Development of a Sizing System for Ghanaian Women for the Production of Ready-to-Wear Clothing

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Abstract

Studies on anthropometric body measurements have intensified worldwide because of the numerous garment fit problems the ready-to-wear industry is facing. The absence of any publication of a national sizing system in Ghana, intended for clothing purposes has resulted in the need for a sizing system that will relate to Ghanaian women and satisfy their different body shapes. The purpose of this paper is to present a detailed procedure used for the development of a size chart based on anthropometric body measurements of Ghanaian women. A total of 842 Ghanaian women aged between 16-35 years were measured using manual measuring procedures. A quantitative approach was used to generate descriptive statistics from the raw data to obtain five sizes of a body measurement table. Correlations were used to determine the relationship between the body dimensions and the selection of key dimensions for the size chart. A step by step procedure used for analysing the raw data obtained from the anthropometric body survey is presented. Size codes, size limits, grading increment and verifiable size charts are generated. This study contributes greatly to knowledge of size chart by providing a detailed procedure involved in developing research based anthropometric data and will serve as the basis for other future research in Ghana and in West Africa. Further anthropometric studies should be conducted to cover all age categories of women in Ghana.

Keywords: Ready-to-wear, anthropometric survey, size chart, sizing system

1. Introduction

Since the introduction of mass production, sizing has been used in dividing standardised body and clothing dimensions into categories for speeding up and enhancing production and retailing of clothes (Beazley, 1997). Clothing standardisation has become necessary and an important issue of ready-to-wear clothing leading to the development of many different sets of body dimensions having the same size designation (Dickerson, 2000). Historically, clothing manufacturers developed their own sizing methods for ready-to-wear clothing for women leading to great variation in sizes and much confusion (Winks, 1997). This has competitive environment with little adherence to proposed systems for standardising body dimensions (Tamburino, 1992a). The industry in recent times has been challenged to satisfy customers clothing fit because of the choices of extremely close body fitting of clothing (Otieno et al, 2005). The search for total satisfaction as a result of clothing fit problems has therefore resulted in a number of anthropometric studies and surveys to improve on the accuracy data obtained

Many countries (USA, UK, Germany, Holland, China, Japan, South African and others) have conducted national anthropometric surveys leading to the development of sizing systems, which were based on their own populations in order to reduce clothing fit problems. The US Department of Agriculture (O'Brien and Shelton, 1941; Yu, 2004c; LaBat, 2007) sponsored

the first large-scale anthropometric women survey conducted in the USA in 1939-1940. Research has shown that anthropometric data collections need to be updated regularly because of changes that occur in the distribution of body dimensions in order to ensure the right measurements are used (Oborne, 1982; Roebuck, 1995). Research has also established that body shapes of women may differ from one geographical location to another due to different lifestyles, diets, socio-cultural values and ethnic composition of populations (Tamburrino, 1992b). Body shape and proportions within a population and age bracket are significant factors when considering clothing fit.

The need for practicable size charts for the production of ready-to-wear clothing has resulted in an increase in the development of new technologies to achieve fast and reliable body measurements data. 2D and 3D body scanners are the latest technology developed for anthropometric surveys. Anthropometric surveys conducted before the introduction of the two-dimensional (2D) and three-dimensional (3D) body scanners, used the manual measuring techniques, which involved the use of tape measure and callipers. Based on the manual methods and the new technologies that are emerging, several clothing standards have been developed by various countries, (USA, UK, Germany, the Netherlands, France, Japan, China and others) which are in use globally.

In Ghana, however, the absence of an official national sizing system has resulted in the clothing companies adopting or modifying size charts from different countries, most specifically USA, UK, and International Organisation for Standardisation (ISO, 8559:1989) creating variations in sizes resulting in clothing fit problems. Research has identified clothing as remaining a culture-bound product group (Usunier, 1993). Although globalisation has resulted in clothing companies trading standardised clothing across the world, presuming universal sizes, the differences in body shapes, sizes and proportions as a result of socio-cultural and geographical factors undermine the concept of globalisation. This therefore demands the use of different size charts that can cater for the clothing needs of specific groups of people. Otieno (1999) indicates that styles can be globally desired but sizing should be local. There is therefore the need for an anthropometric survey to be conducted in Ghana for specific demographic groups.

1.1 Sizing System

Petrova (2007) defines a sizing system as a table of numbers that contains the value of each body dimensions of different group. Sizing system is a process used to establish a size chart consisting of key body measurements for a range of apparel (Schofield and LaBat, 2005). Size charts are presented in a form of tables, which present the value of each of the body dimensions used to classify the bodies encountered in the population for each size group in the system (Yu, 2004c). Each size chart is created to serve one body type category of the population. According to Kunick (1984), Workman (1991), Ashdown (1998), Gupta and Gangdhar, 2004), a sizing system must be a three-dimensional by using the bust, waist, hip girths and stature as the main key measurements. Studies have shown that although sizing systems developed by different countries vary in the body dimensions chosen to divide the population, the basic structure of most sizing systems is very similar (Ashdown, 1998, 2007; Petrova, 2007).

2. Purpose and Methodology

The purpose of this paper is to present a detailed procedure used for the development of a size chart based on anthropometric body measurements of Ghanaian women. The anthropometric survey was conducted in Ghana between November 2008 and March 2009. A total of 842 women aged between 16 and 35 years were measured. This age bracket chosen was based on

the definition of youth by the Ministry of Youth and Sports Ghana (Ministry of Youth and Sport, 2010) as they have been identified as a group which patronise more ready-to-wear clothing than any other group in Ghana (Matthews, 1979). Sampling was carried out in three stages; selection of regions, institutions and subjects. Non-probability purposive sampling technique was used in selecting two regions; Greater Accra and Ashanti regions. Greater Accra is the capital of Ghana, situated in the southern part while Ashanti region is the second largest city, and situated to the northern part of country. As part of decentralising of government, Greater Accra region had been made to coordinate the activities of the southern part of the country while Ashanti region also coordinates the activities of the northern part of the country. 10 institutions and 15 training centres were also purposively selected from the two study area. These institutions met the criteria set for the study and were strategically positioned closer to the survey centres. Women who voluntarily accepted to be part of the survey and were within the age group were measured.

Official letters were sent four months prior to the survey to seek permission from the two Polytechnics in Accra and Kumasi. The permission was necessary because the researcher realised that specific facilities such as space, equipment and human resource would be needed from these institutions. Approval letters were received in good time to help the researcher prepare towards the survey. Contacts were also established through letters with some selected vocational institutions, clothing and hairdressing training centres. Posters and leaflets were designed and posted on the various internal notice boards. Leaflets were distributed randomly to women within and around the campuses by the researcher and the research assistants. This was to boost publicity and create awareness.

Thirty- two body measurement positions and three other variables (age, dress size and region) considered vital in the construction of patterns for clothing of all kinds for women were obtained. The body measurements were taken in conformity with the ISO 8559 (1989) to ensure reliability and validity of the results. Anatomical positions were determined and landmarks placed with suitable adhesive; the measuring positions were determined in between the landmarks (7^{th} Cervical, neck joint, waist, hip, bust, shoulder, wrist, knee and ankle (Kunick 1984). Trained research assistants and the researcher measured all the subjects; this ensured reliability and validity (Cameron, 1982). The process involved two trained assistants at a time, with one taking the measurements and the other recording the measurements. A set special unpadded brassier free of metal fit exactly to give a good bust measurement and brief were used. This was not to interfere with the waist and the hip measurement. Subjects were measured in the provided bras and briefs provided for the survey in a secure and prepared rooms for the survey. The manual measurement method, which involves tape measure for girth measurements, balance scale for weight and height stadiometer was used.

Ethical issues were considered due to the nature of the survey. A subject information sheet highlights privacy of the subject, the right of the subject to withdraw from the survey, health and safety issues were discussed with subjects prior to the exercise. Subjects were reassured of confidentiality and anonymity. Changing rooms were provided to address privacy issue (Cameron, 1984; Beazley, 1997; Otieno, 1998).

3. Data Analysis

The anthropometric data obtained from this study served as the basis of information for the analysis. Statistical Package for the Social Sciences (SPSS) Version 18.0 for windows was employed for data inputting and analysis. According to Kemsley (1957), the usefulness of anthropometric survey will depend on the extent to which these body measurements are

transformed by statistical analysis in summaries or key dimensions and used in solving design problems. Descriptive statistics including mean, standard deviation, and percentile were calculated and utilised for the analysis and correlations were determined. The values were calculated in centimetres with the exception of the weight, which is in kilograms. All values of the standard deviation are rounded to two decimal places. There were 11 vertical measurements and 19 girth measurements. Body dimensions can be analysed when correlations of the body dimensions are determined. Co-efficient Correlation was used in determining the relationships between the body dimensions. Multiple co-efficient analyses helped in measuring the linear associations between two measurements.

Values used in the determination of correlations between the dimensions and identifying key parameters were based on BS 7231 (BSI, 1990). The standard specifies that; if correlation co-efficient is less than 0.5 then there is no relationship; if correlation co-efficient is between 0.6-0.75 then there is a mild relationship; and if correlation co-efficient is more than 0.76 it shows a strong or high relationship.

4. Results and Discussions

The mean and standard deviation were the statistical values used for calculating the initial values for the development of the size chart. The mean is the most commonly used average value for developing size steps (Beazley, 1998; Otieno, 1999, 2008; Gupta and Gangadhar, 2004; Vronti, 2005; Kuma- Kpobee, 2009). Winks (1997) points out that mean can be a convenient indication of obtaining central tendency. Table 1 presents the descriptive statistics for body dimensions.

Table 1: Descriptive Statistics for Body Dimensions

Body Dimensions (cm)	Mean	Median	Mode	Standard Deviation	Minimum	Maximum
Height	159.59	160.00	160.00	6.09	142.00	179.40
Weight (Kg)	54.83	53.85	55.00	7.63	40.00	88.00
Neck Girth	34.84	35.00	35.00	1.48	22.50	47.00
Cervical to Waist	37.80	38.00	38.00	2.33	31.00	44.00
Cervical to Ground	138.56	138.50	137.00	4.93	130.00	156.00
Neck to Shoulder point	12.29	12.00	12.00	0.78	10.00	15.00
Back Shoulder Width	39.02	39.00	39.00	2.49	28.50	49.00
Front Neck Point- Bust	25.61	25.50	25.00	2.10	19.00	35.00
Front Neck point - Waist	40.50	40.00	40.00	2.44	33.00	49.00
Arm length	59.22	59.00	59.00	3.01	51.00	69.00
Shoulder Point to Elbow	32.76	33.00	33.00	1.99	23.30	44.00
Upper Arm Girth	27.79	27.50	28.00	2.95	23.00	38.00
Armscye Girth	36.47	36.00	34.00	3.03	23.00	47.00
Elbow Girth	29.64	29.50	28.00	2.52	21.50	43.00
Wrist Girth	15.47	15.50	15.00	0.87	12.70	18.00
Bust Girth	85.53	84.20	82.00	5.64	75.00	101.00
Under Bust Girth	70.03	69.50	69.00	4.72	60.00	98.30
Across Front	32.05	32.00	31.00	2.26	23.00	40.00
Across Back	33.51	33.50	33.00	2.47	24.00	42.00
Side waist to Ankle	99.21	99.00	99.00	4.47	85.00	112.00
Side Waist to Knee	58.62	58.50	58.00	3.12	49.00	69.50
Side Waist to Hip	20.91	20.50	20.00	1.03	16.00	24.70
Waist Girth	67.71	67.00	66.00	5.41	57.00	86.00
Upper Hip Girth	82.06	82.00	83.00	5.88	63.00	101.00
Lower Hip Girth	96.18	95.50	90.00	6.47	78.00	109.00
Thigh Girth	54.97	55.00	52.00	4.44	44.00	68.00
Knee Girth	35.93	36.00	36.00	2.61	23.00	44.00
Calf Girth	33.68	34.00	34.00	2.75	21.00	40.00
Ankle Girth	24.02	24.00	24.00	2.06	20.00	37.00
Inside Leg Length	75.37	76.00	77 .00	3.38	67.00	82.00
Crotch Length	69.31	70.50	70.00	3.39	60.00	76.50
Outside Leg Length	104.45	104.00	103.00	4.07	98.00	114.00

n=842

(All values are in centimetres with exception of weight, which is in kilograms)

4.1 Percentiles for Determination of Body Measurement Tables

Percentile values for body measurements are of great interest as they are valuable in depicting the spread or range of dimension and used to estimate the degree of coverage. According to Le Pechoux and Ghosh (2002), percentiles of body dimensions are considered as best predictors in determining body measurements. The five major percentiles 5^{th}, 25^{th}, 50^{th}, and 75^{th} and 95^{th} referred to as quartiles were calculated as shown in Table 2.

Table 2: Percentiles of Body Dimensions

Body Dimensions (cm)	Percentiles				
	5th	25th	50th	**75th**	**95th**
Height	150.00	155.17	160.00	163.07	170.00
Weight	43.80	49.20	53.85	59.90	68.65
Neck Girth	29.50	33.00	35.00	36.00	39.38
Cervical to Waist	34.00	36.00	38.00	39.50	42.00
Cervical to Ground	130.00	135.00	138.50	142.00	148.00
Neck to Shoulder point	11.00	12.00	12.00	13.00	13.50
Back Shoulder Width	35.00	37.50	39.00	40.77	43.00
Front Neck Point to Bust	22.51	24.00	25.50	26.62	27.00
Front Neck Point - Waist	35.00	38.00	40.00	43.00	47.00
Arm length	54.00	57.00	59.00	61.00	64.00
Shoulder Point to Elbow	30.00	31.50	33.00	34.00	36.00
Upper Arm Girth	23.50	26.00	27.50	29.50	33.00
Armscye Girth	32.00	34.00	36.00	38.00	41.92
Elbow Girth	26.00	28.00	29.50	31.00	34.00
Wrist Girth	14.00	15.00	15.50	16.00	17.00
Bust Girth	76.00	81.00	84.20	90.00	99.00
Under Bust Girth	62.50	66.00	69.50	72.12	78.00
Across Front	28.50	31.00	32.00	33.00	36.00
Across Back	29.50	32.00	33.50	35.00	37.45
Side waist to Ankle	92.00	96.00	99.00	103.00	107.00
Side Waist to Knee	54.00	56.50	58.50	60.62	64.00
Side Waist to Hip	16.00	18.50	20.50	21.00	22.50
Waist Girth	60.00	64.00	67.00	71.00	77.00
Upper Hip Girth	73.00	78.00	82.00	86.00	92.00
Lower Hip Girth	84.00	90.00	95.50	101.50	112.00
Thigh Girth	47.00	51.50	55.00	58.50	63.00
Knee Girth	32.00	34.00	36.00	38.00	40.50
Calf Girth	29.51	32.00	34.00	35.50	38.00
Ankle girth	21.00	23.00	24.00	25.00	27.00
Inside Leg Length	72.00	74.87	76.00	81.00	87.00
Crotch Length	63.00	67.00	70.50	73.77	78.47
Outside Leg Length	97.00	101.00	104.00	109.00	113.00

n=842
(All values are in centimetres with exception of weight, which is in kilograms)

4.2 Determination of Size Ranges from Raw Data

The development of the size chart was carried out by using values obtained from the statistical information of body dimensions. The mean values and the standard deviation were used for creating size steps for the size chart. The mean value is the most widely used value for size steps and it is equivalent to the average size and the size 12 of every size chart. The determination of a size range involves demarcating the extreme values from the frequency table. Five size steps approach was used to develop the size chart. The outliers were determined based on the values of the five size steps. All values, which were below the values of the smallest and the largest sizes were eliminated and classified as outliers or extreme values. The five sizes were determined between the two values. Table 3 presents the size range of each body dimension, with the number of outliers. To obtain five steps for five categories of body sizes, one standard deviation (1SD) and two standard deviations (2SD)

values are added to the mean to obtain two values that are higher than the mean. One standard deviation (-1SD) and two standard deviation (-2SD) values are subtracted from the mean sequentially to obtain two values that were less than the mean. Cramer (1998) specifies that the entire sample is statistically catered for by using five standard deviation divisions. By subtracting one standard deviation and two standard deviation values (-1SD and -2SD) from the mean, size 8 and 10 are obtained. When one standard deviation value and two standard deviation values (+1SD and +2SD) are added, the values obtained are size 14 and size 16. The mean and the standard deviation figures were all rounded up to the nearest decimal place. Percentages above 0.5 cm were rounded up to 1.0 cm and values below 0.5 have been eliminated. This was to ensure easy calculation of figures for the size chart and to undo any uneven number of millimetres. Table 4 shows the size ranges from the raw data.

Table 3 Size Ranges from Raw Data

Body Dimensions (cm)	-0	Mean -2SD	Mean -1SD	Mean	Mean +1SD	Mean +2SD	SD	+0
Height	12	148	154	160	166	172	6	7
Weight	16	39	47	55	63	71	8	8
Neck Girth	39	32	33	34	35	36	1	38
Cervical to Waist	38	34	36	38	40	22	2	31
Cervical to Ground	4	129	134	139	144	149	5	18
Neck to Shoulder point	6	10	11	12	13	14	1	25
Back Shoulder Width	40	37	38	39	40	41	1	31
Front Neck Point- Bust	11	22	24	26	28	30	2	10
Front Neck point -Waist	23	37	39	41	43	45	2	10
Arm length	13	53	56	59	62	65	3	21
Shoulder Point- Elbow	11	29	31	33	35	37	2	12
Upper Arm Girth	7	22	25	28	31	34	3	18
Armscye Girth	10	30	33	36	39	42	3	20
Elbow Girth	4	24	27	30	33	36	3	10
Wrist Girth	0	13	14	15	16	17	1	18
Bust Girth	16	74	80	86	92	98	6	29
Under Bust Girth	5	60	65	70	75	80	5	19
Across Front	11	28	30	32	34	36	2	34
Across Back	21	30	32	34	36	38	2	31
Side waist to Ankle	8	91	95	99	103	107	4	18
Side Waist to Knee	10	53	56	59	62	65	3	12
Side Waist to Hip	14	19	20	21	22	23	1	12
Waist Girth	13	58	63	68	73	78	5	23
Upper Hip Girth	9	70	76	82	88	94	6	16
Lower Hip Girth	7	84	90	96	102	108	6	24
Thigh Girth	9	45	50	55	60	65	5	23
Knee Girth	3	30	33	36	39	42	3	13
Calf Girth	13	28	31	34	37	40	3	10
Ankle Girth	0	20	22	24	26	28	2	18
Inside Leg Length	17	69	72	75	78	81	3	31
Crotch Length	14	63	66	69	72	75	3	12
Outside Leg Length	11	96	100	104	108	112	4	18

n=842

(All values are in centimetres with exception of weight, which is in kilograms)

The total outliers obtained for the body dimensions were less than 10% of the population. The five steps covered above 91% of all the body dimensions of the population used for this study.

4.4 Determination of Inter-Size Interval

Size interval is the division of sizes in a size chart (Kunick, 1984). The BS EN 13402-3 (2004) states that in order to accommodate variations in height by a country and company system, 4cm or 8cm interval for women is standardised. The same standard also recommended an interval of 4cm or 6cm for both bust and waist1 and 4cm or 5cm for hip in order to have flexible link between the bust, waist and hip. Beazley (1998) used 4cm interval for the key dimensions (bust, waist and hip) for size 8-14 and 6cm interval for size 16 to normalise the intervals. According to Aldrich (2008), many British companies use 5cm interval between all sizes. Kunick (1984) states that there are variability of size interval some as low as 3cm and some as high as 8cm but he proposes that the most logical one is an interval of 6cm and it is one which is used by most countries. With this study, the intervals for the key dimensions wall within the recommended figures. The inter-size interval for height was 6cm, bust girth 6cm, waist 5cm and hip girth 6cm.

4.5 Determination of Size Codes

The size codes were determined after generating the five size steps values from the body dimensions. The size codes were based on the numerical coding methods which are GHA size 8, GHA size 10, GHA size 12, GHA size 14, and GHA size 16. Table 4 shows the size codes together with the body dimensions.

Table 4: Size Codes for the Ghanaian Women

Body Dimensions (cm)	Size Codes				
	Size GHA 8	**Size GHA 10**	**Size GHA 12**	**Size GHA 14**	**Size GHA 16**
Height	148	154	160	166	172
Weight	39	47	55	63	71
Neck Girth	33	34	35	36	37
Cervical to Waist	34	36	38	40	22
Cervical to Ground	129	134	139	144	149
Neck to Shoulder point	10	11	12	13	14
Back Shoulder Width	37	38	39	40	41
Front Neck Point to Bust	22	24	26	28	30
Front Neck point - Waist	37	39	41	43	45
Arm Length	53	56	59	62	65
Shoulder Point to Elbow	29	31	33	35	37
Upper Arm Girth	22	25	28	31	34
Armscye Girth	30	33	36	39	42
Elbow Girth	24	27	30	33	36
Wrist Girth	13	14	15	16	17
Bust Girth	74	80	86	92	98
Under Bust Girth	60	65	70	75	80
Across Front	28	30	32	34	36
Across Back	30	32	34	36	38
Side waist to Ankle	91	95	99	103	107
Side Waist to Knee	53	56	59	62	65
Side Waist to Hip	19	20	21	22	23
Waist Girth	58	63	68	73	78
Upper Hip Girth	70	76	82	88	94
Lower Hip Girth	84	90	96	102	108
Thigh Girth	45	50	55	60	65
Knee Girth	30	33	36	39	42
Calf Girth	28	31	34	37	40
Ankle Girth	20	22	24	26	28
Inside Leg Length	69	72	75	78	81
Crotch Length	63	66	69	72	75
Outside Leg Length	96	100	104	108	112

n=842

(All values are in centimetres with exception of weight, which is in kilograms)

4.7 Determination of Lower and Upper Limits of Sizes

Determining the lower and upper limit is an important step which helps in establishing the limit of each size and demonstrate the extent of coverage for inter size ranges. The value obtained for each size code is used as the midway point and the lower and the upper limit are determined from it. The lower and the upper limits are determined by adding or subtracting half value of the standard deviation of each body dimension to the midpoint value. A value 0.01 is subtracted from the figure obtained below the midpoint to demarcate limits between the lower value of the next size and the upper value of the previous size. In order to avoid overlapping of figures with the next size a value of 0.01 is subtracted from the upper limit making it less than the next value. This procedure has been used by other researchers (Beazley, 1998; Mlauli, 2002; Vronti, 2004; Otieno, 2009, 1999; Kuma Kpobee, 2009). The lower and the upper limit are important in establishing what percentages of the population are covered by each size. The lower, midway point and upper limit of all the body dimensions have been tabulated and presented in Table 5.

Table 5 Lower and Upper Limit of Size Code

Body Dimensions (cm)	GHA Size 8	GHA Size10	GHA Size 12	GHA Size14	GHA Size16
Height	145.00	151.00	157.00	163.00	169.00
	148.00	**154.00**	**160.00**	**166.00**	**172.00**
	150.99	156.99	162.99	168.99	174.99
Weight	35.00	43.00	51.00	59.00	67.00
	39.00	**47.00**	**55.00**	**63.00**	**71.00**
	42.99	50.99	58.99	66.99	74.99
Neck Girth	32.50	33.50	34.50	35.50	36.50
	33.00	**34.00**	**35.00**	**36.00**	**37.00**
	33.49	34.49	35.49	36.49	37.49
Cervical to Waist Level	33.00	35.00	37.00	39.00	41.00
	34.00	**36.00**	**38.00**	**40.00**	**42.00**
	34.99	36.99	38.99	40.99	42.99
Cervical to Ground Level	127.50	132.50	137.50	142.50	146.50
	129.00	**134.00**	**139.00**	**144.00**	**149.00**
	131.49	136.49	141.49	146.49	151.49
Neck to Shoulder Point	09.50	10.50	11.50	12.50	13.50
	10.00	**11.00**	**12.00**	**13.00**	**14.00**
	10.49	11.49	12.49	13.49	15.49
Back Shoulder Width	36.50	37.50	38.50	39.50	40.50
	37.00	**38.00**	**39.00**	40.00	**41.00**
	37.49	38.49	39.49	40.49	41.49
Front Neck Point to Bust	21.00	23.00	25.00	27.00	29.00
	22.00	**24.00**	**26.00**	**28.00**	**30.00**
	23.99	24.99	26.99	28.99	30.99
Front Neck Point to waist	36.00	38.00	40.00	42.00	44.00
	37.00	**39.00**	**41.00**	**43.00**	**45.00**
	37.99	39.99	41.99	43.99	45.99
Arm Length	51.50	54.50	57.50	60.50	63.50
	53.00	**56.00**	**59.00**	**62.00**	**65.00**
	54.49	57.49	60.59	63.49	66.49
Shoulder Point to Elbow	28.00	30.00	32.00	34.00	36.00
	29.00	**31.00**	**33.00**	**35.00**	**37.00**
	29.99	31.99	33.99	35.99	37.99
Upper Arm Girth	20.50	23.50	26.50	29.50	32.50
	22.00	**25.00**	**28.00**	**31.00**	**34.00**
	23.49	26.49	29.49	32.49	35.49
Armscye Girth	28.50	31.50	34.50	37.50	40.50
	30.00	**33.00**	**36.00**	**39.00**	**42.00**
	31.49	34.49	37.49	40.49	43.49
Elbow Girth	22.50	25.50	28.50	31.50	34.50
	24.00	**27.00**	**30.00**	**33.00**	**36.00**
	25.49	28.49	31.49	34.49	37.50
Wrist Girth	12.50	13.50	14.50	15.50	16.50
	13.00	**14.00**	**15.00**	**16.00**	**17.00**
	13.49	14.49	15.4 9	16.49	17.49
Bust Girth	71.00	77.00	83.00	89.00	95.00
	74.00	**80.00**	**86.00**	**92.00**	**98.00**
	76.99	82.99	88.99	94.99	100.99
Under Bust girth	57.50	62.50	67.50	72.50	77.50
	60.00	**65.00**	**70.00**	**75.00**	**80.00**
	62.49	67.49	72.49	77.49	82.49

Across Front	27.00	29.00	31.00	33.00	35.00
	28.00	**30.00**	**32.00**	**34.00**	**36.00**
	28.99	30.99	32.99	34.99	36.99
Across back	29.00	31.00	33.00	35.00	37.00
	30.00	**32.00**	**34.00**	**36.00**	**38.00**
	30.99	32.99	34.99	36.99	38.99
Side Waist to Ankle	89.00	93.00	97.00	101.00	105.00
	91.00	**95.00**	**99.00**	**103.00**	**107.00**
	92.99	96.99	100.99	104.99	111.49
Side Waist to Knee	50.50	53.50	56.50	59.50	62.50
	52.00	**55.00**	**58.00**	**61.00**	**64.00**
	53.49	56.49	59.49	62.49	65.49
Side Waist to Hip	18.50	19.50	20.50	21.50	22.50
	19.00	**20.00**	**21.00**	**22.00**	**23.00**
	19.49	20.49	21.49	22.49	23.49
Waist Girth	55.50	60.50	65.50	70.50	75.50
	58.00	**63.00**	**68.00**	**73.00**	**78.00**
	60.49	65.49	70.49	75.49	80.50
Upper Hip Girth	68.00	73.00	79.00	85.00	91.00
	70.00	**76.00**	**82.00**	**88.00**	**94.00**
	72.99	78.99	84.99	90.99	96.99
Lower Hip Girth	81.00	87.00	93.00	99.00	105.00
	84.00	**90.00**	**96.00**	**102.00**	**108.00**
	86.99	92.99	98.99	104.99	111.99
Thigh Girth	42.50	47.50	52.50	57.50	62.50
	45.00	**50.00**	**55.00**	**60.00**	**65.00**
	47.49	52.49	57.49	62.49	67.49
Knee Girth	28.50	51.50	34.50	38.50	39.50
	30.00	**33.00**	**36.00**	**39.00**	**42.00**
	31.59	34.49	38.49	39.49	44.49
Calf Girth	26.50	29.50	32.50	35.50	38.50
	28.00	**31.00**	**34.00**	**37.00**	**40.00**
	29.49	32.49	35.49	38.49	41.49
Ankle Girth	19.00	21.00	23.00	25.00	27.00
	20.00	**22.00**	**24.00**	**26.00**	**28.00**
	20.99	22.99	24.99	26.99	28.99
Inside Leg Length	67.50	71.50	73.50	76.50	79.50
	69.00	**72.00**	**75.00**	**78.00**	**81.00**
	70.49	73.49	76.49	79.49	82.49
Crotch Length	62.50	64.50	67.50	70.50	73.50
	63.00	**66.00**	**69.00**	**72.00**	**75.00**
	64.49	67.49	70.49	73.49	76.49
Outside Leg Length	94.00	98.00	102.00	106.00	110.00
	96.00	**100.00**	**104.00**	**108.00**	**112.00**
	97.99	101.99	105.99	109.99	113.99

n=842

(All values are in centimetres with exception of weight, which is in kilograms)

5. Development of Garment Measurements

The verification of the developed size chart becomes very crucial for its acceptance. To be able to verify the size chart, garments measurements should be developed for the preparation of the patterns and subsequently the garment for trials. For the development of garment measurement, ease allowance was added to each body dimension on the developed size chart.

Garment patterns were constructed manually using measurement information from the new size chart. The basic blocks for bodice, skirt and trousers of the base sizes from the size chart were constructed and digitised using the System Management of the Gerber Technology (Beazley and Bond, 2003).The basic blocks constructed were graded in all sizes indicated for the study GHA size 8, GHA 10, GHA 12, GHA 14, and GHA16. Using the Pattern Design System 2000 software package, the basic block for the base size 12 was decreased two steps down and increased two steps up to obtain the rest of the sizes.

6. Validation of Size Chart (Fitting Trials)

Prototype garments were prepared and constructed using grey baft (calico) for all five sizes developed from the size chart. Basic garments were made from already prepared bodice blocks, skirts and trousers graded patterns for all sizes. Fifteen garments were constructed for the fitting trials. Patterns from Gerber were transferred from tracing paper unto the fabric using the tracing wheel and tailor's chalk. Measurements of the toile were cross-checked with that from the actual patterns for accuracy.

The fitting trials were conducted using life models. Ten subjects for each size were selected for the fitting trials (Size 8-Size 16). The key dimensions (height, bust, waist and hip) for the study were used to select subjects for the trials. The selection was carried out after measuring the subjects again to determine the key dimensions. Thirty five subjects finally took part in the fitting trials, as this was to ensure that the expected figure is obtained. The subjects wore the prototypes garments for a period of 30 minutes.

Evaluation was made on each subject while in a standing, sitting and walking positions by the researcher (Le Peachoux and Ghosh, 2002). The researcher recorded the visual observations based on the movement of the subjects and overall fit of the garments in relation to the elements mentioned in this section earlier. The relationship between a subject and the prototype garment was therefore judged. The subject wore the basic garments over undergarments were the same as that used for the anthropometric survey for the fit evaluation**.**

7. Conclusions

The development of the size chart will facilitate manufacturing strategies for the production of ready-to-wear clothing for Ghanaian women. The size range of the size chart developed covered over 91% of the women measured. Percentage coverage differed from each body dimension. Most of the women were within sizes 10-14. The verification of the developed size chart demonstrated that the majority of participants had good fit with percentage coverage between 88.6% and 100%. The majority of the (85.7%) of the consumers indicated that they were satisfied with the garment fit. However, some of the vertical body dimensions were long and therefore further work would be carried out. This study recommends that further anthropometric studies should be conducted to cover all age categories of women in Ghana. Since there are no sizing systems for men and children, the study proposes that studies should also extend to the male population as well as the children of all age groups as they will serve as database for sizing in the Ghanaian clothing industry. The development of a sizing system will promote the clothing industry and improve the clothing fit for consumers.

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