

## The Relationship of Anthropometry and Design

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### Abstract

The research aims at studying the definition of Anthropometry, as Anthropometry is the science that defines physical measures of a person's size, form, and functional capacities. Applied to occupational injury prevention, anthropometric measurements are used to study the interaction of workers with tasks, tools, machines, vehicles, and personal protective equipment — specially to determine the degree of protection against dangerous exposures, whether chronic or acute. The study will present the history of Anthropometry as the study of human growth has been a part of anthropology since the founding of the discipline. European anthropology of the early to mid-nineteenth century was anatomy and anthropometry, the science of human body measurements through cultures such as the ancient civilizations of Rome, Greece, and Egypt besides the Anthropomorphic measurements during the Renaissance. The research also demonstrates the different Anthropometric Somatotypes. It also demonstrates Heath-Carter Anthropometric Somatotype.

Current applications include: (Industrial design and architecture -Clothing - Ergonomics - Medicine (nutrition, aging, obesity, sports science, and diabetes). While physical anthropologists and criminologists continue to use anthropometric measurements in the study of human evolution through the comparison of novel fossil remains to archived specimens and forensics, respectively. Anthropometric information is crucial in these fields for optimizing different products and tracking changes brought on by numerous environmental, genetic, and ethical factors.

The research also presents the definition of ergonomics and its criteria, and it also demonstrates the relevance between ergonomics and design.

### Research Problem

With the technological progress that humanity is witnessing, there has become a noticeable tendency to purchase via the Internet, but fear remains among most consumers of this shift due

to the lack of confidence in the offered product, regarding measurements and their conformity with their bodies, as it is displayed on typical bodies that do not match necessarily with actual measurements there-fore here lies the role of anthropometry in determining the method of measuring the human body in the manufacture and marketing of clothing.

### Hypotheses

- The importance of taking measurements of the human body in most local and international clothing brands using anthropometry.

### Research Methodology

The Research follows Descriptive Analytical Methodology.

### Keywords:

Anthropometry, Ergonomic, Design

### ملخص البحث :

يهدف البحث إلى دراسة تعريف الأنثروبومترية حيث أن الأنثروبومترية هو العلم الذي يحدد المقاييس الفيزيائية لحجم الشخص وشكله وقدراته الوظيفية. عند تطبيقها على الوقاية من الإصابات المهنية، تُستخدم قياسات الجسم البشري لدراسة تفاعل العمال مع المهام والأدوات والآلات والمركبات ومعدات الحماية الشخصية - خصيصًا لتحديد درجة الحماية ضد التعرضات الخطرة، سواء كانت مزمنة أو حادة. وسوف يعرض تاريخ القياسات البشرية حيث أن دراسة النمو البشري كانت جزءًا من الأنثروبولوجيا منذ تأسيس هذا التخصص. كانت الأنثروبولوجيا الأوروبية في أوائل القرن التاسع عشر وحتى منتصفه هي علم التشريح والقياسات البشرية، وهو علم قياسات جسم الإنسان من خلال ثقافات مثل الحضارات القديمة في روما واليونان ومصر إلى جانب القياسات المجسمة خلال عصر النهضة. يوضح البحث أيضًا الأنماط الجسدية الأنثروبومترية المختلفة. كما يوضح أيضًا النمط الجسدي الأنثروبومتري لهيث كارتر

في حين يواصل علماء الأنثروبولوجيا الفيزيائية وعلماء الجريمة استخدام القياسات البشرية في دراسة التطور البشري من خلال مقارنة بقايا الحفريات الجديدة بالعينات المؤرخة والطب الشرعي، على التوالي، فقد امتدت التطبيقات الحالية إلى: (التصميم الصناعي والهندسة المعمارية - الملابس - بيئة العمل - الطب (التغذية والشيخوخة والسمنة وعلوم الرياضة والسكري)

في هذه الصناعات، تعد بيانات القياسات البشرية ذات قيمة لا تقدر بثمن لتحسين المنتجات المختلفة ومراقبة التغييرات التي تحدث استجابة لمختلف أنماط الحياة والعوامل الوراثية والأخلاقية.

يقدم البحث تعريف بيئة العمل ومعاييرها، كما يوضح العلاقة بين بيئة العمل والتصميم

### مشكلة البحث

مع التقدم التكنولوجي الذي تشهده البشرية أصبح هناك اتجاه ملحوظ إلى شراء عبر الإنترنت، ولكن يبقى هناك خوف عند معظم المستهلكين من هذا التحول نظرا لعدم الثقة في المنتج المعروض وذلك فيما يخص القياسات و تطابقها مع اجسامهم حيث انه يتم عرضه على اجسام نموذجية لا تتطابق بالضرورة مع القياسات الفعلية وهنا يكمن دور الانثروبومتري في تحديد طريقة قياس الجسم البشري في صناعة الملابس وتسويقها

### أهمية البحث

- تحديد الطريقة المستخدمة من قبل معظم ماركات الملابس المحلية والعالمية في اخذ قياسات الجسم البشري

### منهج البحث

- الوصفي التحليلي

### الكلمات المفتاحية:

الانثروبومتري - الارگونوميك -التصميم

## Introduction

Have you ever been shopping for clothes and wondered why you were a size “small” and not a “medium”? How about the size of your seat cushion or the legroom in an airplane? Many products and services today are designed and optimized based on human body measurements. This data is collected using anthropometry – the study of measuring the human body and form – and has been a tool of physical anthropologists for centuries. Anthropometric data collected from individuals around the world help scientists identify physical variations among humans and populations. Since we know that people come in all shapes and sizes, understanding this variability is key to making sure that everyone is considered and accounted for.

Human life allows for, and in fact demands, that a person take care of his look, dress appropriately, retain his dignity, and appreciate for clothing's sake. Clothing serves two functions from the perspective of a human life: To cover the body and to enhance beauty. Undoubtedly, the clothing serves as both a cover for your humiliation and an ornament for you. (1)

## Anthropometry Definition

First, we will demonstrate some of the anthropometry definitions as defined in the dictionary. “Anthropometry is the science of obtaining systematic measurements of the human body.”

“Anthropometry is the branch of anthropology concerned with comparative measurements of the human body and its parts.” (5)

“Anthropometry is the study of human body measurement for use in anthropological classification and comparison. The use of such data as skull dimensions and body proportions in the attempt to classify human beings into racial, ethnic, and national groups has been discredited, but anthropometric techniques are still used in physical anthropology and paleoanthropology, especially to study evolutionary change in fossil hominid remains.” (5)

“Anthropometry is the science that defines physical measures of a person’s size, form, and functional capacities. Applied to occupational injury prevention, anthropometric measurements are used to study the interaction of workers with tasks, tools, machines, vehicles, and personal protective equipment — specially to determine the degree of protection against dangerous exposures, whether chronic or acute.” (5)

## Anthropometry History

Since the discipline's inception, anthropology has included the study of human growth. Early to mid-19th century European anthropology focused on anthropometry, the study of how human bodies are measured. (7)

Most anthropologists and anatomists at the time of those studies, circa 1910, thought that stature and other quantifiable physical characteristics, such head shape, might be employed as "racial" markers. The term "race" is used here to refer to the scientifically debunked idea that human beings may be classified into biologically separate groupings based on phenotypes (a person's physical characteristics and behavior). (3)

Alphonse Bertillon (1853-1914); The Developer of Anthropometry

The anthropologist and Society of Anthropology of Paris's first president, Louis-Adolphe Bertillon, was the father of Alphonse Bertillon. Alphonse Bertillon is recognized as the father of anthropometrics based on his classification scheme known as the "anthropometric system" or "judicial anthropometry," even though the procedure of taking human measurements had its roots in ancient cultures. Alphonse Bertillon started his career as a criminal records clerk for Paris police force. Bertillon noticed the recurring issue that it was getting harder and harder to identify repeated offenders due to the alphabetical organization of criminal records and the prevalence of criminals using aliases to evade deportation and harsher punishments.

Bertillon developed a new classification method based on anthropomorphic measurements to over-come this problem, presuming that human dimensions are inherently very changeable and bone density is constant beyond the age of 20.

Bertillon measured inmates in custody for their height, width, foot size, head length and width, middle finger length, left forearm length, and other morphological and differentiating traits (as indicated below). Then, he added frontal and profile photographs to each file and categorized everyone as tiny, medium, or giant. An example of such photography is still used today as a "mug shot." This system of classification was put into operation when Bertillon persuaded the Paris criminology department to adopt it, and it allowed for the quick and simple identification of unfamiliar people and repeat criminals. Later known as "Bertillonage," this anthropometric system spread quickly around the world in the late 1800s and the early 1900s. (6)

### Ancient Anthropometric Measurements

Anthropometric measurements were predominantly used by the ancient civilizations of Rome, Greece, and Egypt for artistic representations of the human form's beauty, strength, and other desirable qualities such as symmetry, and the "width of a human hand" or "length of a human foot" served as units of measurement.



Fig .1: Anthropometric Measurements in Ancient Egyptian Artwork



### Anthropomorphic Measurements During the Renaissance

During the Renaissance, artists used human proportions to apply anthropometric measurements to their creations. The works of the legendary artist Leonardo da Vinci, who measured the human form by examining cadavers, are among the most well-known examples. He is portrayed here with the iconic Vitruvian Man. For accurate anthropometric measurements, other artists used live models and historical achievements.

### Twentieth Century Anthropometrics

The term "morphometrics" refers to a branch of anthropometrics that was developed in the 20th century to characterize differences in human size and shape within different populations. Using multivariate statistics, various biological landmarks are analyzed to determine their distinctive forms, ratios, or angles.

The development of morphometrics into the discipline of geometric morphometrics, which makes use of potent computational modeling to examine numerous qualities, has been facilitated by the usage of computers in modern society. The assessment of bone density is currently one of the geometric morphometrics' most widespread uses.

Anthropometry is now utilized extensively in the fields of industrial design, garment design ergo-nomics, and architecture to optimize goods using statistical information on the distribution of body dimensions in the population. The distribution of body dimensions fluctuates because of alterations in lifestyle, diet, and ethnic makeup of populations (such as the growth in obesity), necessitating routine update of the anthropometric data collection.

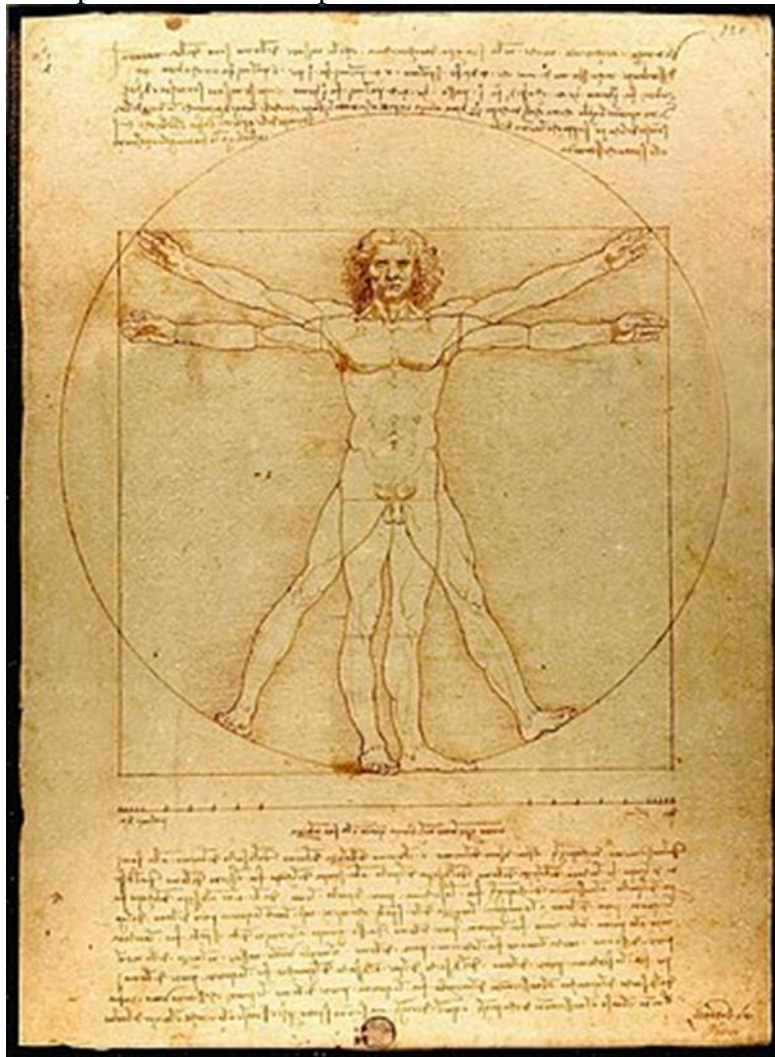


Fig 2: The Vitruvian Man by the Italian Renaissance artist and scientist Leonardo da Vinci

### Anthropometric Somatotypes

Human body types, or somatotypes, can be described using anthropometric measurements. Endo-morph, Ectomorph, and Mesomorph are the three basic somatotypes, while some people may exhibit a combination of two somatotypes. (4)

Somatotyping is a technique for describing and evaluating the body based on its relative endomorph (relative fatness), mesomorph (related musculoskeletal robustness), and ectomorph (relative linearity) scales.

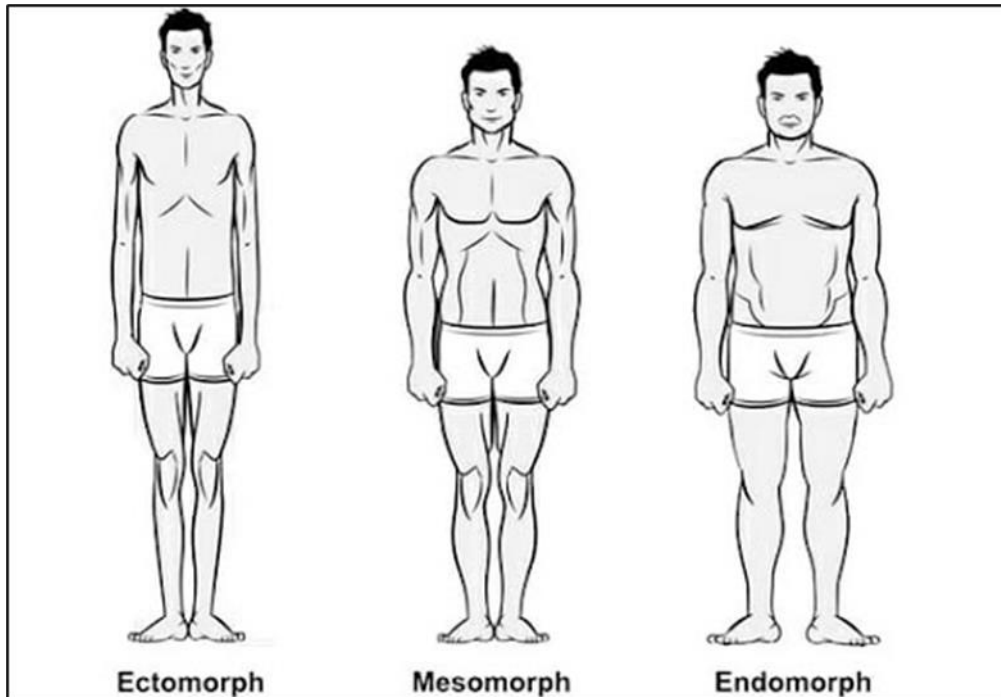


Fig .3: The somatotypes main (endomorph, ectomorph, and mesomorph)

### Endomorph

An endomorph is a human being whose tissues are primarily derived from the endoderm and who exhibit traits including a huge trunk, a large digestive tract, fat storage, and tapering extremities. To determine how much body fat is present, the degree of endomorph is determined by measuring the thickness of the triceps, subscapular, and suprailia skinfolds after correcting for height. These measures are often paired with at least one other measurement of body fat percentage, such as underwater measurements, to confirm their validity.

### Ectomorph

A linear body shape, a wide surface area, thin muscles, and subcutaneous tissue, and moderately developed digestive viscera are characteristics of ectomorphs, which are humans whose tissues are pre-dominantly derived from the ectoderm. Ectomorph is determined by measuring height and mass, then determining the degree of linearity. The CF Ponderal Index, a cubic connection, is applied in the Heath-Carter approach.

### Mesomorph

Humans that largely derive their tissues from the mesoderm and display more muscle, bone, and connective tissue are referred to as mesomorphs. These people are often shaped like rectangles and have rigid bodies that fall somewhere between endomorph and ectomorph. As a measure of musculoskeletal development, mesomorph is determined using the bone diameter

and muscle circumference of the individual's two upper and two lower limbs, corrected for skinfold thickness. (10)

### **Heath-Carter Anthropometric Somatotype**

The Heath-Carter methodology can be used to determine the different somatotypes in order to provide direct measurements of human body size, structure, and composition. (2)

### **Current Applications of Anthropometry**

While anthropometric measures are still used by physical anthropologists and criminologists in the study of human evolution through the comparison of fresh fossil remains to preserved specimens and forensics, respectively, its current applications also include:

- Industrial design and architecture (e.g., vehicle seating and cockpits)
- Clothing (e.g., military uniforms)
- Ergonomics (e.g., seating)
- Medicine (e.g., nutrition, aging, obesity, sports science, and diabetes)

In these industries, anthropometric data is invaluable to the optimization of various products and observing the changes which occur in response to various lifestyle, genetic, and ethical factors.

### **Ergonomics**

Ergonomics is based on the premise that activity permeates every aspect of human life, including leisure, work, family, education, spirituality, and physical activity, in terms of anthropometric measurements. Because of this, certain tools and equipment are required for every activity. The study of human mobility, comfort, and other anthropometric measurements is central to the discipline of ergo-nomics, which is concerned with the design and production of these tools. Ideal designs are typically produced by an interdisciplinary team of anthropologists, psychophysicists, and physiologists. To assess ergonomic designs, a series of tests that include the following are conducted:

- Collecting anthropometric data to determine the "ergonomic dimensions" of posture and movement.
- Documenting the user's subjective sensations of comfort while utilizing the apparatus.
- Assessing the instrument's capacity to carry out the desired function used to evaluate ergonomic designs. (9)

In the subject of ergonomics, anthropometric measurements are taken in several positions, such as sitting, standing, and lying down, as well as several variations of these poses (such as with arms extended, facing a table, lifted over the head, etc.). In addition, multivariate statistics are frequently used to analyze a variety of anthropometric data to develop the best possible design due to the large degree of human variability caused by ethnicity and body composition.

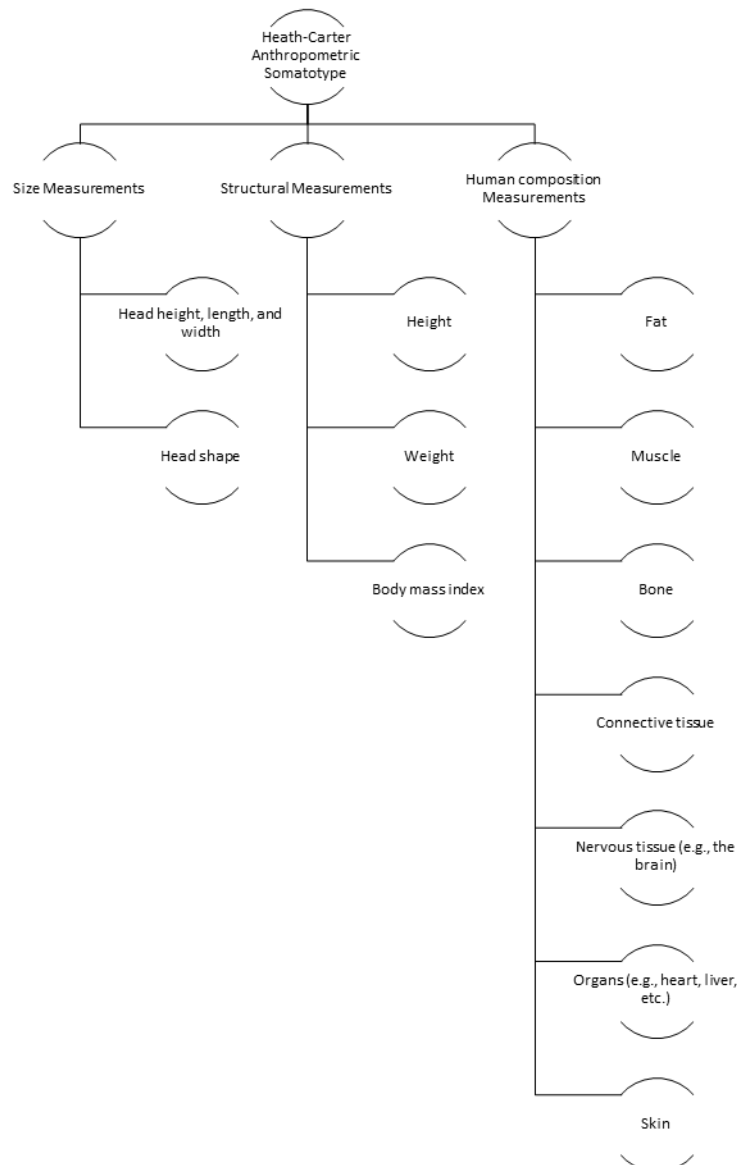


Fig. 4: Heath-Carter Anthropometric Somatotype

#### Criteria that define a successful match:

- Functional Efficiency
- Ease of use
- Comfort
- Health and safety
- Quality of working life

#### Criteria Compatibility

The claim made by ergonomists that this issue is not as serious as it first appears. This has some basis. There are unquestionably situations where ergonomic enhancements made in the name of health and safety pay off in favorable ways for productivity—and vice versa. Similarly, a product that is simple to use will operate safely and effectively for the same reason. It is challenging to use goods that are often dangerous and ineffective. However, it would be naive



to pretend that these kinds of fundamental standards that we have used to define a good fit are never at odds, and the more we go into these waters, the more challenging the issue gets. (7)

### **Ergonomics and Design**

When we refer to a product as being "economically designed," what exactly do we mean? Unfortunately, the quick response to this question is far too frequently "not very much." These days, the phrase is frequently utilized (or abused) in the advertising industry. It is widely used, for instance, in the marketing of ostentatious, exorbitantly priced, and excessively designed furniture (particularly office furniture), which is claimed to be "good for you" based on a notion about how to sit properly that may or may not be true. The most expensive and economically unacceptable models I've seen are expensive indeed. 'If people are dumb enough to buy this, it's their own silly fault,' is a statement that we can choose to ignore.

However, to the responsible professional ergonomist this situation is regrettable in the extreme, not least in that it can only serve to bring his or her profession into disrepute.

### **Kin anthropometry**

Because it includes measuring the human body to use it for human movement, Kin anthropometry is strongly related to the disciplines of physical education, sports science, pediatrics, physical anthropology, gerontology, and ergonomics.

### **Medical Science**

Despite the fact that radiological measurements, CT, MRI, 3D imaging, geriatrics, pediatrics, and bariatrics (obesity) are more recent medical applications than early anthropometric measurements, which have been used in the field of medicine as a correlate of disease since the early 17th century. Since the late 1800s, radiography has been utilized to acquire X-rays that can be used to assess internal features such as bone density and lung function. CT has been utilized to obtain cross-sectional images of the human body, much as it has been used to quantify bone mineral density, distinguish between cortical and trabecular bone density, and spot degenerative abnormalities in the spine. High resolution images of the brain and other organs have been obtained using MRI, and 3D imaging has made it possible to quantify the many anatomical features found in the human body. Human health and quality of life have been improved using the data produced by various imaging techniques. In cosmetology, unwanted traits brought on by damage or aging can be improved by employing facial anthropometry to spot imbalances and 3D imaging and reconstruction software to compute the necessary adjustments. Breast cosmetology, which uses mammography, 3D imaging, and other imaging techniques to measure breast density, volume, and asymmetry to choose the best surgical course of action, is another medical use of anthropometry.

### **Pediatrics**

As was already established, anthropometrics has long been used as a gauge of human health. As a result, anthropometrics is frequently used to evaluate how humans grow and develop, both "in utero" and during childhood. During this time, the most crucial anthropometric measurements to take are those of the head circumference, weight, and length/height. Given that head circumference and brain growth are associated, it is particularly significant. Pediatric head circumference measures are used to detect severe and/or chronic malnutrition in young children as well as possible fetal growth problems. To track the child's growth over time, weight is also utilized to determine whether malnutrition is present. Length and height are used to calculate the basal energy expenditure, height for age, height index, and body mass index.

Extremely low height for age could be a sign of musculoskeletal problems or chronic malnutrition. (2)

### Conclusion

Based on this research, anthropometry was and still playing an important role in many of the afore-mentioned fields, especially in apparel design.

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