

Full Length Research Paper

Anthropometric data of Bahirdar City's adult men for clothing design

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The aim of this study is to establish anthropometric data for garment industries in Bahir Dar City for the design and manufacturing of clothing. Data were collected from nine Bahir Dar City tailors' adult men measurement for shirt and trouser making. Totally, about 350 and 1000 measurements were collected for shirt and for trouser. Data purging process has been carried out before using it for developing standards. Data collected were analysed using percentile base for the 5th, 50th, and 95th percentile. Based on the percentile, standard sizes for the two products were developed. Size charts are also established for both products. Visible difference has been observed on standards when compared with Italy and USA standards for the same measurements. This proved that further studies should be conducted in all regions and ethnic groups in Ethiopia for clothing design and beyond for other applications.

Key words: Anthropometry, clothing design, tailor, Bahir Dar, Ethiopia.

INTRODUCTION

Anthropometry is the science that measures the range of body size in a population. Many scholars agree on the needs to measure human body dimensions in order to develop standards and solve variations in body size due to different reasons such as geographical location, nutrition, ethnic group, etc. Anthropometric data of a country are vital database for clothing design and other design applications. It is also an important parameter in population studies. Developing such a database is common in many other countries of the world (Aminian and Romli, 2012; Bukhari, 2011; Mirmohammad et al.,

2011; Gharib and Rasheed, 2009; Tunay and Melemez, 2008; Rashid et al., 2008; Lin et al., 2004). In Africa, however, measuring human body dimensions has been given limited attention though African body dimensions are significantly different from others. Due to this, African people are being challenged with unfit products, machines, equipment, etc. So far, attempts have been made to establish Ghanaian Adults' ophthalmic (Alex and John, 2010), Nigerian paraplegics (Ayodeji et al., 2008) and Nigerian adult working class (Igboanugo et al., 2002), Black South African Women (Hattingh et al., 2008)

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Nasofacial Anthropometry of Adult Bini Tribe in Nigeria (Omotoso et al., 2011). In Ethiopia, specifically, an updated and comprehensive Anthropometry of Ethiopian Population is largely unknown. There is no institution which tries to develop the Ethiopian Anthropometry in spite of the rapid industrialization and increase of Ethiopia-specific designs in the garment industries. This study is, therefore, an attempt to study Bahir Dar City adult men body dimensions for clothing design.

In clothing industry, designing in different size to address majority of the population is a common approach. However, in Ethiopia body measurement is mostly made by tailors to design cloths that fit individuals unlike that of some suit manufacturers using western standards. Though custom made products have their own advantages, the people prefer to buy readymade products for their cheap price and accessibility in a short time. This phenomenon highly affected the development of garment industries in Ethiopia. Among others, unavailability of standard anthropometric data is one of the causes for not producing readymade clothes in the garment shops. Moreover, since mass production or long production often bring economies of scale in product design through reduced setup time and stoppages, it is a desired condition for the sector's development. These circumstances inculcate the development of Anthropometric data to determine a minimum number of different sizes (and the dimensions of each size) that will accommodate all users.

Due to this, different countries have their own standard body dimension or size standards. Based on that, garment manufacturers produce different garments like shirts and trousers specifically for the intended people from the standard body measurement or size. This study develops size measurement of shirt and trouser for Bahir Dar City adult men based on data collected from tailors found in the City.

RESEARCH METHODOLOGY

This research is intended to study measurements of shirts and trousers design and production. These two products have their own requirements and specifications. The trouser design take measurements of waist circumference, hip circumference, back crotch depth, front crotch depth, pant length, inner seam, knee width, hem circumference measurements. Similarly, basic shirt takes measurements of neck circumference, shoulder width, front body length, front armpit distance, chest circumference, back armpit distance, back body length, cuff circumference, side length, sleeve length.

The study was conducted at Bahir Dar City. Data were taken from tailors' measurement in the city. Initially, 15 tailors were selected for the study, however, since some of the tailors do not have proper recording system for the basic measurements and some of them were not willing to provide their data, only nine tailors were considered in this study. Based on the above basic measurements for the two products, data collection sheet was printed and filled from tailors' data books. Totally, 350 and 1000 measurements were collected for shirt and trouser respectively. 350 actual measurements were taken by the researchers to validate

reliability of the data collected from the tailors.

Data were analysed to filter out and remove anomalies. Then, based on the purified data 5th %, 50th % and 95th % were computed and standard size charts were also developed for the two products under study. Finally, size charts developed were compared with international size chart to validate in the measurements.

RESULT AND DISCUSSION

Before interpreting the data, normality test was made using Skewness and Kurtosis tests mainly used to measure asymmetry of distribution and central tendency respectively. To keep the normality of the data, outliers were removed from both the samples of shirt and trouser taken from the tailors. If Skewness and Kurtosis ratio to their standard error is between -2 and 2, then the data are assumed to be normally distributed. With this process, only 300 data were considered for further analysis out of 350 in the case of shirt and 861 out of 1000 data in the case of trouser. Table 1 and Table 2 show the final normality test result obtained.

The purified data were taken to develop frequency distribution. The relative frequency indicates percentile of occurrence in order to find how many times the value of measurement occurs and it helps us to find the proportion of measurements in the particular population occurrence.

The main objective of this study is to develop a standard anthropometric data for shirt and trouser design and readymade clothes production. After purging the data frequency distribution has been made to further classify the data. As the anthropometric principles suggest, the target must include design for the smallest and the largest.

The size cluster classification is made with 5th percentile smallest size groups, 50th percentile for medium size groups, and 95th percentile for largest size groups. There is an erroneous tendency to consider the 50th percentile dimensional data as sufficient to accommodate the majority of users. This must not be done. The 50th percentile dimensions accommodate only a portion of the population, not a majority of the users. A person who is 5th percentile body size does not necessarily have 5th percentile neck or waist circumference dimensional measurements.

Based on these basic assumptions, the researchers try to classify the sample standard into three percentile groups: 5th percentile, 50th percentile, and 95th percentile (Tables 3 and 4). The standard design will have letter and size code classifications to make it easy and understandable for the user. All the measurements are grouped into five known clusters: the small size 'S' representing the 5th percentile population, medium size 'M, L and XL' representing the 50th percentile populations and large size 'XXL' representing the 95th percentile population. Tables 3 and 4 represent measurement groups in small, medium and large categories. In addition to this, the size codes are assigned for each and every

Table 1. Normality test of Shirt Data.

| | | Statistic | Std. error | Ratio Test stat/Std. error | Remark |
|---------------------|----------|------------------|-------------------|-----------------------------------|---------------|
| Front Armpit | Mean | 23.0667 | .06145 | | |
| | Skewness | -.134 | .141 | -0.95 | Normal |
| | Kurtosis | -.520 | .281 | -1.85 | Normal |
| Neck | Mean | 38.0000 | .12448 | | |
| | Skewness | .000 | .141 | 0 | Normal |
| | Kurtosis | -.177 | .281 | -0.63 | Normal |
| Shoulder | Mean | 46.0000 | .12448 | | |
| | Skewness | .000 | .141 | 0 | Normal |
| | Kurtosis | -.177 | .281 | -0.63 | Normal |
| Front Body Length | Mean | 64.4833 | .12015 | | |
| | Skewness | .024 | .141 | 0.170 | Normal |
| | Kurtosis | -.289 | .281 | -1.03 | Normal |
| Chest Circumference | Mean | 90.0000 | .12448 | | |
| | Skewness | .000 | .141 | 0 | Normal |
| | Kurtosis | -.177 | .281 | - 0.63 | normal |
| Back Armpit | Mean | 25.0667 | .06145 | | |
| | Skewness | -.134 | .141 | -0.95 | Normal |
| | Kurtosis | -.520 | .281 | -1.85 | Normal |
| Back Body Length | Mean | 70.0000 | .12448 | | |
| | Skewness | .000 | .141 | 0 | Normal |
| | Kurtosis | -.177 | .281 | -.63 | normal |
| Cuff | Mean | 23.0667 | .06145 | | |
| | Skewness | -.134 | .141 | -0.95 | Normal |
| | Kurtosis | -.520 | .281 | -1.85 | Normal |
| Sleeve Length | Mean | 59.0000 | .12039 | | |
| | Skewness | .000 | .141 | 0 | Normal |
| | Kurtosis | -.435 | .281 | -1.55 | Normal |

Table 2. Normality test of trouser data.

| | | Statistic | Std. error | Ratio statistics /Std. error | Remark |
|---------------------|----------|------------------|-------------------|-------------------------------------|---------------|
| Waist Circumference | Mean | 85.1336 | .16317 | | |
| | Skewness | -.005 | .083 | -0.060 | normal |
| | Kurtosis | -.578 | .166 | -3.48 | |
| Hip Circumference | Mean | 91.5064 | .09910 | | |
| | Skewness | .001 | .083 | 0.012 | Normal |
| | Kurtosis | .442 | .166 | 2.66 | |
| Back Crotch | Mean | 24.4576 | .04760 | | |
| | Skewness | -.041 | .083 | -0.49 | Normal |
| | Kurtosis | -.845 | .166 | -5 | |
| Front Crotch | Mean | 19.5587 | .04735 | | |
| | Skewness | -.002 | .083 | -0.024 | Normal |
| | Kurtosis | -.811 | .166 | -4.88 | |

Table 2. Contd.

| | | | | | |
|-------------------|----------|---------|--------|--------|--------|
| Pant Length | Mean | 97.9965 | .14307 | | |
| | Skewness | .001 | .083 | -0.006 | Normal |
| | Kurtosis | -.306 | .166 | -1.83 | |
| Inner Seam | Mean | 74.9919 | .18036 | | |
| | Skewness | .016 | .083 | 0.193 | Normal |
| | Kurtosis | -.132 | .166 | -0.795 | |
| Hem Circumference | Mean | 31.1614 | .08296 | | |
| | Skewness | -.029 | .083 | -0.35 | Normal |
| | Kurtosis | -.932 | .166 | -5.6 | |

Table 3. Percentile distribution for shirt.

| Measurement | Size class n th % | Measurement taken from tailors in cm | Actual measurement taken in cm |
|---------------------|---------------------------------|---|-----------------------------------|
| Neck | 5 th % | 33 cm | 34 |
| | 50 th % | 37.5 cm | 37 |
| | 95 th % | 43 cm | 40 |
| Front Arm pit | 5 th % | 20.4 | 22 |
| | 50 th % | 22.81 | 23 |
| | 95 th % | 25.2 | 24 |
| Shoulder | 5 th % | 42.2 | 42 |
| | 50 th % | 45.9 | 43 |
| | 95 th % | 50.7 | 46 |
| Front body length | 5 th % | 60 | 64 |
| | 50 th % | 63.2 | 65 |
| | 95 th % | 67.7 | 68 |
| Chest circumference | 5 th % | 84.8 | 77 |
| | 50 th % | 89 | 87 |
| | 95 th % | 93.7 | 92 |
| Back armpit | 5 th % | 23 | 23 |
| | 50 th % | 25 | 24 |
| | 95 th % | 27.7 | 27 |
| Back body length | 5 th % | 65 | 65 |
| | 50 th % | 69 | 67 |
| | 95 th % | 74 | 71 |
| Cuff | 5 th % | 21 | 17 |
| | 50 th % | 23.2 | 22 |
| | 95 th % | 25.3 | 23 |
| Sleeve length | 5 th % | 55.5 | 56 |
| | 50 th % | 59.4 | 60 |
| | 95 th % | 63.7 | 67 |

Table 4. Percentage distribution for trouser.

| Measurement | Size class n th % | Measurement taken from tailors in cm | Actual measurement taken in cm |
|--------------------|---------------------------------|--|--------------------------------------|
| Waist | 5 th % | 73 | 73 |
| | 50 th % | 83 | 84 |
| | 95 th % | 110 | 95 |
| Hip circumference | 5 th % | 80 | 84 |
| | 50 th % | 94 | 95 |
| | 95 th t | 120 | 107 |
| Back crotch depth | 5 th % | 22 | 22 |
| | 50 th % | 26 | 25 |
| | 95 th | 27 | 28 |
| Front crotch depth | 5 th % | 17 | 18 |
| | 50 th % | 20 | 20 |
| | 95 th | 22 | 22 |
| Pant length | 5 th % | 88 | 90 |
| | 50 th % | 97 | 103 |
| | 95 th | 105 | 110 |
| Inner seam | 5 th % | 62 | 72 |
| | 50 th % | 72 | 77 |
| | 95 th | 88 | 80 |
| Hem circumference | 5 th % | 28 | 28 |
| | 50 th % | 30 | 30 |
| | 95 th | 35 | 35 |

Table 5. Size chart for shirt.

| Letter Code1 | Size Code2 | Neck | Front armpit | Shoulder | front body length | Chest circum. | Back armpit | Back body leng. | cuff | Sleeve leng. |
|--------------|------------|-------|--------------|----------|-------------------|---------------|-------------|-----------------|------|--------------|
| S | 34 | 33-35 | 21 | 41-43 | 60-61 | 85-87 | 23 | 65-67 | 21 | 55-57 |
| M | 36 | 35-37 | 22 | 43-45 | 61-63 | 87-89 | 24 | 67-69 | 22 | 57-59 |
| L | 38 | 37-39 | 23 | 45-47 | 63-65 | 89-91 | 25 | 69-71 | 23 | 59-61 |
| XL | 40 | 39-41 | 24 | 47-49 | 65-67 | 91-93 | 26 | 71-73 | 24 | 61-63 |
| XXL | 42 | 41-43 | 25 | 49-51 | 67-69 | 93-95 | 27 | 73-75 | 25 | 63-65 |

cluster as seen in Tables 5 and 6 for shirt and trouser.

The study has compared the data taken from the tailors with the actual measurements by the researchers. This was to validate whether the data gathered from the tailors represent the actual measurement of the people. As a result, for comparison purpose the 5th, 50th and the 95th percentile of all the measurement for both shirt and trouser is indicated in Tables 3 and 4. As seen from the

tables almost all the measured data are within the data taken from the tailors. Thus, this proves that the data gathered from the tailors represent Bahir Dar city adult men body dimensions.

Size charts developed in this study are also compared between that of America and Italy by considering measurements of neck, circumference, shoulder with sleeve length, chest circumference as key indicators for

Table 6. Size chart for trouser.

| code ¹ | size code | Waist circum. | Hip circum. | Back crotch | Front crotch | Pant length | Inner seam | Hem circum. |
|-------------------|-----------|---------------|-------------|-------------|--------------|-------------|------------|-------------|
| S | 76 | 74-78 | 84-87 | 22 | 17 | 88-92 | 62-67 | 27-29 |
| M | 80 | 78-82 | 87-90 | 23 | 18 | 92-96 | 67-72 | 29-31 |
| L | 84 | 82-87 | 90-93 | 24 | 19 | 96-100 | 72-77 | 31-33 |
| XL | 89 | 87-92 | 93-96 | 25 | 20 | 100-104 | 77-82 | 33-34 |
| XXL | 94 | 92-96 | 96-99 | 27 | 22 | 104-108 | 82-87 | 34-35 |

Table 7. Comparison among Bahir Dar, American and Italian size for shirt.

| Bahir Dar Size | | | American size | | | Italian Size | | |
|----------------|--------|-------|---------------|--------|---------|--------------|--------|---------|
| Neck | Sleeve | Chest | Neck | Sleeve | Chest | Neck | Sleeve | Chest |
| 33-35 | 76-79 | 85-87 | 33-34 | 80-81 | 84-86 | 33-35 | 84 | <91 |
| 35-37 | 79-82 | 87-89 | 35-37 | 82-84 | 89-94 | 36-38 | 84 | 91-96 |
| 37-39 | 82-85 | 89-91 | 38-39 | 85-86 | 96-102 | 38-39 | 84-90 | 96-101 |
| 39-41 | 85-88 | 91-93 | 40-42 | 87-89 | 107-112 | 40-41 | 90-92 | 101-107 |
| 41-43 | 88-91 | 93-95 | 43-45 | 90-91 | 116-122 | 42 | 90-92 | 107-117 |
| | | | 46-47 | 91-93 | 127-132 | 43 | 92-94 | 117-122 |
| | | | 48-49 | 93-94 | 137-140 | 44-46 | >94 | 122-91 |

Table 7b. Comparison among Bahir Dar, American and Italian size for trouser.

| Bahir Dar size | | | American Size | | | Italian Size | |
|----------------|-------------|------------|---------------|--------------|------------|---------------|--------------|
| Waist circum. | Hip circum. | Inner seam | Waist circum. | Hip. circum. | Inner seam | Waist circum. | Hip. circum. |
| 74-78 | 84-87 | 62-67 | 76-80 | 92-96 | 80-81 | 74-78 | 91-95 |
| 78-82 | 87-90 | 67-72 | 84-88 | 100-104 | 82-83 | 78-82 | 95-99 |
| 82-87 | 90-93 | 72-77 | 92-96 | 108-112 | 84-85 | 82-86 | 99-103 |
| 87-92 | 93-96 | 77-82 | 100-104 | 116-120 | 86-87 | 86-90 | 103-107 |
| 92-96 | 96-99 | 82-87 | 108-112 | 124-128 | 88-89 | 90-94 | 107-111 |
| | | | | | | 94-98 | 111-115 |
| | | | | | | 98-102 | 115-119 |

shirt.

From the comparison of the people of Bahir Dar having neck size of 33 to 43 cm, their chest varies from 85 to 95 cm. However, for the American, their chest measures from 84 to 122 cm. Particularly, if we take neck circumference of 41 to 43 cm the Bahir Dar's chest circumference is limited to 95 cm. For American it reaches 122 cm and for Italian it reaches 117 cm. For this particular case, the sleeve length (half of the shoulder plus the upper and lower arm length) of the Bahir Dar is shorter compared to that of American and Italian. The imported shirts with neck circumference of good fit like that of the Ethiopian are very loose around the chest, shoulder and sleeve. In the Italian size, the front body of the shirt runs from 78 to 82 cm for the neck (34 cm), but

in the Bahir Dar size the front body length is from 60 to 69 cm. This shows that the Italians majorly have high body length and width. Similar to the shirt, measurements taken as key indicators for trouser size data comparisons are waist, hip and inner seam length. From Table 7a and b, for the same waist circumference, that is the same pant size the hip circumference and the inner seam of the Italian have bigger hip circumference and have longer inner seam length. This shows that Bahir Dar's are short in length and hip circumference is lower for a given size of trouser. That is why the trousers imported to Ethiopia having the European size standard have wider hip circumference. This makes most readymade trousers to be modified in their length, hip and waist to fit the buyer. Thus, the above developed size chart will definitely solve

such problems. Products designed particularly for Bahir Dar city may use the size as a general measurement guide. But the designer and manufacturer may design his/her own styles taking this chart as basic measurements.

Conclusion

As it is shown from the data analysis, the Bahir Dar city adult men size chart has been developed for shirt and trouser. The comparison of Bahir Dar size with European and US standards shows that there is a significant difference for the same neck and waist measurement and other parts of the body measurement. The Italian and US body measurement is generally bigger than the Ethiopian body dimension. This was the problem that creates loose fit garments manufactured and imported to Ethiopian customers as per the Italian and USA body size standards. It will be helpful for the garment manufacturers intended for Bahir Dar city customers. In addition to this, it may also be useful for importers or traders of garment for the Ethiopian people. This size chart has a significant importance for the Ethiopian standards authority to set garment standard measurements for Ethiopian society. Besides this importance, these data and size chart may be used as basic input for the main anthropometric data of Ethiopia that will be developed in the future to design workplace, equipment; they can be used for different institutions like health.

Conflict of Interests

The authors have not declared any conflict of interests.

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