

Somatometry

(The purpose of ~~this~~ chapter is to demonstrate individual variation at the morphological level and to acquaint the readers with the tools and techniques used in its measurement and description of the observations on various body segments.)

(Somatology is a systematized knowledge of the techniques for measuring and recording observations on the human body. It includes direct surface measurements on different parts of the human body by most reliable means and scientific methods.) (The scope of observations and measurements, however, is limited only by the nature of the problems to which it is applied. As we have stated earlier that Anthropometry is simply a system of techniques and therefore should not be considered as an end but as a means. Since somatometry is a division of anthropometry, the above considerations are directly inherent in it.)

(Like any other technique anthropometry or somotometry requires specific conditions :

- ✓ **1. The relevance and the scope of measurement** - Of the numerous somatic measurements available one has to make a selection of the measurements and observations to be taken. Only those measurements should be selected which have a well defined purpose. This naturally depends upon the specific objectives of each investigation undertaken. Measurements have their definite functions and therefore the measurements must be clearly defined, standardized in technique and should be unequivocal in interpretation.
- ✓ **2. Perfection of methods and procedures** - (The measurements selected should be comparable with those taken by other investigators trying to solve a similar problem.) (There should be uniform technique with a strict definition of a land mark for each measurement.) (The term used for each measurement should be absolutely identical. If this is not done and there is a lack of uniformity then it may result into erroneous comparisons and conclusions.) At the same time absolute precision should be the ideal goal (Personal error should be minimised and wherever committed it needs to be evaluated and taken into account.)
- ✓ **3. Good technique makes it obligatory to use accurate instruments** - There are specific firms that specialize in making such instruments and they also provide detailed catalogues which facilitate ordering.
- ✓ **4. In spite of the availability of accurate instruments it is necessary that the investigator should know the exact spot where the point of the calliper should be placed,**

the procedure for handling it for obtaining certain maximum diameters should be known to the investigator. These are some of those aspects which require actual practice in the laboratory or in the field. As for instance the method of applying the anthropometric steel tape can only be learnt by practice. Even after long careful practise the precision is subject to the variations of the so called 'personal error'. If a single observer repeating an identical measurement on the same subject obtains, different results that vary even sometimes to 1.0 cms, then we should ensure that the personal error is not compounded.

Generally, it is argued that anthropometry/somatometry can not have a unique and uniform system, because the measurements of the human body may be employed for various diverse purposes e.g. industrial, aesthetic, military, medical, criminal identification, eugenic or purely for research purposes. These different requirements may necessitate different procedures of work techniques in each case. However, for the sake of the comparison of results maximum possible uniformity must be attained. This naturally requires due precision in definitions.

As regards the development of anthropometry we have already stated in the first chapter. It seems clear that prior to 1870 there was a complete unification in the incipient techniques of anthropometry. Paul Broca's system was in common use. However, later on in Germany there was a strong tendency for national individualism which affected even anthropometry. It was in the year 1874 on the occasion of the Congress of the German Anthropological society that Von Ihering initiated a departure by proposing the inclusion of new measurements and techniques. After a debate for about 8 years his plan was finally approved at the XIII General Congress of the German Anthropological Society held in 1882 at Frankfurt/Maine and was known as a Frankfurt Agreement. This however resulted into considerable confusion on account of the adoption of the new technical nomenclature and methodology. On the other hand, in England also there was an attempt to introduce new heterogeneous element. P. Topinard proposed a new series of anthropometric measures in 1885. All these attempts resulted into a period of maximum confusion. The situation thus was ripe for fresh attempts for international unification of anthropometric measurements. For this specific purpose of unification of anthropometric techniques a committee was appointed by XI International Congress of Pre-historic Anthropology and Archaeology held in Moscow in 1892. However, the first step towards the desired unification was made after the XIII International Congress of Prehistoric Anthropology and Archaeology held in Monaco in 1906. This was devoted solely to the craniometric measurements and hence the resultant publication was titled as 'International Agreement on Anthropometry'. The Agreement for unification of the somatic measurements was accepted in 1912 at the time of the XIV Congress held in Geneva. Later on in the year 1932 an International Committee under the Chairmanship of H.V. Vallois was created in London. The American Association of Physical Anthropologists also decided in 1938 to participate in the discussions of the London

Committee just for the sake of enhancing precision and reliability of techniques but insisted that instead of having a standard procedure the technique should be in accordance with the problem. Therefore finally it was resolved to dissociate American Association of Physical Anthropologists from the deliberations and conclusions of the International Committee of Standardization.

* The scope of the technique of measuring living subjects seems to have reached its peak with the work of R. Martin who determined 120 measurements which included 49 on the head and 71 on the body and numerous indices. Later he reduced the specified 120 measurements to 69 in his anthropometric blanks for living subjects. Of these 69, 22 measurements were considered most important followed by 6 less important and the remaining 41 unimportant. T. Mollison in 1938 made a considerable reduction in the number of measurements and indices proposed by R. Martin for the living. H.V. Vallois of the Anthropological Laboratory of the School of Higher Studies of Paris limited these measurements to 47 and 29 indices. Many other anthropologists like A. Hrdlicka, M.F. Ashley Montague, E. Frizzi etc. made further modifications and restrictions on the number of somatic measurements. Thus, it is evident that many anthropologists have increased or reduced the number of measurements according to the interest and the purpose of investigation.) END

In order to take accurate measurements and ensure their reliability the following recommendations have been made :

1. All instruments should be absolutely clean and their precision duly verified by a reliable verifier.
 2. While taking stature and weight the subject should either be nude or with minimal clothing.
 3. The landmarks for each measurement should be fixed very carefully, keeping their definitions in mind.
 4. All paired measurements should be taken on the left side so as to avoid any occupational deformities.
 5. While taking measurements with the callipers no pressure should be applied on the points of landmark located on the skin surface.
 6. Flexible steel tape should usually be placed perpendicular to the axis of the segment being measured. However, no pressure should be exerted on the skin surface.
 7. Only normal healthy individuals between 25-50 years of age should be included as adults in the sample.
 8. For the sake of clarity all measurements should be taken in the same unit e.g. cms or m.m.
 9. The instruments should be read perpendicularly and inclination should be avoided.
- The above recommendations should invariably be adapted in accordance with the conditions and circumstances of the environment.

SOMATOMETRIC INDICES

1. Relative sitting Height
2. Relative Hand Index
3. Relative Upper Arm Index
4. Relative Fore Arm Index
5. Relative Biacromial Breadth Index
6. Relative Chest Girth Index
7. Arm Index
8. Hand Index
9. Relative Thigh length Index
10. Relative Lower arm Length Index / Fore Arm Hand Index
11. Relative Lower leg Index
12. Relative Foot Index
13. Femoro-humeral Index
14. Femoro-Tibial Index
15. Relative Trunk Breadth Index
16. Ponderal Index
17. Robusticity Index
18. Relative Skeletal Index

✓ 25. Relative Sitting Height Index ✓

$$\frac{\text{Sitting height vertex}}{\text{Stature}} \times 100$$

26. Relative Span Index

$$\frac{\text{Span}}{\text{Stature}} \times 100$$

✓ 27. Biacromial Index ✓

$$\frac{\text{Biacromial breadth}}{\text{Stature}} \times 100$$

The biacromial index is also referred to as shoulder breadth index.

Narrow-shouldered	upto 21.9
Medium-shouldered	22.0-23.0
Broad-shouldered	23.1 and above

According to Brugsch.

In respect of this index the racial differences are of little significance as they are masked by differences in stature. It is noted that groups of small stature have relatively broad shoulders. But in relation to trunk length the Brachycormic black races have the widest shoulders. The differences between diverse constitutional types are more definite. During growth the biacromial index decreases rapidly in small children.

30. Relative Chest Girth Index ✓

$$\frac{\text{Chest girth}}{\text{Stature}} \times 100$$

Narrow chest	X-50.9
Medium chest	51.0-55.9
Broad chest	56.0-X

According to Martin and Saller.

Thoracic circumference is measured with anthropometric tape at the level of the 4th rib or chest above the nipples. It is therefore possible to record either the static circumference (i.e. during the quiet stage, intermediate-between expiration and inspiration) or the dynamic circumference i.e. the mean between normal expiration and inspiration. The difference between these two measures gives physiological information. Thus, there could be several thoracic circumferences, unless the technique is also described the published results are of no value. It may also be noted that thoracic circumference is relatively independent of stature, but has a high correlation with weight.

Classically the thoracic circumference index is equal to 50. Permitting for individual variations the stature may be twice the thoracic circumference. It is difficult to interpret racial differences. Populations with short lower limb seem to have relatively developed thorax. Thorax of women is relatively less developed than that of a man. From the constitutional point of view this index provides information about the subject's volume and musculature rather than his breathing capacity.

Relative Upper ✓
34. Arm length index ✓

$$\frac{\text{Upper Arm length}}{\text{Stature}} \times 100$$

Short	:	upto 18.9
Medium	:	19.0-19.9
Long	:	20.0 and above

According to Olivier.

This index varies among ethnic groups. It is noted that Whites have medium arm length. It is little shorter in the yellow races. On the other hand Negrillos have long arms. Sexual difference is non-significant. Boys generally have longer arms than girls.

✓ ✓
35. Fore arm length index

$$\frac{\text{Fore arm length}}{\text{Stature}} \times 100$$

Short	:	upto 14.9
Medium	:	15.0-15.9
Long	:	16.0 and above

This index is larger in African Negroes and low in Whites and Japanese. Women have a slightly lower index than in men.

✓ ✓
36. Arm Index or Inter brachial Index

$$\frac{\text{Length of the forearm}}{\text{Length of the upperarm}} \times 100$$

38. Hand Index or Breadth Index of the Hand ✓ ✓

$$\frac{\text{Hand breadth}}{\text{Hand length}} \times 100$$

Narrow Hand (dolichocheir)	upto 42.9
Medium Hand (mesocheir)	43.0-47.9
Broad Hand (brachycheir)	48.0 and above.

According to Olivier.

Generally, White and Yellow races have hands which are relatively broad or short. Melanoderms, particularly Africans and Negrillos have a relatively narrow or long hand. Women have a longer or narrower hand than men.

Hyperdolichocheir	upto 40.9
Dolichocheir	41.0-43.9
Mesocheir	44.0-46.9
Brachycheir	47.0-49.9
Hyperbrachycheir	50.0 and above

According to Martin and Saller

44. Thigh Length Index ✓✓

$$\frac{\text{Thigh length}}{\text{Stature}} \times 100$$

Short	upto 28.9
Medium	29.0-29.9
Long	30.0 and above.

This index is normally greater in these who have tall stature. Women have thighs that are relatively longer than those of men. This fact compensates for the relative shortness of the crural segment of this limb. There is a progressive and regular increase of the index both before and after puberty.

45. Crural Length Index ✓✓

$$\frac{\text{Leg length}}{\text{Stature}} \times 100$$

This index is also correlated with stature. Its range of variation can be divided into the following three classes :

Short	upto 21.9
Medium	22.0-23.9
Long	24.0 and above.

It is noted that Melanoderms have relatively long legs, whereas White and yellow races have relatively short legs. The index is slightly lower in women than in men.

46. Cruro-femoral Index or Femoro-tibial Index ✓ ✓

$$\frac{\text{Leg Length}}{\text{Length of the thigh}} \times 100$$

The index is high in Melanoderms, medium in yellow races, low in Whites. It is lower in women than in men.

47. Foot length index ✓ ✓

$$\frac{\text{Foot Length}}{\text{Stature}} \times 100$$

This index expresses the relative value of this measurement. Normally, foot length is more or less proportional to stature. However, sometimes men of a small stature have a relatively longer foot than those who are tall in one and the same group. The index is generally greater in tall populations, smaller in populations of small stature and in women.

49. Intermembral Index

$$\frac{\text{Upper limb length}}{\text{Lower limb length}} \times 100$$

The intermembral index diminishes as stature rises due to the proportionality between stature and upper limb length. However, it is observed that the lower limb is relatively shorter amongst those with small stature. Sexual difference is appreciable. Women have shorter upper limbs in relation to both stature and the lower limbs.

50. Relative trunk breadth index

$$\frac{\text{Bitrochantric breadth}}{\text{Biacromial breadth}} \times 100$$

51. Femoro-humeral index

$$\frac{\text{Length of upper arm}}{\text{Length of thigh}} \times 100$$

52. Mammilo-acromial Index

$$\frac{\text{Bithelion breadth}}{\text{Biacromial breadth}} \times 100$$

53. Lower leg-foot index

$$\frac{\text{Length of foot}}{\text{Length of lower leg}} \times 100$$

54. Relative thoracic index

$$\frac{\text{Sagittal chest depth}}{\text{Transverse chest breadth}} \times 100$$

55. Relative skelic index

$$\frac{\text{Total leg length}}{\text{Length of frontal trunk}} \times 100$$

Classification	Range of variation
Hyperbrachyskelic	X-74.9
Brochyskelic	75.0-79.9
Subbrachyskelic	80.0-84.9
Mesatiskelic	85.0-89.9
Submicroskelic	90.0-94.9
Macroskelic	95.0-99.9
Hypermacroskelic	100.0-X

According to Manouvrier

56. Ponderal Index ✓ ✓

$$\frac{1000 \times \sqrt[3]{\text{weight}}}{\text{Height vertex}}$$

57. Robusticity Index or Consitutional Index ✓ ✓

Total Stature (in cms) - [Thoracic girth (in cms.) + Total weight (in kg)]

Very strong] Hypersthenic	X-10
Strong		11-15
Good] Normosthenic	16-20
Medium		21-25
Weak		26-30
Very weak] Asthenic	31-35
Bad		36-X

According to Tschermorutzky

For this index the maximum Thoracic or Chest grith (in cms.) + the total weight (in kgs.) is to be subtracted from the total stature (in cms.)

✓✓ Relative Lower Arm Length Index / Fore Arm Hand
Index = $\frac{\text{Hand Length}}{\text{Fore Arm Length}} \times 100$

✓✓ Relative Hand Index = $\frac{\text{Hand Length}}{\text{Height Vertex}} \times 100$

→ KEY = ✓✓ - Indices which are marked by
Double ticked green colour
pen have to be written
in the files.

METHOD AND PRECAUTION VARIO MEASUREMENTS

1. Name of the measurement- Height Vertex

Landmark used- Floor to Vertex

Instrument used- Anthropometer

Method- - The subject is made to stand on a horizontal plane, barefooted, stretching upwards to the fullest extent with heels together and back in contact with the vertical measuring anthropometric rod. Subject head should lie in the eye ear plane. It is required that the subject back should be straight as possible. Then the anthropometric rod is placed at the back, running parallel to the subject and the cross bar is placed at the vertex in the mid sagittal plane and the reading is noted.

Precautions-

- 1) Subject should stand bare foot.
- 2) Subject head should lie in the eye-ear plane.
- 3) Subject should stand in attention position with arms hanging.
- 4) Extra pressure should be put on the head, while locating the vertex point.

2. Name of the measurement- Sitting- Height Vertex

Landmark used- Sitting Surface to Vertex

Instrument used- Anthropometer

Method- It measures the vertical distance from vertex to the sitting surface of the subject. In order to record this measurement accurately the subject should be seated on a horizontal table surface with his head in eye-ear plane. The vertebral column should be fully stretched (with more or less straight lumbar region) to its maximum. The thighs should be almost horizontal and touching the table surface. Anthropometer should be held at the back of the subject and the crossbar of the anthropometer should be fully extended so as not to miss the vertex. (Anthropometer).

Precaution-

1. Subject should sit with his/her back straight as possible.
2. The thighs should be almost horizontal and touching the table surface.
3. The crossbar of the anthropometer should be fully extended so as to not miss the vertex.

3. Name of the measurement- Upper Arm Length

Landmark used- Acromion to Radiale

Instrument used- Rod Compass

Method- The Subject is asked to stand straight and his/her arms should hang along side of the body. In order to take measurements, the Acromion landmark is properly located by palpating the Spine of the scapula and tracing it laterally to the acromion process. The determination may be facilitated by swinging the arm to and fro. One end of the rod compass is placed on the Acromion point, for locating the radial point, it is to be remembered that it is the highest point on the border of the head of the radius while the arm is hanging and the palmar surface is directed inwards, it is the articulation which is marked by a dimple distinct groove and the other end of the crossbar of the Rod Compass is placed here. The scale is to be read in accordance with the orientation of the Crossbar.

Precaution-

1. Both Acromion and the Radiale should be located carefully.
2. Acromion should be located at the lateral most point on the Acromion process.
3. Subject should not move the shoulder in any direction.
4. Orientation of the Crossbar should be correctly maintained.

4. Name of the measurement- Fore Arm Length

Landmark used- Radiale to Stylium

Instrument used- Rod Compass

Method- While taking measurements, firstly the radial point is to be located. It is to be remembered that it is the highest point on the border of the head of the radius while the arm is hanging and the palmar surface is directed inwards, it is the articulation which is marked by a dimple distinct groove and one end of the crossbar of the Rod Compass is placed here. For locating Stylium point, as it is located on the distal margin of the styloid process of the radius, it must be sought from below to upwards and the crossbar is kept on the observed point and the reading is noted.

Precaution-

1. Tips of the crossbar should not hurt the subject to avoid it, finger tips of the investigators should be touched along with the crossbar.
2. Both landmarks should be carefully determined and marked.

5. Name of the measurement- Hand Length

Landmark used- Stylium to Dactylion

Instrument used- Sliding Calliper

Method- It is measured from stylium to the tip of the middle finger with out nail (Dactylion), parallel to the axis of the finger. While taking the measurement the palm should be fully extended and the arm should be in hanging position.

Precaution-

1. While locating the Dactylion point, it should be carefully seen that the nail is not long in the middle finger.
2. This measurement should be taken with a blunt end sliding calliper.
3. The hand should be fully extended.

6. Name of the measurement- Hand Breadth

Landmark used- Metacarpal Mediale to Metacarpal Laterale

Instrument used- Sliding Calliper

Method- This measurement is taken between the heads of the second and fifth metacarpals, using their most projecting points. These points are also indicated as metacarpal radiale and metacarpal ulnare. This measurement is not truly transverse but is rather oblique. Mostly, right hand is broader than the left, (Rod compass/Sliding calliper).

Precaution-

1. Maximum reading has to be noted.
2. Mediale and the Lateral landmarks has to determined carefully.

7. Name of the measurement- Thigh Length

Landmark used- Iliospinale to Tibiale

Instrument used- Rod Compass

Method- The point tibiale corresponds to the medial extremity of the interline of the knee. More precisely it corresponds to the upper and medial border of the tibial condyle which is situated practically at the level of the inferior apex of the patella. In order to locate this landmark it is often necessary first to flex and then to extend the knee. The crossbar of the rod compass is kept at the point and the reading is noted.

Precaution-

1. Subject should stand straight.
2. Landmarks should be carefully located.
3. Anthropometer should be parallel to the leg.
4. For precise measurement Mollison recommends that 7% should be subtracted.

8. Name of the measurement- Lower Leg length

Landmark used- Tibiale to Spherion

Instrument used- Rod Compass

Method- This is the length of the tibia. It is the measured length between the Tibiale mediale and Spherion tibiale sites. The subject should be seated on the sitting stool for this measurement with the right ankle crossed over and resting on the left knee. One end of the caliper is placed on the marked Tibiale mediale site and the other end positioned on the marked Spherion site.

Precaution-

1. Spherion should be located at the lowest point on the medial malleolus.
2. Orientation of crossbar must be reversed and the reading should be recorded in accordance of the crossbar.

9. Name of the measurement- Foot Length

Landmark used- Acropodian to Pterion

Instrument used- Rod Compass

Method- The length of the foot is measured from pterion- the most backward projecting point of the heel to the extremity of the longest toe marked by acropodian, while the subject is standing erect and sustaining is full weight on the two feet. (Anthropometer).

Precaution-

1. Both crossbars of the compass should be parallel to each other.
2. The longest toe should be marked as acropodian and the most backward projecting point of the heel as pterion.

10. Name of the measurement- Foot Breadth

Landmark used- Metatarsale mediale to Metatarsale laterale

Instrument used- Rod Compass

Method- Foot breadth is the distance between the heads of the first and fifth metatarsals, while the subject is standing erect. Like the hand breadth it is an oblique measurement. (Anthropometer).

Precaution-

1. Maximum breadth should be taken.

2. Subject should be in eye-ear plane
3. Measurement should be taken obliquely.

11. Name of the measurement- Biacromial Breadth

Landmark used- Acromion to Acromi

Instrument used- Rod Compass

Method- The Subject is asked to stand straight and his/her arms should hang along side of the body. In order to take measurements, the Acromion landmark is properly located by palpating the Spine of the scapula and tracing it lateral to the acromion process. The determination may be facilitated by swinging the arm to and fro, so as to ensure that the point determined is the lateral most point of the acromion process. Then the crossbars of the rod compass are placed on the Acromion point and the reading is noted

Precaution-

1. Both crossbars of the compass should be parallel to each other.
2. Landmarks should be carefully located
3. Arms should be hanging down .

12. Name of the measurement- Bitrochanteric Breadth

Landmark used- Trochanterion to Trochanterion

Instrument used- Rod Compass

Method- The subject assumes a relaxed standing position with the feet together and arms resting across the chest. The anthropometrist should stand in front of the subject and the blades of the anthropometer should be positioned on the most lateral aspects of the Trochanteria. The crossbars of the rod compass is placed on both the landmarks and the reading is noted.

Precaution-

1. The subject should stand straight with his/her feet together.
2. Trochanterion should be located laterally.
3. Crossbars of the rod compass should be placed laterally and extend on the landmarks.

13. Name of the measurement- Bicristal Breadth

Landmark used- Iliocristale to Iliocristale

Instrument used- Rod Compass

Method- Subject allowed to stand straight after this the Iliac crest is located as the most lateral point on the iliac crest. It can be felt while sliding the finger from below to upwards. As it is the maximum distance between the most lateral points of the iliac crest as felt through the skin, then the crossbars of rod compass is placed very lightly on the soft parts of the iliac crest and the reading is noted.

Precaution-

1. Subject should stand straight
2. Maximum reading should be noted.
3. Crossbars of the rod compass should be placed very lightly on the soft parts and should be suppressed.

14. Name of the measurement- Chest Breadth

Landmark used- Maximum Breadth across the 4th Rib

Instrument used- Rod Compass

Method- Subject is asked to stand straight and the arms should be abducted slightly and he/she should be in a state of respiratory rest. The compass placed laterally across the 4th Rib and the reading should be taken horizontally without depression of soft parts and the maximum reading is noted.

Precautions-

1. Compass should be placed laterally on 4th Rib.
2. The subject should be in a state of respiratory rest.
3. Compass should be depressed on soft body parts.

15. Name of the measurement- Chest Depth

Landmark used- Maximum depth across the 4th rib

Instrument used- Rod Compass

Method- - Subject is asked to stand straight and raise his/her arms slightly and he/she should exhale and inhale normally and then the pelviometer is placed across the 4th Rib, with both of its arms in the center and the maximum reading should be taken.

Precautions-

1. Both arms of the pelviometer should be parallel to the ground.
2. The subject should respire normally.
3. Maximum reading is noted.

16. Name of the measurement- Chest Girth

Landmark used- Maximum girth across the 4th Rib

Instrument used- Measuring Tape

Method- This measurement should be taken by lifting the arms of the subject and placing the tape around the chest at the level of 4th rib. The subject is asked to drop the arms while the tape is still held in place by the investigator and the reading is noted in centimeter.

Precaution-

1. Measuring Tape should be placed properly around the chest.
2. Reading should be noted in centimeter.
3. Tape should be placed across the 4th rib.

17. Name of the measurement- Arm Girth

Landmark used- Maximum Circumference of the Arm

Instrument used- Measuring Tape

Method- Maximum circumference of the arm is taken when bicep muscles are most developed. The measurement is taken horizontally and at right angle to the axis of the hanging arm, tape is wrapped around and the reading is noted.

Precaution-

1. Reading should be taken at the place where the bicep muscles are most developed.
2. The measurement should be taken horizontally in centimeters.

18. Name of the measurement- Body Weight

Instrument used- Weighing Machine

Method- Firstly it is checked or verified that the pointer of the weighing machine is at Zero(0).

Then the subject is asked to stand on the machine and the total weight is noted.

Precaution-

1. Pointer should be at Zero(0).
2. Subject should stand barefoot on the machine with least clothing on the body.

