

Body Measurement Technology and Utilisation: Implications for Africa

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Abstract

Anthropometry is fundamental in medicine, ergonomics, clothing, nutrition, fitness and health among other areas. Although utilised worldwide for clothing purposes, body measurement was based on manual and more recently, digital methods mainly in selected countries especially in the West. Current trends focus on new technology including state-of-the-art body scanning and subsequent utilisation and integration of such data in medicine, ergonomics, clothing design, health and fitness. Major national surveys continue to be conducted worldwide, but these are proprietary especially because of the cost implications and funding arrangements. While some measurement of African populations has been conducted, documentation and dissemination of such data is limited, thereby creating an apparent gap in knowledge and its application. The purpose of this paper is to contextualise body measurement in clothing technology and the utilisation of such data in Africa; and to present views from clothing technology perspectives that were collected from specialists and final year university students. Using an interview schedule, data were collected and analysed. Areas for focus were knowledge, educational programmes, usability, availability, new technology and its up-take, research and utilisation in industry. Findings reveal the urgent need for current comprehensive anthropometric data regarding African populations such as the Kenyan one. Poor resources and relevant knowledge, technology cost, poor up-take are reasons for lack of utilisation. To leverage funding, collaboration between governments, educational and research institutions on the one hand and related industry on the other is recommended. Integration of new digital and scanning technologies in body measurement could enhance global competitiveness; with validity and usability of such data across the different disciplines. The importance, context and implications of body measurement technology in clothing in Kenya and Africa are discussed.

Key Words: Anthropometry, Body Measurement, Clothing Technology

Introduction

Subject Area of Anthropometry

Anthropometry is an area of study that focuses on the measurement and classification of the body to determine size and shape (Kroemer, Kroemer, & Kroemer-Elbert, 1986). Variability in size and shape has been the subject of curiosity and theoretical propositions (Zwane & Magagula, 2006; Shin & Istook, 2007; Pisut & Connell, 2007). One supposition is that the origin of anthropometry is the trickery of Procrustes, a 14th Century robber who owned an inn on a lonely path where he would obtain money from travellers of whoever estimated their body size wrongly. The eight-head theory suggests that the human body length is normally eight times the length of its head. It is also thought that Quetlet (Anthropometry, 2000) was the first to systematically measure body size around 1870. Although considered to be as old as man, the scientific study of body size and shape became recognised as a discipline in the 1950s (Simmons & Istook, 2003). Anthropometry is fundamental in sport and exercise science, medicine, automobile design, ergonomics, equipment design, clothing, nutrition and sizing surveys among other areas. Despite clothing technology being viable for research and economic activity in Kenya and the rest of Africa, the development and utilisation of anthropometric technology is confined to South Africa, and therefore remains elusive to the rest of the continent, with an apparent gap in literature. The purpose of this paper is to contextualise body measurement technology and utilisation in Kenya; and to present views from clothing technology perspectives that were collected from specialists and final year university students. In the clothing area, key issues regarding clothing sizing, manufacture and marketing are related to body dimensions. Since not any two people are identical in size and shape, measurement is crucial. Before body measurement, it is important to determine the key dimensions, methods, procedures, instruments, samples and even ethical issues (Apeagyei, Otieno & Tyler, 2007). After measurement, deciding size codes, labeling, size ranges, increments and allowances must be scientifically and logically discerned. In developing standardization for national and international platforms, the scientific analysis and validity of data is also important (Otieno, 2008) as well as developing appropriate sizing systems (Loker, Ashdown Schoenfelder, 2005; Bye, Labat & Delong, 2006; Shin & Istook, 2007). Garment generation involving pattern development and fit trials are key steps in

utilization of anthropometric data. In determining target markets and niches, consumer satisfaction is a key consideration. Meeting consumer needs is therefore a marketing strategy in creating satisfaction and averting dissatisfaction with the fit of garments (Otieno, Harrow & Lea-Greenwood, 2005; Zwane & Magagula, 2006; Mastamet-Mason, 2008). In the clothing area therefore, definitive body measurement and efficient utilisation of such data in garment sizing is crucial, and therefore lack of such technology in many parts of Africa is major shortcoming.

Anthropometric Technology in Africa

Although utilised worldwide, body measurement was based on manual (traditional approaches) and more recently, digital methods mainly in selected countries outside Africa, especially in the West. South Africa is the exception, where new scanning technology and databases about her population are now being utilised extensively in the clothing area especially in universities. In Kenya, the Digital and Learning Centres (DALC) educational institution acquired a 3-Dimensional (3D) scanner in 2010, thereby joining the few in Africa who utilise this digital technology (Otieno, 2010). Comparatively, literature regarding sub-Sahara African populations is scanty and segmented, not documented or even focuses mainly on under-nutrition (Cheruiyot, 2013). Precedent anthropometric studies have utilised manual approaches for example, South African school children (Daly, Tsomondo & Jones, 1973), rural communities in Nigeria (Adekolu, 1990), adults from Malawi (Garrow & James, 1993), obesity in Blacks in Zimbabwe (Zinyowera, Msamati & Banadda, 1994), blacks in Cape Peninsula in South Africa (Steyn, Bourne, Jooste, Fourie, Rossouw & Lombard, 1998), Kenyan urban children (Otieno, 1999) and adults from Malawi (Msamati & Igbigbi, 2000). Most of these studies have only measured a target group and have been generalised to the specific samples. Outside South Africa therefore, there is a gap in literature relating to the clothing surveys, poor dissemination of data, lack of scientific data and limited use of new technology, including 3D scanners. The application and utilisation of current reliable anthropometric data for areas such as clothing sizing and marketing is often limited, and relies on data from other populations. For example, the Kenya Bureau of Standards body size charts are based on data adapted from non-Kenyan samples (Cheruiyot, 2013).

Although some studies have been conducted on populations for clothing purposes, their dissemination is usually limited and have utilised only the manual technologies. Otieno (1999) found that Kenyan children upper torsos were longer than the British counterparts and thus developed size charts for this population. Mastamet-Mason (2008) identified the unique body shapes of Kenyan women and underscored the need for specific size charts for them. For many countries in Africa consumer dissatisfaction with clothing fit, lack of scientific data, limited know-how and sizing variation confusion have been major impediment to the utilisation of clothing technologies. Retailers and manufacturers continue to utilise various, and sometimes incomprehensible size charts and sizing systems that lead to this confusion and hence dissatisfaction among consumers.

Body Measurement Surveys using Manual Approaches

Although traditional approaches in anthropometry have been utilised since the 1950s when it was established as a specialised area of study, these methods have various disadvantages: require contact and therefore intrusive, they are manual and tedious and sometimes inaccurate, and can generate unreliable and invalid data (Simmons & Istook, 2003). Measurement error and observer error have been identified as challenging (Gordon & Brandtmiller, 1992) and training of measurers is usually done to enhance reliability and validity. Tools for measurement include the weight scale, camera, tape measure, anthropometers and calipers. Manual methods require identifying body landmarks that determine the beginning and end of a measurement (Simmons & Istook, 2003). These manual body measurements and their definitions are based on national and international standards (e.g. ASTM, 1999; ISO 1981; ISO 1989, KEBS, 2002).

In the clothing area, various surveys have been conducted since the last century. In the American surveys, women and children were measured in the 1930s from which their first Clothing Standard CS-215-58 was developed (O'Brien & Sheldon, 1941). These generated size charts that have since influenced the clothing industry worldwide. The first international standard on definitions, body measurement procedures was published in 1977 (ISO 3635). Kenya's standard on sizing systems (KS 08-412:2002), adapted earlier from other countries, was revised in 2002 (KEBS, 2002). The Harpenden

surveys in Britain generated children's growth charts. The British women's survey in the 1950s produced the first comprehensive size charts (Kemsley, 1951). The British children's data were generated from various surveys of the 1980s as were the male surveys in 1980. In Germany various surveys have been conducted on large sample every five years since the first survey in 1989 (Dob Verband, 1989). In Kenya, such surveys have utilised limited samples to develop size charts (Otieno (1999; Mastamet-Mason, 2008; Cheruiyot, 2013).

Body Measurement Surveys using 3D Scanning Technology

3D body scanners measure the size and shape of the body using state-of-the-art light or laser technology. The procedure produces true-to-scale high fidelity digital images (models) in seconds. Linked to a computer, this is automatic and unlike traditional manual methods, is accurate, fast and generates a digital list of measurements and develops size charts and related patterns for garment production (Simmons & Istook, 2003; Ashdown, Loker & Adelson, 2004).

Although 3D scanning has been utilized in other disciplines such as medicine, ergonomics and engineering, the clothing area has since the last two decades of the 20th Century been researching its use and application. Companies worldwide now use 3D technologies and strategies to devise sizing systems for the clothing market. Body scanning technologies have various advantages: automatic, non-contact, instant, accurate, fast, unlimited uses, valid (no observer error) and reliable (repeatable). 3D database are manageable, have greater accuracy and because they are fully automatic, accentuate privacy and therefore address ethical concerns. 3D scanners generate customized measurements, virtual visualization with realistic models and enable body shape analysis. Further, such 3D data is used for product development e.g. automotive seating and clothing design (Simmons & Istook, 2003; Fiore, Lee & Kuntz, 2004). For other areas, such data is used in animation, gaming and graphics, health and fitness management and reverse engineering (e.g. prototyping, simulations). Other uses are development of standards and tolerances and in nutrition studies to evaluate Body Mass Index, anorexia, obesity and growth rates. In bio-medical application data is used to evaluate asymmetries, malignant growths, bone lengths and rehabilitative engineering.

However, due to the varying approaches and incompatibility of measuring techniques, the development of common standards on interpretation of terms and identification of landmarks for benchmarking is still being evaluated (Simmons & Istook, 2003). Since the beginning of this century, major national surveys continue to be conducted worldwide using cutting-edge scanners, but these are proprietary especially because of the cost implications and funding arrangements. Size UK, the British survey in 2001 measured 5000 men and 5000 women and generated size charts (Bougourd & Treleven, 2002). SizeUSA followed in 2004 measuring 5000 men and 5000 women. Various other surveys have captured the body size and shape of nations including SizeMexico in 2005, SizeChina in 2006, SizeCanada in 2007, SizeTaiwan and SizeGreece in 2008. While some measurement of African populations has been conducted, documentation and dissemination of such data is limited, thereby creating an apparent gap in knowledge and its application as a competitive tool.

The applications of 3D body data in the clothing industry are numerous: body measurement for individuals and large samples, automatic 3D body models and data, customised fit, standardization, size charts for the mass market, online shopping application, niche and target markets, creation of consumer satisfaction, protective gear, uniforms, wearable technology, 3D product development, testing, validation, internal joint location approximation, seamless output data for made-to-measure apparel CAD applications, 3D animation and integrated size recommendation. McCormick, Kimuyu & Kinyanjui (2002) found that most personnel in Kenyan apparel industry are inadequately skilled to tackle fit issues and seldom employ modern technologies.

Methods

Literature review revealed that although some limited research had been conducted in the area of clothing technology in Africa, its dissemination was limited and only manual approaches were utilised. The only exception was South Africa where robust 3D technology continues to be utilised in government and educational institutions. Such data are usually proprietary and therefore disseminated in a limited manner.

To evaluate the Kenyan situation regarding the utilisation of body measurement technology in the clothing area, an interview schedule was developed and piloted

utilising 3 students and 1 staff member at Kenyatta University in Kenya. The items focussed on body measurement knowledge, educational programmes, usability, availability, new technology and its up-take, research and utilisation in industry. Kenyatta University is considered to have offered aspects of clothing technology for the longest period in higher education in Kenya. Random sampling was utilised to select 10 students from clothing related units in the department of Fashion Design and Technology. A sampling frame (a list of final year students) was obtained from the department with twenty final year students. Since staff taught and researched different units relating to anthropometrics, purposive sampling was used to select five lecturers. Only those members who taught aspects of anthropometrics were selected for the interview. These qualitative data were analysed along themes and are discussed below.

Results

The areas for focus in the interview were knowledge and skills, educational programmes, usability, availability, new technology and its up-take, research and utilisation in industry. Results reveal the urgent need for current comprehensive anthropometric data regarding African populations such as the Kenyan one.

Knowledge and Skills Relating to Anthropometrics

All the student respondents had not heard about human measurement until they came to study clothing-related courses at the university. But although they had some familiarity, they were unaware that it was a specialised area of scientific study. For staff, human measurement was utilised only in the development of basic patterns for the construction of patterns using the metric method. While some of them had learnt pattern making in secondary school and tertiary colleges, it was only at degree level that they became aware of anthropometrics, but even then, not as a scientific area of study. It was evident that the term ‘anthropometrics’ was not usually used in teaching and learning. When asked how they rated their knowledge in this area, all students stated that it was basic, while only one staff member acknowledged that her familiarity with this area was because of her current research interests in human measurement. Currently anthropometrics is not being taught as a distinct unit of study and therefore both the students and staff did not possess or practise specific skills in this area. Both students

and staff expressed a desire to be trained in the key skills that underpin human measurement, for example procedures, principles, data collection and analysis, development of key dimensions and size charts.

Educational Programmes that Offer Anthropometrics

Respondents stated that there were no specific programmes at school, tertiary or university level that offered anthropometrics in the clothing area. The main reasons for this were ignorance, lack of expertise in curriculum development, teaching and researching in this area; and lack of technology resource.

Availability and Usability of Technology

When asked if they were familiar with any measurement instruments, all students stated that they had used only the tape measure and weight scales. While staff members had used these instruments, they were also familiar with other manual technologies such as anthropometers and calipers. Some staff members, through literature, were aware of new digital technologies such as 3D body scanners. However they had never seen or experienced such technologies. Both students and staff expressed enthusiasm in learning and utilising the state-of-the-art body scanning technologies.

Uptake of New Technology in Anthropometrics

It was evident that neither students nor lecturers had accessed or utilised 3D body scanning technologies for clothing purposes. The main reasons were ignorance, lack of training, lack of the technology (resources) and awareness of the impact of such technologies. While only one student was aware of the 3D scanner at DALC institution, all lecturers were aware of it but had never seen or used it.

Research and Utilisation in the Industry

When asked if they had been engaged in research relating to human measurement, all students stated in the negative. Only one staff member was at the time of this study, utilising manual body measurement for research. Some staff members stated that they were aware that some clothing manufacturers were utilising anthropometric measurements to develop patterns for customised fit, but these were a minority.

Respondents were not aware of any national surveys that had been conducted in Kenya for the purposes of developing size charts or standards. When asked about the future of clothing anthropometrics, they all expressed the need to develop the teaching and researching of this area especially at university level, engage industry in collaborative research and projects to develop data bases, standards and size charts. For competitiveness and benchmarking, respondents suggested that the global arena demands the utilisation of the state-of-the-art body scanning technology.

Discussion

It is apparent that knowledge and skills relating to human measurement are lacking in the teaching of this area at university level. Although aspects of anthropometrics are utilised in the clothing area in pattern development, the pertinent subject matter relating to principles and practices, valid data and its analysis and utilisation are not taught. Since anthropometrics is specialised area of study (Simmons & Istook, 2003), knowledge and competencies in this area are important in order to fully benefit from it. An understanding of pertinent issues for example ethical (Apeagyei *et al.*, 2007), customer satisfaction (Otieno *et al.*, 2005) and development of sizing systems (Labat *et al.*, 2006), is therefore important.

Findings revealed that currently there were no specific programmes teaching anthropometrics units at university level. Some reasons for this were ignorance, lack of expertise in curriculum and teaching the subject and resources. While other universities in developed countries like America and Britain have long established teaching and research paradigms, and only South Africa in Africa following suit, the rest of Africa has not. With global competition in the clothing industry, developing a knowledge and skills' base is necessary.

Regarding availability and usability of technology, findings revealed that other than the tape measure and weight scales, other instruments are not available and therefore have never been utilised for teaching or research. Since anthropometrics is a specialised area, appropriate instruments and methods are utilised, thereby creating a knowledge and skills base (Simmons & Istook, 2003). While other countries are utilising 3D technologies and data, it was evident that in Kenya, this technology is only available at DALC where it is proprietary. Many people in Kenya are therefore not

familiar with 3D body scanning technology for clothing purposes. This concurs with what Mason (1998) decried earlier regarding the lack of basic clothing design technologies such as Computer-Aided Design and Pattern Design systems in higher education and apparel industry. There is an apparent ignorance about the importance of size and fit in garment. McCormick *et al.* (2002) found that most personnel in Kenyan apparel industry are inadequately skilled and seldom used new 3D technologies. The main reasons were ignorance, lack of training, lack of the technology (resources) and lack of awareness about the impact of such technologies in the clothing industry.

Since 3D technologies are not being widely used in Kenya like in other parts of Africa, a lot of their advantages are not being realised: customisable measurements, interactive software tools, batch processing, measurement export to multiple CAD systems, tracking body fat and muscularity, body size and shape analysis, surveys, target marketing/niches, virtual displays at point of sale, customized clothing and product development, standardization of sizing for Africa, enhancing consumer satisfaction, company size charts, online buying, collaboration with exporters and importers, virtual garment try-on for online shopping and e-commerce for internet shopping (Istook & Hwang, 2001; Ashdown *et al.*, 2004; Bye *et al.*, 2006). Further, Kenya, like other parts in Africa does not possess body measurement data bases, especially 3D, from population surveys.

Conclusion

Poor resources, lack of relevant knowledge, technology cost, and poor up-take are reasons for lack of utilisation of anthropometric technology in Kenya. There is need for introducing courses in anthropometrics in the clothing-related training institutions of higher learning in Kenya. A relevant curriculum needs to be developed to service this knowledge area of specialisation of clothing technology. This would meet the needs of many scholars who, although willing to study, teach and research in the area, have nowhere to go for training in anthropometrics. Cross-discipline research between the clothing area, nutrition and sports science would benefit related industries, education and communities. For example an anthropometric survey on children would provide body measurement data for clothing sizing and standardisation; nutritional status and health implications of active and inactive children. Special programs to address

community issues such as stunting, malnutrition, obesity would be evaluated and developed. There is need for a comprehensive nationwide anthropometric survey that can reveal the valid size and shape of the Kenyan population, perhaps Size Kenya, using new body scanning technology. To determine a reliable database, this cutting-edge technology could be utilised so that all the advantages could be accrued with benchmarking and training of staff and students. Further, this could be replicated to the other parts of Africa so that a comprehensive data base could be developed for use in clothing, exercise science, nutrition, ergonomics and other areas. To leverage funding, researchers could seek collaborative efforts between government institutions such as KBS in Kenya. Further, regional partnerships could lead to sharing of research between educational institutions where specific programmes could be enhanced to focus on anthropometry with specific utilisation of on new technology such as 3D body scanners.

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