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Developing Standard Size Charts for Ethiopian Men between the Ages of 18-26 through Anthropometric Survey

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ABSTRACT

In this study an anthropometric survey of Ethiopian males from 18-26 years was taken. Sixty three variables were measured using a sample size of 440 males in Bahir Dar University based on the nine regions of Ethiopia (Tigray, Afar, Amhara, Oromia, Benishangul gumuz, Gambella, Harari, Somale, South Nation of Ethiopia). Using inferential statics the data was analyzed to compare the means of the 63 variables to test for significance, the p value was set 0.05. The grand mean of the sample was compared to the nine group mean to see if the differences warrant the creation of the size chart for the whole Ethiopia or individual sizing chart for different group. The body measurements of each group is different, that means the body proportion between the region or ethnic group is extremely different so it is preferable to do the size charts for each individual region because the ground mean is different from the mean of each region.

Keywords: Ethiopia, anthropometric survey, inferential statics, size chart

Introduction

In Ethiopia the human body has been a subject of study in much time for years and it was not until recent years that more precise knowledge became available through anthropometry. The search for perfect clothing fit has a long history relating to various efforts to determine body anthropometry for the development of patterns and garments in the clothing industry.

The shapes of human figure types continue to change mainly due to sedentary lifestyles grow dietary habits, migration patterns and the impact of rising trends that affect body shape ideals.

The most notable differences in body size and shape relate to ethnic diversity, age and gender. In principle, there is no equal body proportion. With age increase, many adults become shorter and many also heavier. Ethiopians body structure means their hand is short and their upper torso is long; in again the buttock of China is much greater than

Ethiopians, which results uncomfortably. Consequently, the garment which is imported to Ethiopia is not accurate fit for consumer and it is suitable and not comfortable .The aim is to establish an acceptable sizing system for general use in that market sector. With regard to sizing, surveying the bodies of Ethiopian males between 18 to 26 age's , which results in the need to offer numerous sizes during the development of the human body, different changes in width, height and weight are evident with the increase in age. It is important to consider that the human body develops, grows and changes during the lifecycle by increase in size, differentiation of structure and the alteration of shape. These changes need to be understood in order to make clothing that fits comfortably and is suitable for its intended purpose. Such information, however, requires to be updated over time to take into consideration the changing rate of growth from one generation to another .Considering this, clothing manufacturers and retailers should be responsible enough to study the body sizes and figure types of their consumers before they design and manufacture garments. This should be done to ensure that garment s fit the intended shape, silhouette and size of the consumer identified.

Literature Review

The issues that will be discussed in this chapter are directed at providing a greater understanding in the areas of sizing and fit satisfaction. Included in the beginning of this section is the definition of terms, which provides useful explanations needed throughout this study. The pertinent subjects that will be included in the rest of this section are a background in the development of sizing standards and why these standards have become inadequate, the difficulties faced in determining satisfactory fit and how satisfactory fit relates to the men's underwear industry. A study by Macrini was designed to give the industry a scientific standard that could be applied to sizing men's apparel. Although his size study did not create any new theory, his approach created a standard for sizing men's apparel through the use of anatomical statistics. The objective was to provide a benchmark of accuracy for sizing and fit so that designers and patternmakers would have a text of dimensions to construct and grade sizes with confidence. (Jernigan, 1990).

Today, the term "anthropometry", as used in the field of physical anthropology, refers to the measurement of living human individuals for the purposes of understanding physical variation. Contemporary research in the field can be generally divided into two categories: static anthropometry and dynamic anthropometry. The two are also sometimes referred to as "structural anthropometry" and "functional anthropometry", to make it clear that one is chiefly concerned with body size, and the other with actions performed by the body. This survey is concerned with static anthropometry.
In general, static anthropometry documents the measurement of body dimensions in a series of standard fixed postures, such as standing or sitting upright.

Traditional static anthropometric data documents the length of limbs, bodily circumferences, volumetric measurements, and so forth. In most cases, measurements are made relative to standardized Reference Planes The word "anthropometry" means measurement of the human body. It is derived from the Greek words anthropos("man") and metros("measure") (Bridger, 1995:71) and is thus known as the science of measuring the human body and his parts in specific. Anthropometry is the study of human body measurement, a branch of anthropology, the study of human social and physical development.

This three-dimensional measuring process studies the range of human physical dimensions, such as size (for example height), breadth (for example shoulder width) and distance between anatomical points (for example upper arm length). According to Tsang, Chan and Taylor, the study of anthropometry is confined to width, length

and girth measurements. This view is in contrast with somatotyping, which refers to the physique and appearance (body shape) of the human body. Anthropometry, therefore, defines body size and measurements. The term anthropometry can be expanded to include both static and dynamic anthropometry. Static (or structural) anthropometry is the measuring of the dimensions of a human being, while dynamic (or functional) anthropometry is the measuring of the stretch and movement of a human being. This study is an investigation of and report on a static (or structural) anthropometric survey. Anthropometry involves the systematic measurement of the physical properties of the human body; it is the study of human size and shape. This is achieved by measuring and recording data from human subjects. Some anthropometric measurements are straightforward and easy to gather such as height or weight but other parts of the body like faces, fingers and feet with their complex geometry represent a much tougher challenge.

Anthropometry is the science of human body measurements, which provides information vital to the design of products ranging from clothing to airplane seating. In anthropometric sizing, body measurements are used to somehow classify people and summarize the people into classes to arrive at body sizes (Whitestone & Robinette, 1997). McConville, et Al (1979), described anthropometric sizing analysis as size dimensions (e.g., tall and slender, short and heavy) and then analyzing the anthropometric data for these

At an American Society of Testing Materials (ASTM) meeting studies sizing system in March 1982, the Task Group on Sizing from both military and industry, highlighted the need to standardize sizes of garments, infant through adult, male and female In 1983, Brunn stated in a study that body measurement charts needed to be revised at least every 10 years on the basis of maintaining accurate sizes. In 1987, a study done by Shannon reported that both Sweden and West Germany found important changes in body measurements when they updated their apparel sizing systems to reflect physical changes that had occurred in their

Several recent apparel industry initiatives like whole-body scanning, computer assisted design (CAD), and computer assisted manufacturing (CAM) are believed to supply the tools needed to help resolve some of the issues related to out-of-date sizing standards. However, these initiatives do not address the importance of fit preference and the perceived interaction of garment fit characteristics with the body. Until now very little anthropometric data has been collected specifically to satisfy the needs of the U.S. apparel industry.

The following are recently conducted sizing studies that aimed to provide a variety of manufacturers with useful anthropometric data by collecting uniform data Many believed that the design of products for the 21st century would be based On Civilian American and European Surface Anthropometry Resource)

Data similar used digital scanning techniques to create a 3-D computer simulation of its subjects. This international study had more than 20 commercial partners. Civilian American and European Surface Anthropometry Resource utilized a whole body scanner that was developed by Cyber ware to capture a 3-D image of the human body in 17 seconds with a single scan. This comprehensive study consisted of 4000 subjects measurements from the US and Canada. The remaining 6800 were collected from sites in the Netherlands and Italy. The study included men and women between the ages of 18 and 65. Also provided software and measurement protocols like fit mapping, which is a process that determines if an individual does or does not fit a particular piece of clothing or equipment. The issues of this research are standing from greater understanding of different researches. There are many researches about the size charts development. Many idea is generated from

past researchers based on the idea generated, this research is usable for improve systematic way of work and suitable software, material and equipment is understudied from the research studied the past

Categorizing by Age

Thus, understanding the relationship between age and the sizing of clothing is an important issue. Sizing and fitting of men's of South America is categorizing according to their ages. Because as individuals age, their body proportions change resulting in a need for apparel sizing that can accommodate these changes. (Antovese August 2003)

Categorizing by Ethnic Group

In certain relevant body groups to arrive at appropriate dimensional design values, which will accommodate the size variability within each group (Ranieri, 1985.) In conducting an analysis of U.S. Navy women's clothing, McConville, et Al (1979), developed a sequence of steps that were found to be useful in conducting an anthropometric sizing survey.

Used Landmark

Macrini's (1990) study utilized landmarks, which illustrated how to measure each aspect of the body. There were 37 different measurements that were used to determine proportions of men of particular height and chest variances in addition to other specific measurements. The study's design would allow manufacturers to factor in variances of weight or height to determine accurate fit based on ethnic 18background and geographical location. Macrini believed that his approach would provide a grade rule system for the men's apparel industry while adding to the industry's scientific knowledge

Categorizing by Diversity

America has a long history of being a culturally diverse nation. But never has its diversity presented as many opportunities and challenges for retailers as it does so diversity is used the researcher as the research is actual analyzed. As reported by Labatt (1987), subjects differ in levels of fit satisfaction at different areas of the body.

Use of MANOVA and ANOVA for Data Analysis

In this research, MANOVA is used MANOVA was used to determine the effect of ethnicity, age, and interaction on the dependent measurement variables. MANOVA was specifically used because, like ANOVA, it allows one or more categorical independents as predictors and ANOVA tests determined whether or not ethnicity and age group were useful in predicting underwear measurements. ANOVA tests for underpants and undershirts were conducted separately.

Methodology

This research was designed to test the following;

- **Null hypothesis: There** is not significant different in body proportion of males in Ethiopia based on nations and nationality.
- **Alternative hypothesis:** There are significant of differences in body proportion of males in Ethiopia based on Nation and Nationality.

Data Collection

The data for this research originated from two sources. The Ethiopian National statistics agency which has conducted its third National Population and Housing Census in the months of May and November 2014 and Bahir dar university registrar office. Both sources were useful in meeting the objectives of the research.

Population

Ethiopian population size is above seventy three million and seven hundred fifty thousand and nine hundred and thirty two (73,750,932) the target population for researcher is men's present in Ethiopia so

thirty seven million and two hundreds seventeen and one hundred thirty (37,217,130) men present in Ethiopia according to the information taken from national statics of Ethiopia which is surveyed in 2014.

Samples and Sampling Techniques

The sample for this research originated from two sources:

1. The Ethiopian National statistics agency which has conducted its third National Population and Housing Census in the months of May and November 2014
2. Bahir dar university registrar office. The sampling technique is determined by select a cluster sampling representing the study population among probable sampling. Bahir Dar University were, therefore, selected to participate in the study so that the sample size is determined below.

Sampling frame

Table 1. Male population by region -2014

REGION	Males
Tigray	2126465
Afar	775,117
Amhara	8641580
Oromia	13595006
Somalia	2472490
SNNP	7425918
Gambella	159787
Benishangul-gumuz	398655
Harari	92316
Total	37164182

Instruments:

The researcher used tools to gathering data.

- Measuring tape
- Camera
- Peppers
- Pens

Data Collection Procedure

The researchers used procedures to measure body for sixty variables for each sample size for the nine regions of Ethiopia. The data source for this project is list below.

A. Primary Source

- Interview of people
- Measuring men body age between 18 to 26
- Questioners
- Observing
- Camera

B. Secondary Source

- Internet
- Books
- Data from university

The researcher test anthropometric survey of variables for age between 18 to 26,weight, height, head circumstance, sleeve length, hand circumstance, biceps circumstance, wrist circumstance, elbow circumstance, heel ankle circumstance ,shoulder girth, chest level, abdomen level, waist level, shoulders girth, half front length, center front length, high neck point to front chest level, shoulder tip to center front waist, center back length, back total length, shoulder tip to center back waist, total hip level, hip depth at center front, hip depth at side seam, hip depth at center back, half the front hip, half the back hip, out seam to floor, inseam to floor, crotch depth, out seam to ankle, inseam to ankle, crotch length, total thigh circumstance, total calf circumstance, knee level from waist, knee level to ankle level, total ankle circumstance, foot circumstance, upper arm length, crotch depth, head to sitting, shoulder to elbow length, elbow to fingertip length, knee to floor, buttock to knee length. Based on the above variable result the researcher test all variables for each region of Ethiopia by ANOVA using of post hock test to determine the significance and not significance and factor analysis to determine key variable of the project.

Limitations

- High range between human body
- Equipment like 3d body scanner, computerized not having personal scale, so it takes more time and less of appropriate.
- Dalliance of data collection materials for more than a month.

Data Analysis:

Detail statistical analysis of the raw data was carried out to gain a general understanding about the shapes and sizes characterizing of population of males. Important insights were gained based on such analysis.

Post Hock Test

The data compares nine different regions, the ANOVA data comparison is preferable. In this the key terms are;

Alpha (μ) = 0.05, it is given
Significance = p, it is calculated
Ho= null hypothesis
H1=alternative hypothesis
μ1= Tigray, μ2=Affar, μ3=Amhara, μ4= Oromia μ5=Somali, μ6= Benishangul Gumuz, μ7= south nation, μ8= Gambella μ9= Harari

If p value is < μ, then Ho is rejected; that means at least one mean is different, proceed check H1

If p value is > μ, know Ho is accepted, in this case no need of proceed to check H1.

Table 2. Post hock tests for all variables; remaining 51 variables; details are in Appendix 1

ANOVA						
		Sum of Squares	Df	Mean Square	F	Sig.
Age of Student	Between Groups	1.313	8	0.164	0.024	1
	Within Groups	2830.65	420	6.74		
	Total	2831.963	428			
Weight of Student	Between Groups	5338.964	8	667.37	23.97	0
	Within Groups	11694.97	420	27.845		
	Total	17033.934	428			
Height of Student	Between Groups	0.728	8	0.091	30.33	0
	Within Groups	1.26	420	0.003		
	Total	1.987	428			
Body Mass Index	Between Groups	97.759	8	12.22	2.018	0.04
	Within Groups	2543.196	420	6.055		
	Total	2640.955	428			
Head Circumference	Between Groups	5.082	8	0.635	1.411	0.19
	Within Groups	189.052	420	0.45		
	Total	194.134	428			
Sleeve Length	Between Groups	1774.651	8	221.831	52.88	0
	Within Groups	1761.853	420	4.195		
	Total	3536.505	428			

*57 variables are significant and 5 variables are not significant

T-test

T-test determines the difference between ground mean or total mean of Ethiopia and each regional mean that is used to find out and decide peoples present in Ethiopia have different body size.

Table 3. T test for weight

One-Sample Test							
	Test Value = 0						
	T	Df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		
					Lower	Upper	
weight of student	189.95	428	0	57.857	57.26	58.46	
One-Sample Statistics							
Re		N	Mean	Std. Deviation	Std. Error Mean		
0	weight	0[a,b]	.	.	.		
Tgaiy	weight	18	54.33	3.726	0.878		
Afar	weight	26	57.54	6.713	1.316		
Amhara	weight	72	55.57	5.096	0.601		
Oromia	weight	134	56.2	4.375	0.378		
Somalia	weight	26	55.83	5.175	1.015		
Benshngulgumz	Weight	27	68.07	5.03	0.968		
South nation	Weight	72	62.15	6.543	0.771		
Gambela	weight	27	56.96	6.136	1.181		
Harrar	weight	27	56.02	4.793	0.922		

Weight in kg

*The T-tests were carried out for all 57 variables; the detail are shown in Appendix 2

In this case the researcher analysis that the mean difference (for Ethiopia or general) of weight of the student is =57.857 but there is significant when compared with each region as it mentioned in above table. Even though it's 95% confident interval is between 57.26&58.46

- These is the weight of the students ,the mean of Benishangul and South nation is more than confident interval
- The only 95% confident interval is the weight of afar and the other is below confident interval

Results

To analyses the collected data, to fit upper and lower torso garments of Ethiopian males, to develop methodologies and standardized procedures for measuring man's between18-26ages, to describe standard measurement through anthropometric survey, to conduct an anthropometric survey of body measurements. The result of body measurement of the region compared. A series of the research tests were run to complete this objective.

The results of the ANOVA tests determined that there were significant differences in the body measurements among ethnic groups and age groups. This section provides the results from variety of ANOVA tests which were conducted to determine between which ethnic and age groups the differences in measurements occur. Following the ANOVA tests, Tukey LS Means comparison of differences tests for significant main effects were observed even in cases where Interaction was marginally significant.

Hence, $p(0.000)<\mu(0.005)$ then Ho is rejected, that means at least one mean is different, H1 is accepted.

Table 4. Results

Multiple Comparisons

Dependent Variable: side seam length

Tukey HSD

(I) Re	(J) Re	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Tgaiy	Afar	-1.321*	.361	.009	-2.45	-.19
	Amhara	-1.100*	.311	.013	-2.07	-.13
	Oromia	-1.189*	.296	.002	-2.11	-.27
	Somalia	-1.734*	.361	.000	-2.86	-.61
	Benshngulgumz	-3.028*	.359	.000	-4.15	-1.91
	South nation	-2.576*	.311	.000	-3.54	-1.61
	Gambela	-2.583*	.359	.000	-3.70	-1.47
	Harrar	-.609	.361	.755	-1.74	.52
Afar	Tgaiy	1.321*	.361	.009	.19	2.45
	Amhara	.221	.270	.996	-.62	1.06
	Oromia	.131	.253	1.000	-.66	.92
	Somalia	-.413	.327	.941	-1.43	.61
	Benshngulgumz	-1.707*	.324	.000	-2.72	-.70
	South nation	-1.256*	.270	.000	-2.10	-.42
	Gambela	-1.263*	.324	.004	-2.27	-.25
	Harrar	.712	.327	.423	-.31	1.73
Amhara	Tgaiy	1.100*	.311	.013	.13	2.07
	Afar	-.221	.270	.996	-1.06	.62
	Oromia	-.089	.173	1.000	-.63	.45
	Somalia	-.634	.270	.316	-1.48	.21
	Benshngulgumz	-1.928*	.266	.000	-2.76	-1.10
	South nation	-1.477*	.197	.000	-2.09	-.86
	Gambela	-1.484*	.266	.000	-2.31	-.65
	Harrar	.491	.270	.671	-.35	1.33
Oromia	Tgaiy	1.189*	.296	.002	.27	2.11
	Afar	-.131	.253	1.000	-.92	.66
	Amhara	.089	.173	1.000	-.45	.63
	Somalia	-.545	.253	.435	-1.33	.24
	Benshngulgumz	-1.839*	.249	.000	-2.61	-1.06
	South nation	-1.387*	.172	.000	-1.92	-.85
	Gambela	-1.394*	.249	.000	-2.17	-.62
	Harrar	.580	.253	.346	-.21	1.37

	Tgaiy	1.734*	.361	.000	.61	2.86
	Afar	.413	.327	.941	-.61	1.43
	Amhara	.634	.270	.316	-.21	1.48
	Oromia	.545	.253	.435	-.24	1.33
Somalia	Benshngulgumz	-1.294*	.324	.002	-2.30	-.28
	South nation	-.842*	.270	.049	-1.68	.00
	Gambela	-.849	.324	.180	-1.86	.16
	Harrar	1.125*	.327	.018	.11	2.14
	Tgaiy	3.028*	.359	.000	1.91	4.15
	Afar	1.707*	.324	.000	.70	2.72
	Amhara	1.928*	.266	.000	1.10	2.76
	Oromia	1.839*	.249	.000	1.06	2.61
Benshngulgumz	Somalia	1.294*	.324	.002	.28	2.30
	South nation	.451	.266	.748	-.38	1.28
	Gambela	.444	.321	.903	-.56	1.44
	Harrar	2.419*	.324	.000	1.41	3.43
	Tgaiy	2.576*	.311	.000	1.61	3.54
	Afar	1.256*	.270	.000	.42	2.10
	Amhara	1.477*	.197	.000	.86	2.09
	Oromia	1.387*	.172	.000	.85	1.92
South nation	Somalia	.842*	.270	.049	.00	1.68
	Benshngulgumz	-.451	.266	.748	-1.28	.38
	Gambela	-.007	.266	1.000	-.84	.82
	Harrar	1.967*	.270	.000	1.13	2.81
	Tgaiy	2.583*	.359	.000	1.47	3.70
	Afar	1.263*	.324	.004	.25	2.27
	Amhara	1.484*	.266	.000	.65	2.31
	Oromia	1.394*	.249	.000	.62	2.17
Gambela	Somalia	.849	.324	.180	-.16	1.86
	Benshngulgumz	-.444	.321	.903	-1.44	.56
	South nation	.007	.266	1.000	-.82	.84
	Harrar	1.974*	.324	.000	.96	2.98
	Tgaiy	.609	.361	.755	-.52	1.74
	Afar	-.712	.327	.423	-1.73	.31
	Amhara	-.491	.270	.671	-1.33	.35
Harrar	Oromia	-.580	.253	.346	-1.37	.21
	Somalia	-1.125*	.327	.018	-2.14	-.11
	Benshngulgumz	-2.419*	.324	.000	-3.43	-1.41
	South nation	-1.967*	.270	.000	-2.81	-1.13

As it tried to analysis in above table 4 in the data analysis, the result is understated that as the measurement of benishengul is greater from other region measurement. In different variable the benishengul measurement is significantly different with other but some variables of measurement is the significantly not different with gambella like by side seam as mentioned in above table. The number of variable which is significant (**p value is < μ, then Ho is rejected; that means at least one mean is different**) and which are not significant result is mentioned in the following table based on their means. There is 57 number of significant of variables (**p value is < μ, then Ho is rejected; that means at least one mean is different**) and only 5 variables is not significant (**p value is > μ, know Ho is accepted**)

Conclusions

Body measurements based on Ethnicity or Region there is significant differences in the body measurements of ethnic groups with 95% confidence. Therefore, body measurements used in producing a garment for those men' will differ among ethnic groups. Interaction between ethnicity is significant at a 95% confidence interval for both upper and lower torso measurements.as the researchers understand from data analysis and result body Measurements of gambella, Benishangul and SNPE is greater than the other region by sleeve length and all length of lower torso. Thus, the impact of ethnic group on body measurements will depend on the ethnicity or regional.

Generally the body measurements of each group of region is different that means the body proportion between the region or ethnic group so the research is prefer to do the size charts for each individual region.

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