

## INTRODUCTION

Anthropometry literally means the measurement of man. It is derived from Greek words, anrhropos which means man and metron which means measure. As an early tool of physical anthropology, it has been used for identification, for the purpose of understanding human physical variation.

International Encyclopedia of Ergonomics and Human factors (vol. 1) narrated that the word Anthropometry was coined by French naturalist Georges Cuvier.

In view of the fact that no two individuals are ever alike in all their measurable characters (except perhaps monozygotic twins) and that the later tend to undergo change in varying degrees, hence persons living under different conditions and members of different ethnic groups and the offspring of unions between them frequently present interesting differences in body form and proportions. It is therefore, necessary to have some means of giving quantitative expression to the variations exhibited by such traits. Anthropometry constitutes a means towards this end, The anthropologists are concerned with functional relationships among traits and between traits and the environment.

Anthropometry as defined by Juan Comas is a systematized body of techniques for measuring and taking observations on man, his skeleton, the skull, the limbs and trunk etc., as well as the organs, by the most reliable means and scientific methods."

## HISTORICAL AND EPISTEMOLOGICAL PERSPECTIVE

The journey of the concept of anthropometry began in the age of early man when they start to fulfill their needs in the pre-historic times. The units of measurement were probably among the earliest tools invented by humankind. It was this concept of measurement which first initiated the ways of comparison between the ecofacts and artifacts, shapes and sizes of inorganic materials like tools and organic materials like plants and animals and later on man began his/her comparison with others in view of morphology, strength of the body, behaviour, etc.

The earliest known uniform systems of weights and measures all seem to have been created at sometime in the 4th and 3rd millennia B.C. by the ancient people of Egypt, Mesopotamia and the Indus Valley. Such kinds of measurements although are related with the human livings of that time, but they all are indicative and cognitive examples of an Anthropometric beginning.

### CLASSICAL ANTHROPOMETRY-

In the 4th century BC, Aristotle and several contemporaries produced a more empirically founded system, based on animal dissection. Later in the 4th century BC first use of human cadavers for anatomical comparisons on humans occurred. Herophilos in particular developed a body of anatomical knowledge much more informed by the actual structure of the human body.

In India around 3rd and 4th Century the Sushruta Samhita an Ayurvedic text was written. It contains a description of 1120 illnesses, 700 medicinal plants and a detailed study on human forms in the situation of a particular disease. His research led to what is referred to as a modern comparative human anatomy.

Such concepts of measurement also paved the way to manufacture several kinds of measuring instruments. The oldest preserved measuring rod is a copper alloy bar which was found by the German Assyriologist Eckhard Unger while excavating at Nippur. Measuring rods for different purposes (construction, tailoring and land survey) have been found from China and Ancient Egypt.

The ideas and these innovative tools diffused in view of acceptance as well as its universal application in renaissance. European artists like Leon Batista, Alberti, Leonardo da Vinci, Michelangelo Buonarroti, etc. used comparative anthropometry to measure the proportion of statues, so as to make correct copies and figures. Credits of doing aesthetic and architectural anthropometry should be given to these inventors.

Later on, a vertical scaled rod named 'Anthropometron' was devised by a German physician Johann Sigismund Elsholtz to measure the human body in relation to disease, general character and physiognomy. In 1654, he published a book entitled *Anthropometria*, in which he has examined the relationship between proportions of the human body and the incidence of disease. He employed anthropometry in medical terms and thus medical anthropometry was further concretised.

However, the history of scientific anthropometry dates back to the times of Johann Friedrich Blumenbach (1753-1840) who laid the foundations of Craniology and is regarded as 'The Father of Physical Anthropology'. He classified mankind into three different types on the basis of the cranial forms seen from the above (*norma verticalis*). Though the idea of racial classification on the basis of anthropometry was introduced by Blumenbach but the first scientific data on anthropological craniometry were reported by Vesalius (1514-1564). He reported his observations on the skulls of

Greeks and Turks as globular, that of the Bulgars oblong and that of the Germans rounded with flat occiput.

Craniometric methods were first applied by Daubenton (1716-1800). Camper (1772-1789) developed projection method to measure the extent of prognathism and other craniological observations.

Comparative Racial Anthropometry was scientifically applied by Charles White in 1794. He may be said to be a pioneer in osteometry. He studied certain measurements on the long bones of the upper limb of the Negroes, Europeans as well as Chimpanzees.

Swedish professor of anatomy Anders Retzius [1796- 1860] first used the cephalic index in Physical anthropology to classify ancient human remains found in Europe. He classified skulls in three main categories; "dolichocephalic" (from the Ancient Greek kephalê, head, and dolikhos, long and thin), "brachycephalic" (short and broad) and mesocephalic" (intermediate length and width).

It was only later on that anthropometry developed to a great extent owing to the efforts of scholars like Broca, Flower and Turner. Broca (1824-1880) made the study of craniology and craniometry more systematic and accurate.

H. Von Ihering was the first to make the departure from Broca's method. His suggestions were ultimately accepted under the Frankfurt Agreement arrived at during the XIII General congress of the German Anthropological Society held at Frankfurt/Main in 1882. This included change in techniques, use of new nomenclature, introduction of new measurements. In 1884 Topinard, a close associate of Broca suggested some changes in the list of measurements and techniques initially proposed by Broca. This, however, resulted into the emergence of two Schools of anthropometry:

1. The German School

2. The French School

Samuel George Morton [ 1799-1851) wrote two major monographs, *Crania Americana* [1839), *An Inquiry into the Distinctive Characteristics of the Aboriginal Race of America* and *Crania Aegyptiaca* [1844]. He concluded that the ancient Egyptians were not African but white and that Caucasians and Negroes were already distinct three thousand years ago. In accordance with Morton's theory of Polygenism, the races had been separate from the start. Josiah C. Nott and George Gliddon carried Morton's ideas further. Charles Darwin apposed the idea of polygenism while arguing about monogenism in his 1871 *The Descent of Man*.

In 1863 Thomas Huxley Compared skeletons of apes to humans and gave a detailed account about it in his book *Evidence as to Man's Place in Nature*. Thus, racial and taxonomic anthropometry evolved as the main stream anthropological research in 18th and 19th century.

At the turn of the 18th to 19th century, Franz Joseph Gall developed Cranioscopy, a method to determine the personality and development of mental and moral faculties on the basis of the natural Shape of the Skull. Cranioscopy was later known as phrenology by his student Johann Spurzheim. It claimed to be able to predict traits or intelligence and phrenometry as a branch of anthropometry was intensively practiced in the 19th and the first part of the 20th century.

Another fact worthy of mention is the contribution of a young French anthropologist M. Alphonse Bertillon who in 1882 established the individual identity of criminals and inaugurated the famous system of "Bertillonage based upon eleven easily taken measurements. This system continued for a long time but later on the emphasis shifted to finger print system of Galton and Henry.

During the 1940s anthropometry was used by William Sheldon when evaluating this somatotype, according to characteristics of the body can be translated into Characteristics of the mind. Inspired by Cesare Lombroso's criminal anthropology, he also believed that criminality be predicted according to the body type. Thus constitutional anthropometry was propounded in the first half of the 20th century.

At the same time English anthropologists continue to have their own techniques, which resulted in a state of confusion rendering the results not different investigators non-comparable.

The first attempt at International unification for anthropometric measurements was made by R. Collignon in 1892. But it proved to be a futile exercise.

The first step towards the desired unification was taken at XIII International Congress of Prehistoric Anthropology and Archaeology held in Monaco in 1906. XIV Congress which met in Geneva in 1912 succeeded in having the "International Agreement for unification of measurements on the living subjects". Such congress, conference, committees were continuously held later on. Many deliberations made were incorporated later in the International Agreement Report. After World War II, Henri Vallois has finally compiled the techniques of measuring the human body and its various segments on the basis of this international agreement, which was published in Current Anthropology as a report entitled "Anthropometric Technique [Vallois, 1965].

## MODERN ANTHROPOMETRY

The nineteenth and twentieth century's had experienced an enlightenment in view of the growth of our discipline by establishing fundamental theories of culture and social change on the one side, genetic and evolutionary thoughts on the other. Darwin, Mendel, Hardy Weinberg, Hugo De Vries, Wright, Haldane, Dobzhansky, etc. have given an illuminating path to physical anthropology. This kind of spark in the discipline has marginalised the classical anthropometry. Julian Huxley, etc.

The newer fields of research like physical growth, development, medico-legal applications constitutional medicine, sports, nutritional and adaptability started to emerge later as research fields in physical anthropology.

The notion of New Physical Anthropology was given by Professor S.L. Washburn in 1951. With the discoveries of electronic microscope and Computer systems, metric methods were revolutionised and now they were capable of measuring even the ultra microscopic structure of the human body like chromosome, cellular organelles, deoxyribonucleic acid, etc.

Today anthropometry has started to employ few innovative tools as colorimeter, spectrometer,

radiographs, scanners, etc. apart from the traditional tools by which bones and body parts are measured in multiple dimensions.

In the view of the contributions of the Indian scholars like B.S. Guha, Irawati Karve, D.N. Majumdar, P.C. Biswas, S.S. Sarkar and others, the University Grants Commission sponsored a Summer School in Anthropology which was held at Dalhousie in 1965 where a committee was formed under the chairman P.C Biswas. S S. This committee suggested essential measurements for ethnic as well as growth studies. Chora (1958) devised a pelvimeter for orientation and measurement of the innominate bone.

Statistical constraints like mean, deviations, etc. happened to be more useful in the interpretation of the report.

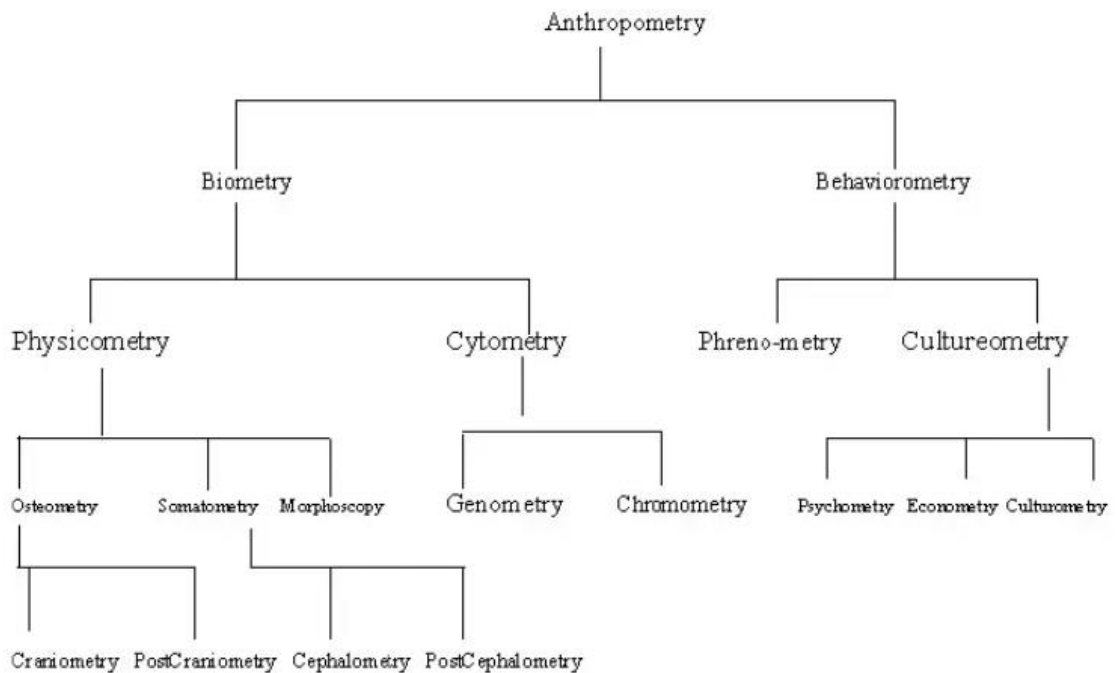
It is inevitable today that mankind cannot be measured in view of the cellular, chromosomal, genetic, biochemical, molecular, socio-cultural and ecological units . Hence, Anthropometry does not mean, in real sense, to mere morphological or physicomterical devices of mankind, but it is meant by the explorative methods in view of biological and social-cultural understanding of mankind,

## DIVISIONS OF ANTHROPOMETRY

Holistically humans are identified , not only by body parts, but several other behavioural and cultural traits are involved in characterising this species. These traits are of several kinds by which today man can be measured not only in terms of quantitative values; but generative variables are also required in measuring mankind. As our nature is interdisciplinary, so we are in need of developing a holistic method of measurement as a unique science. Hence, anthropometry being the measurement of man in the true sense, involves both quantitative and qualitative values (units) to compare humans and humankind with others. In quantitative units it covers the bones and morphology of man, whereas qualitative units contain enumeration of frequencies as well microscopic examination, measurement of the fundamental elements that value the specificity of mankind.

ANTHROPOMETRY may be classified in accordance with the emergence of quantitative and qualitative units, as depicted in Fig. 1

**Fig.1- Proposing New Scheme of Anthropometry in view of Evolutionary and Holistic Perspectives**



First is Biometry, which is the application of statistical analysis to biological data. It is further divided into two-

a) Physicomerty and b) Cytometry

a) Physicomerty- measuring characteristics and changes in physiological functions of the human body. It is further sub-divided into 3-

1. Osteometry- the measurement of the skeleton and its parts. When such measurements are confined to skull only we call it craniometry. And when measurements are confined to post-cranial skeleton we call it post-craniometry.

2. Somatometry- it deals with the measurements on the living human body or the cadaver. When the measurements are confined only to head and face, then it is known as cephalometry. When the measurements are confined only upon the trunk and the limbs, then it is known as post-cephalometry.

3. Morphoscopy- it is the visual observation and description of physical traits not capable of exact measurements. E.g. form and character of hair, skin colour, form of nose and lips, etc.

b) Cytometry- it is the measurement of the characteristics of cells (size, count, morphology, DNA content, etc.) And the existence and absence of specific protein on the cell surface or in the cytoplasm. It is sub-divided into two-

1. Genometry- measurements of the DNA content of the cell i.e. Genome.

2. Chromometry- measurement of the cell on the basis of color or pigments present in/on it.

Second branch of anthropometry focuses on human behaviors, as they are also processed in the terms of the traits and patterns. The patterned traits manifest a complex culture. Although the traits have been taken as a qualitative unit of study of cultures and societies, the frequencies of these traits have been usually quantified by several investigators.

Behaviorometry can be divided into 2 categories-

a) Phrenometry and b) Cultureometry

a) Phrenometry- phrenology is the science which studies the relationship between a person's character and the morphology of the skull. It is claimed to be able to predict traits or intelligence and phrenometry as an anthropometry was intensively practised in the 19th and the first part of the 20th century.

b) Cultureometry- this branch of anthropometry concerns over studies of cultures and societies. On the basis of the tools of data collection like- observation, interview, questionnaire schedule, etc. research techniques like Sociometry, Econometry and Psychometry emerged in the past century.

- Psychometry- it is the field of the study concerned with the theory and techniques of psychological measurement.
- Econometry- It is the application of statistical methods to economic data in order to give empirical content to economic relationships.



## The Measurement And Its Types

In general terms measurement refers to the act of measuring or to a measured dimension. In reference to anthropometry the term measurement refers to a definite measure between two clearly defined landmarks. Whereas the term 'measure' refers to the act or process of ascertaining the extent, dimensions, quantity etc. of some thing especially by comparison with a standard measurement In reference to anthropometric work the term measure refers to dimension of a clearly defined distance between two specified points.

In the context of anthropometric work landmarks or points are always related to bony points, usually fixed, and often covered by a thick layer of muscular and adipose tissue

Depending upon the location of the landmark the measurements may be of different kinds, which are as follows:

1. Linear measurements. These measurements measure the vertical distance between the surface landmarks. The distance of a specific landmark from the ground level as for instance length or height also fall in this category e.g head length. facial height, stature, etc.

2. Transverse measurements: Transverse measurements are those measurements which are taken between two landmarks lying perpendicular to the linear axis. e.g. head breadth, bizygomatic and bigonial breadth, biorbital breadth. biacromial breadth

3. Angular measurements: The angular measurements are those measurements which measure the profile of a particular part of body or prognathism with respect to the two land marks linearly distanced from each other. e.g. facial profile angle and nasal profile angle.

4. Circumferential measurements: Are those measurement which provide us

with the values of the circumference of any specific part of the body in, head circumference, upper arm circumference, calf circumference, etc.

5. Skin fold measurements : Skin fold measurements are designed to measure the thickness of a fold of subcutaneous fat, that has been picked up at a specific landmark of a body Such measurements are

taken with the help of a skinfold calipers designed to exert a constant pressure at all settings of a caliper jaws. e.g. skinfold thickness at biceps, triceps and sub scapular (under the inferior angle of the left scapula), suprailiac, etc.

It may be pointed out that both linear and transverse measurements may sometimes be obtained indirectly by subtracting from a larger measure. Such measurements are indirect and are called Derivative measurements. On the other hand, the measure obtained between two definite landmarks are called direct measurements.

## Applications of Anthropometry

Physical anthropology right from its inception has been concerned with the study of man's physical characters, their origin, evolution and present state of development.

We know that man in all his varieties is the result of the effects of past as well as the present causes. Therefore, the nature of environmental conditions need to be studied.

It is for this reason that in physical anthropology there is much emphasis on comparisons.

Appreciation and evaluation of the tent of human variability and caring for the factors which account for their current distribution have been the basic concern of physical anthropology. Anthropometry, the basic technique of physical anthropology has greatly contributed on this aspect. Besides, the technique of anthropometry has application in many areas of human concern and welfare. It is proposed to enlist some of the more important applications of the science of anthropometry:

1) Morphological differences within and between populations may be demonstrated by comparing anthropometric results statistically. Variations can be expressed by calculating the standard deviation of the sample, which indicates as to what proportion of the sample deviates from the average measurement by a given amount. Thus, anthropometry helps in understanding and evaluating both individual aeration as well as population variation. In this sense it provides a definite measure for the somatological variability in human populations and also to indicate the direction of human evolution. In this context, anthropometry is a positive help in achieving the objectives of physical anthropology to a great extent

2) This understanding of the somatic variability utilizing the anthropometric approach at the individual level provides funher opportunity for the identification of individuals and the departed populations. Anthropometry, far the same reasons, is also helpful in understanding the ethnic affinities between populations.

3) Anthropometry is the basic technique for evaluating the fossil evidence and for understanding many osteological remains in fossil forms. Metric analysis of the skull involves taking lincar measurements from standardized landmarks. These measurements are then used in working out indices or they are subjected to statistical comparison. The resulting analysis may then be interpreted leading to statements about evolutionary change or inter-population or intra-population differences In the phylogenetic study of man from pleistocene remains the long bones and pelvic girdle are worth while in determining such behavioural factors as posture and locomotion. For the determination of set and

estimation of stature post cranial remains are such more important. Similarly, the skull sutures and dentition may be useful in the assessment of age. Much information on the nutritional status of the population can be sought through the observations of post cranial remains. The study of the skeletal frame may also reveal the incidence of important pathologies including degenerative changes of bone with increasing age.

4) On the other hand comparative anthropometry is the basis for a clear understanding of comparative anatomy of primates particularly those closer to man.

5) The study of the processes and patterns of human growth and development (Autological anthropometry) is another area where anthropometric techniques are basically used. On the basis of such studies the pattern of growth of an individual child can be evaluated. In case this pattern does not conform to the norm remedial measures may be adopted immediately.

6) In the last few decades anthropometry has found its application in many other areas. It is quite useful in the field of Medicine and Health. On the basis of measurements of the body the constitution and physique of an individual can be worked out and clear cut classification of ecto, meso and endomorphy can be made.

At the same time specific body constitution peculiar to certain diseases like Tuberculosis has also been possible. Thus, such studies may be helpful in identifying the specific body constitution prone to certain diseases may be known in advance. The general standards of health can also be evaluated by using composite measurements like height and weight. Life Insurance Corporation of India has been using this method for a long time.

7) In recent years anthropometric measurements have been found quite useful in the field of orthopedic surgery, particularly in the preparation of artificial limbs.

8) Anthropometric observations are of particular use in the field of Dentistry. It can assist the dentist with the required data on the dimensions of the teeth and Jaw various periods of growth. The normal range of variation of different structures and their changes due to environment are of particular interest to dentists.

9) Anthropometry has definite application in the field of Eugenics, where we are basically concerned with the promotion of better traits in future generations. This can be achieved by a close collaboration of Geneticist and Physical Anthropologist. Anthropometric knowledge can also be applied in the field of

mental health. Today we are aware that a major section of the population is increasingly affected by one or the other mental disorder, like schizophrenia and mental retardation. It may be possible to detect some of the mental abnormalities (besides cases of microcephaly and Hydrocephalus etc.) well in advance.

10) The techniques of anthropometry have also been found extremely helpful in evaluating the physique and the constitution suitable in different sports specialities, so that the selection of the best team for the International competitions can be made out with the help of anthropometric techniques so much so that now a new branch entitled Kin Anthropology has been developed.

11) Another area where anthropometry has made significant contribution is the field of Forensic science. In Forensic science individual characterization involving determination of age and sex is important. Physical anthropology helps in such assessments by utilizing its knowledge in the fields of Osteology, Osteometry and Somatology. Morphological variation in human populations includes variation in those characteristics useful for sex and age analysis. Data for the estimation of sex and age are necessarily comparative in nature. Yet some criteria are often used as implied absolutes. The knowledge of anthropometry is helpful in reconstructing the somatic picture (including facial details) of the culprit whom some member of the public might have seen while committing the crime. This of course requires large scale stomatological surveys of the population which can provide the basic data for reconstruction purposes.

Another aspect where anthropometric techniques have been applied successfully is the examination and evaluation of the photographs of the individuals. It happens quite often that a certain individual belonging to another country obtains a valid visa and thereafter may not return to his native place for ulterior motives, including the spying activities and the collection of classified information from the country. When such individuals are apprehended, they conveniently deny the credentials as given in the visa and the photograph. The facial physiognomy is subject to change with the lapse of time, particularly in such cases where individuals try to hide their identity. In the circumstance it is necessary that a careful photographic comparison based on the proportions of the face must be conducted. Anthropometric techniques including somatoscopic techniques are quite useful in such evaluations.

The cases of disputed paternity may also be evaluated and solved to some extent by utilising anthropometric approach. In such a situation one can easily score out the similarities between the putative father and the child whose paternity is in dispute.

12) In the field of Human Genetics particularly in evaluating the zygosity of the twins, anthropometric techniques have a definite usage. On the basis of relevant measurements the individual somatotypes can be worked out and we can have an idea whether the twins are monozygotic or dizygotic. This

zygosity diagnosis will obviously be based on the concordance and discordance of the twins for each character or each trait studied.

13 ) in more recent years anthropometric measurements and standards are being increasingly used in industry - dress designing, shoes, seats in railways, aeroplanes and buses, helmets, furniture designing and manufacture of artificial limbs etc.

14) In studies on human adaptation to varied climates and ecologies it is considered necessary that anthropometric techniques including somatological examinations must be applied so as to reveal the phenotypic variations which are significant in the process of adaptation are carefully identified and worked out.