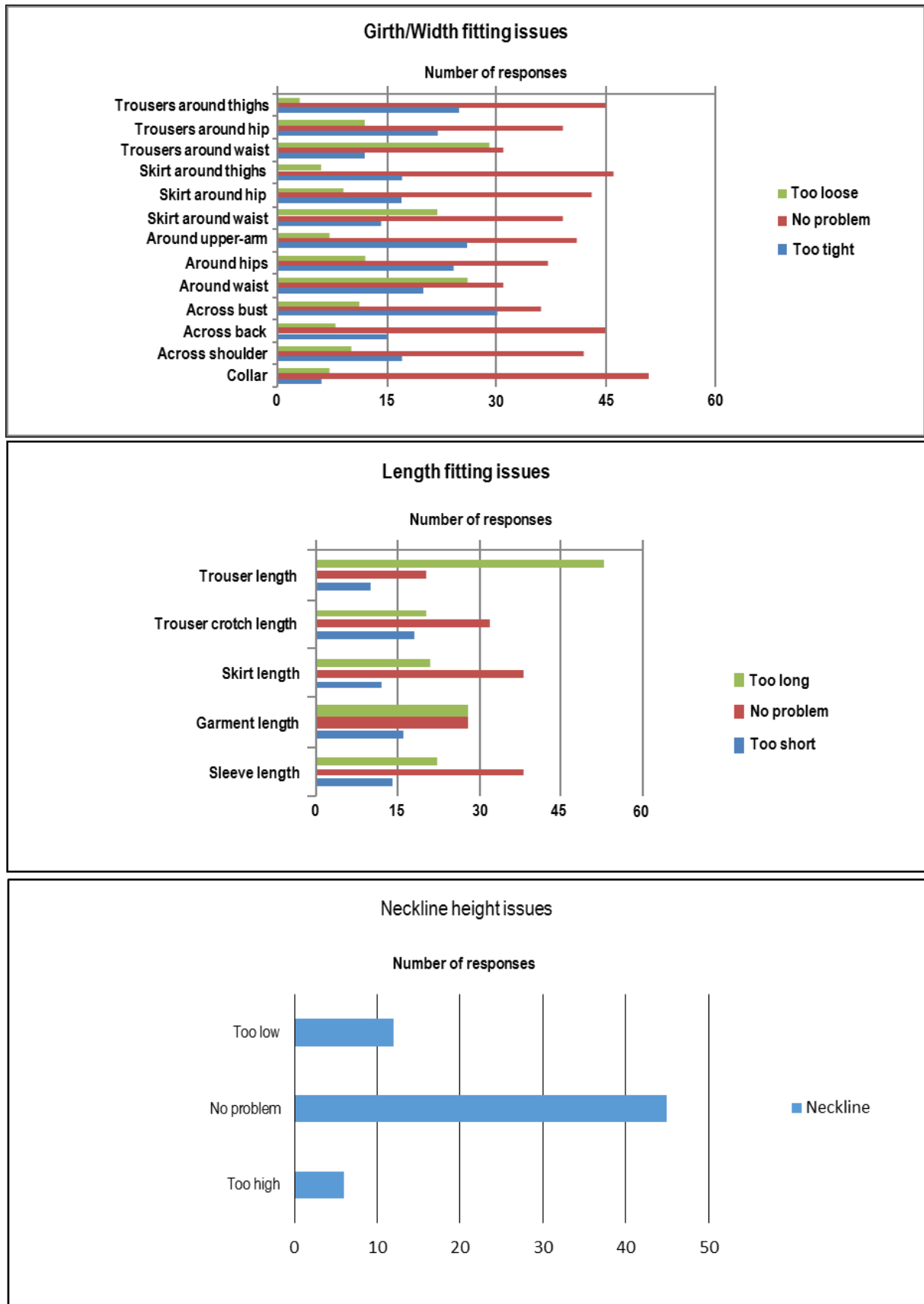


FIGURE 9: NUMBER OF RESPONDENTS REPORTING FIT PROBLEMS

Over-body apparel fit concerns

On the evidence of the results presented, the implications are that a number of South African women may experience problems with purchasing ready-to-wear apparel to fit them well, or to their particular expectations. To explore this further, the subjects' comments about the fit problems they encountered in practice and, specifically, where on their body these were experienced, are illustrated in Figure 9, which is divided into sections of fit, girth, length and neckline height. Just under half (72/155) of the subjects completed this question. The subjects reported fit problems in all the areas across the range of apparel features, with 46% of the subjects, on average, reporting apparel fit problems. This should be a cause for concern for retailers in terms of potential lost sales or high apparel return rates.

In terms of girth fit, most problems were encountered across the bust (41/77), around the waist (46/77) and, with trousers, around the waist (41/72). Of these, there were more problems of the apparel fit being too tight across the bust rather than too loose (30:11). In terms of waist fit, the predominant fit issue was too loose rather than too tight, particularly for the trousers (29:12), the latter being more pertinent in the light of the large number (n=62) of subjects who had expressed a preference for close fitting trousers. In terms of the apparel length fit, the predominant issue was of apparel being too long rather than too short.

This implied that the size charts in use might be overestimating the height of South African females in general. In this category, the highest numbers of fit issues expressed for trouser length fit, indicated about 64% of the respondents reporting trousers being too long and 12% reporting them to be too short.

CONCLUSIONS

The majority of the subjects were assessed as having a triangular/pear followed by rectangular body shapes. There were significant differences between subject perceptions of their own body shapes and sizes and their body shapes assessed by the expert panel. Furthermore, for a given upper or lower body apparel size derived from Winks' Technical Report ISO/TR 10652(1990[E]) using bust girth and hip girth

measurements for each subject, there was considerable variability in the corresponding sizes as perceived by the subjects themselves. Similarly, for a given waist girth predicted from Winks' size chart according to the hip girth, there were also significant variations in the measured waist girths of the subjects. If the currently in-use retailer size charts are adaptations of Winks (1990), then the data suggests that these need revision to better represent the current body shapes and sizes of South African women.

Limitations of the size chart, Technical Report ISO/TR10652 (1990 [E], Winks (1990), were clearly highlighted in the discrepancy between the predicted and self-perceived apparel sizes, particularly for those women larger than apparel size 14. As previously mentioned, this was (and is) the only referenced and acknowledged size chart in the public domain for body shapes of South African origin.

It would be instructive to perform similar analyses with other, non-South African, size charts in the public domain, and assess their validity for use for South African females. As Kasambala et al., (2014) pointed out; with the influx of internationally branded ready-to-wear apparel available to South African consumers might not be manufactured for South African consumers' body shapes and sizes.

Apparel labelling is another factor for retailer/manufacturers to re-consider. There was considerable variability in the measured waist girths (>20 cm in some cases) of those subjects, who, ostensibly, saw themselves as the same apparel size. The apparel sizes that the subjects perceived themselves to be are likely to be determined by the sizes quoted on the labels of ready- to-wear apparel that they purchase, and the corresponding apparel measurements may well vary between retailers, or even for different product ranges at the same retailer, depending on the size specifications used for their target markets. In terms of apparel fit, subjects reported particular problems with bust fit (too tight) and the waist (too loose) and apparel length (too long). Clearly, all these findings are a clear indication that deficiencies exist with the size charts and sizing systems in current use for the manufacture of women's apparel in South Africa.

Therefore, retailers and manufacturers might usefully rethink their target market strategies, develop a greater understanding of the women's ready-to-wear apparel sizing and fit problems for both locally produced apparel and those imported into the country.

LIMITATIONS

These data cannot be generalised to all women in South Africa. This would require the analysis of data from additional samples or the future development and measurement of a fully representative sample, such as that collected from a focused study of women or a South African National Body Sizing Survey.

FURTHER STUDIES

This study found that a large percentage of the Black South-African subjects were overweight or obese and the disagreement between the derived and the subjects' perceived body sizes increased for apparel labelled size 14 and larger. Hence, it would be pertinent to study the apparel sizing and fit concerns of plus-sized Black South-African women in particular.

There is little doubt that to produce size charts to fit different body shapes and/or bespoke clothing would impose additional manufacturing and implementation costs for the apparel industry. However, such a strategy offers the potential of a reduction in lost sales and in customer returns due to poorly fitting apparel ensuing from body shape variations. This is, however, beyond the scope of the current paper and is recommended for future studies.

ACKNOWLEDGEMENTS

The authors wish to thank the Department of Life and Consumer Sciences, of the University of South Africa, for providing partial funding for this study.

REFERENCES

Bee, P., 2006, 'The BMI myth', *The Guardian*, 28 November, 18.
Chl, L., & Kennon, R., 2006, Body Scanning of dynamic posture, *International Journal of Clothing Science and Technology*, 18(3), 166-178.

Defty, A., 1988, *The fascinating art of creating patterns*, 2nd ed, Penwrite (PTY) LTD, Durban.

Gribbin, E.A., 2014, Body shape and its influence on apparel size and consumer choices, in M.E. Faust & S. Carrier, (Eds.), *Designing of apparel for consumers: the impact of body shape and size*, Woodhead Publishing Limited, USA.

ISO 20685 (2010) [E], Method for reducing error in 3-D scanning, The International Organisation for Standardisation.

ISO 7250-1(2008), Basic human body measurements for technological design -- Part 1: Body measurement definitions and landmarks. The International Organisation for Standardisation.

ISO/TR10652 (1990 [E]).Standard sizing systems for clothes, The International Organisation for Standardization.

John, L., 2007, "It says it's Large, but it's medium", *Cape Argus*, 8 December, 1-4.

Kasambala, J., Kempen, E. & Pandarum, R., 2014, Female consumers' perception of apparel fit, personal values and emotions considering their body shape, *The Retail and Marketing Review*, 10(1), 95-108.

Kasambala, J., Kempen, E. & Pandarum, R., 2014, 2016, Female consumers' perception of apparel fit, personal values when considering apparel sizing, *The International Journal of Consumer Studies*, 40 (2), 143-15.

Khan, T., 2008, Survey will get the measure of us all, so we can dress comfortably" *Business Day*, 4 February.

Liddelow, J., 2011, What' your body shape? viewed 19 June 2016, from <https://www.style-makeover-hq.com/body-shape.html>.

Liddy, S., 2011, Body image perception: Learning to love the body you have now, *The blog*, viewed 25 June 2017, from http://www.huffingtonpost.com/susan-liddy-ma-pcc-cpcc/body-image-perception_b_873846.html.

Macduff, L. & Smith, J.R., n.d., African body dimensions – A South African anthropometric initiative, viewed 16 October 201, from uns.ac.id.

Mckinnon, L. & Istook, C., 2002, The effect of subject respiration and foot positioning on the data integrity of scanned measurements, *Journal of Fashion Marketing and Management: An international Journal*, 6(2), 103-121.

Milliam, R., 2017, South African women body dimensions/size charts and body shapes, Figure forms, in conversation.

- Makhanya, B., De Klerk, H., Adamski, K. & Mason, A., 2014, Ethnicity body shape differences and female consumers' apparel fit problems, *International Journal of Consumer Studies*, 38, 1-9.
- Muthambi, A., de Klerk, H & Mason, A., 2015, Sizing for ethnicity in multi-cultural societies: Validation of the size specifications for young South African women, *Journal of Family Ecology and Consumer Sciences*, 44, 1-10.
- Marshall, S., Jackson, H. & Stanley, M.S., 2012, *Individuality: in apparel selection and personal appearance*, 7th edn, Prentice Hall, New York.
- Ola-Afolayan, O. & Mason, A., 2013, A customised size chart for the African pear shaped plus-sized South African women. DEFSA Conference Proceedings, Kenya.
- Pandarum, R. & Yu, W., 2015, Apparel sizing and fit, in R. Nayak & R. Padhye (Eds.), *Apparel Manufacturing Technology*. Woodhead Publishing, UK.
- Strydom, M., 2006, An evaluation of South African Apparel related population measures and sizing systems, Master's dissertation, University of Pretoria, Pretoria:
- Simmons, K., Istook, C. & Devarajan, P., 2004a, Female figure identification Technique (FFIT) for apparel. Part II, *Journal of Textiles and Apparel, Technology and Management*, 4, 1-16.
- (TC)2., 2016, 3D body scanner, viewed 14 September 2017, from <http://www.tc2.com>.
- Venter, F.C., Walsh, C.M., Slabber, M. & Bester, C.J., 2009., Body size perception of African women (25-44) in Mangaung, *Journal of Family Ecology and Consumer Sciences*, 37, 12-22.
- Watson, K. & Watson, O., 2013, Prospects for the textile and clothing Industry in South Africa, *Textile Outlook International*, No, 166, December.
- Winks, J.M., 1990, The development of standard sizing systems for clothes, Master Dissertation, University of Port Elizabeth, Port Elizabeth.
-