PRACTICAL MANUAL

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PRACTICAL MANUAL

Contents

Learning Objectives

After going through the practical manual you will be able to:

- understand the practical aspect of somatometric measurements;
- visualize various measurements used by anthropologists for determining obesity; and
- define anthropometric indices for assessing nutritional status at right place.

1.0 INTRODUCTION

Somatometry is the metric study of living human body. This science of measurement of human body also holds immense significance in racial classification, evolutionary studies and in designing of clothes and equipment. This section will facilitate you with concise description of standard techniques, positions and methods for taking somatometric measurements. Somatometric measurements are defined on the basis of various anatomical landmarks and are useful in describing the morphology of man.

Somatometry (measurement of the dimensions of body) involve different types of instruments for taking measurement, as you learnt in your course Introduction

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to Biological Anthropology depending upon its nature. Anthropometric measurements use growth references and standards for determining the growth, nutritional status and welfare of children and adolescents. The anthropometric measures such as Z-score and percentiles have been widely used to assess the nutritional status of an individual and his/her growth. In this section, we have also covered nutritional status assessment through anthropometric indices and dietary practices. Nutritional status is the total of the anthropometric indices of an individual which are influenced by consumption of nutrients. All this information is obtained by physical, biochemical and dietary practices which depends on the quality and the quantity of food consumed and the individual's physical health. The nutritional status of an adolescent has an important implication on his/her health, in developing of chronic diseases and holds importance in breaking the sequence of malnutrition. Dietary pattern that is a crucial factor to determine the nutritional factor, is the general outline of the food and nutrient intake and utilization which is characterized on the basis of common eating habits. And, the analysis of dietary patterns provides a more all-inclusive imprint of the food intake habits or practices within a population.

1.1 GROWTH STATUS: SOMATOMETRY

Somatometry is made of two words 'somato' which means living and 'metric' which refers to measurement, so in simple terms it means measurement of living beings. Therefore, somatometry a division of anthropometry is defined as a systematic technique to measure living body including head and face. Anthropologists have formulated number of measurements for describing the morphology of man. These measurements are not arbitrary and are based on anatomical landmarks and have been in use for hundreds of years. They are useful in comparing various kinds of people living in different geographical regions, i.e., for racial comparisons or to study variations in body types. Physical growth of children is studied on the basis of their body measurements. The nutritional status of young and adults is also assessed with the help of these measurements. It also facilitates in the determination of certain physiological functions like vital capacity, basal metabolic rate, etc. Data generated on the basis of anthropometry surveys of populations has been an asset for designing proper equipment for use in industry and defence purposes, spaceships, garments, etc. The anthropometric surveys also provide norms of the physique of any population and trends of changes in morphological traits. Let us learn how we take body weight or weight, stature commonly called as height, and mid upper arm circumference. You are familiar with landmarks and procedure of some measurements, nevertheless lets go through it again.

Body weight

Weight should be taken by means of standard weighing machine without any zero error with fine accuracy. The weight should be taken with minimum clothes and barefoot. Body weight is measured in kilograms, which gives an idea of body mass.

Instrument used: Weighing machine

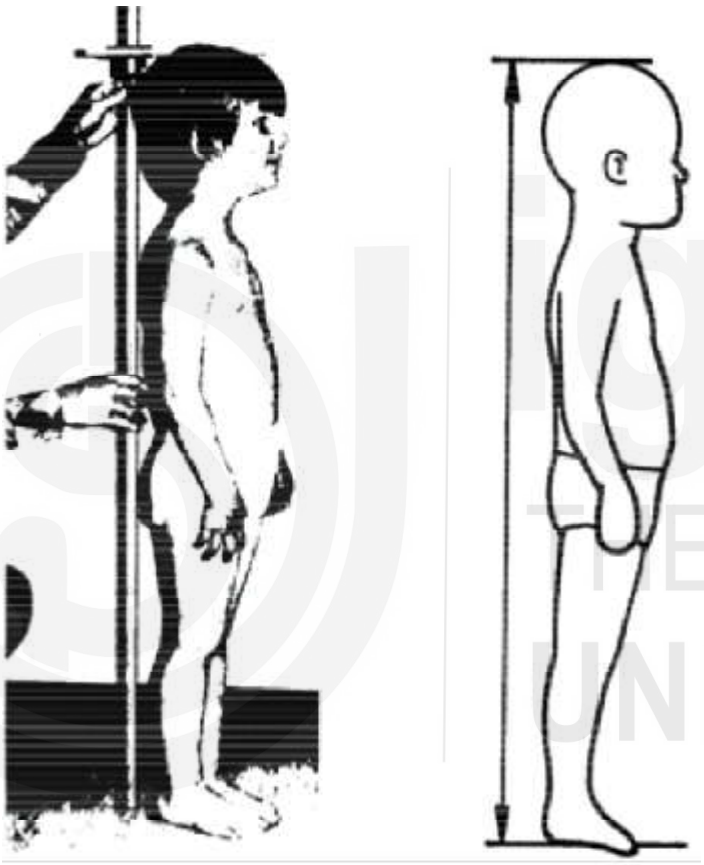
Method: The needle of the weighing scale is adjusted to remove the zero error. The subject stands with equal weight on both the feet. The head of the subject should be forward. The reading on the weighing scale is noted when the needle is stationary.

Precautions

- ✓ Take care that the subject is wearing minimum number of clothes.
- ✓ Weight should not be taken right after taking meals.
- ✓ Make proper adjustment for clothes worn by the subject at the time of taking weight.
- ✓ It is recommended that at the time of recording weight of the clothes should also be adjusted.

Stature

Stature (floor-v): It measures the vertical distance from the standing floor to the vertex.



Source: www.ovrt.nist.gov

Vertex (v): It is the highest point on the head when the head is in the Frankfurt-Horizontal (FH) plane, also known as eye-ear plane. Vertex is not an anatomically fixed point and is dependent on the orientation of the head.

Instrument used: Anthropometer

Method: The subject should stand erect, barefoot on a level floor against the wall with her/his back and buttocks touching the wall. The heels should touch the wall and toes are at an angle of 45° to each other. The shoulders should not be raised upwards. The arms should be in standard arm hanging position and the palms of the hands should touch the thighs. The anthropometer is placed on the back of the subject if the vertical wall is not available. The head of the subject must rest without any strain in the eye-ear plane or FH plane, i.e., tragion and the

right orbitale must lie in the same horizontal plane (Refer to the BANC 101 Manual). Now with the position of the subject set, standing on the right side of the subject with anthropometer in the median sagittal plane of the subject and allow moving cross-bar to touch the vertex lightly. Note that the anthropometer is in vertical position.

Precautions

- ✓ The subject is barefoot.
- ✓ The heels, back and buttocks of the subject should touch the wall.
- ✓ The toes are at an angle of 45°.
- ✓ The arms should be in standard arm hanging position.
- ✓ The head of the subject should be in eye-ear plane

In case of adults or child the height is measured up to the nearest millimeter using anthropometer. And, a sliding board made of wood is used for measuring the length of children. Infantometer is used for the measurement of recumbent length in case of children who are less than 2 years of age.

***Mid Upper Arm Circumference (*MUAC)**

The accurate and a reliable way to measure fat-free mass, is the upper arm circumference at the midway between the tip of shoulder and the tip of elbow on the left side of arm. The mid arm point is assessed by measuring the distance from the tip of the shoulder to the elbow and then dividing it by 2.

Instrument used: Flexible steel tape.

Method: The subject is asked to hang the hand freely in standard arm hanging position. The tape is placed horizontally around middle of the upper arm where generally the bicep muscles are most developed and reading is recorded.

Precaution

- ✓ The arms should be hanging freely.
- ✓ The tape should neither be tightly nor loosely held.

Note that the low reading of MUAC represents the loss of muscle mass. For determining the risk of mortality (in children) and individuals having HIV/AIDS, MUAC is the best assessing and screening tool. It is the only anthropometric tool for evaluating the nutritional status in case of pregnant women as well.

Practice 1

Take weight and mid upper arm circumference of five subjects

S.No	Name of the Subject	Weight of the Subject (kg)	Mid Upper Arm Circumference (cms)
1			
2			
3			
4			
5			

1.2 ASSESSMENT OF CHRONOLOGICAL AGE

Chronological age is the number of years represented by revolutions of earth around the sun. It is calculated from the date of birth. In other words, it is the definite number years an individual has lived his/her life in years, months, days or in a combination of all of these factors. For e.g. 16 years, 3 months and 10 days.

Chronological age estimation approach provides the age of an individual in terms of years, months and days. It is mainly used to evaluate the accurate age of an individual with respect of day, month & year. Let's understand this with the help of an example, if an you want to find out the age of an individual born on April 02, 1990 on January 10, 2016, then subtract 10.01.2016 by 02.04.1990.

$$2016.1.10 - 1990.4.2 = 25.7.8$$

Anthropometric measurements use growth references and standards for determining the growth, nutritional status and welfare of children and adolescents. The growth standard indicates that all children are potentially able to achieve a level, whereas a growth reference is the distribution that is used for the purpose of comparison.

The anthropometric measures such as Z-score and percentiles have been widely used to assess the nutritional status of an individual and his/her growth. The parameters of growth are

- Undernutrition that includes underweight, stunting and wasting; and
- Over nutrition involving overweight and obesity.

Z-scores (-2 and +2) and Percentiles (5^{th}, 85^{th}, 95^{th}, 97^{th}, 99^{th} percentiles) are used to categorize various health conditions. Moreover, sex-age specific anthropometric measures cut points are also evaluated using these factors.

As per WHO, use of growth chart i.e., growth reference on the basis of Z-scores assesses the nutritional status and growth of an children and growth charts are prepared on the basis of data generated.

1.2.1 Percentiles

The percentile of populations falls below the variable's value. Rank scale is used and it is more understandable. It also indicates the expected prevalence.

Limitations:

- Values are lumped to the lowest or highest percentiles
- This factor does not suit, in case of assessing longitudinal growth status and
- It is not comparable across different anthropometries.

The following table represents the percentile-Z-score conversion values

0.2^{nd}	-3
2.3^{rd}	-2
2.5^{th}	-1.96

5th	-1.64
15th	-1.04
16th	-1
50th (median)	0
84th	+1
85th	+1.04
95th	+1.64
97.5th	+1.96
97.7th	+2
99.8th	+3

Source - Wang and Chen 2012

Additionally, percentile also defines the population's expected percentage that should be above or below the table. Different age-sex specific percentiles are also used to evaluate the growth of children and their nutritional status on the basis of anthropometric measures and other health conditions as well such as low or high blood pressure.

An interesting information, Z-score and percentiles are convertible to each other. For e.g. Z-scores of 2 and -2 matches to the 97.7th and 2.3rd percentiles while the 85th and 5th percentile correspond to Z-scores of 1.04 and -1.65 respectively (Wang and Chen 2012).

1.2.2 Z-Scores

It is defined as the number of standard deviations away from the mean, when the distribution is in a normal process. The scale is continuous from -" to ". The main advantage of this factor is that it :

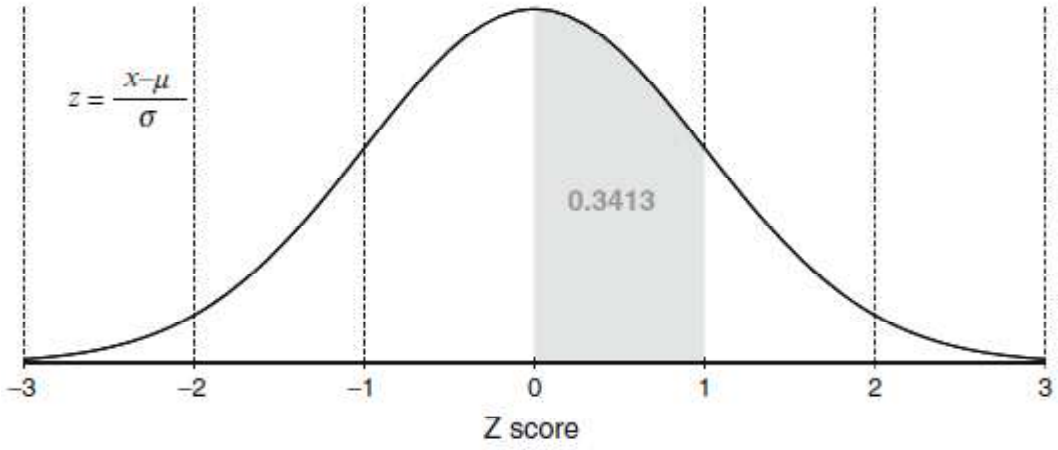
- allows comparison between sexes and ages;
- also helps in quantifying the extreme values; and
- is good for evaluating the growth status in longitudinal changes.

One of the major drawbacks of this factor is that it is difficult to perceive than percentiles, especially for the public.

Z-scores are calculated on the basis of distribution of reference population; thus, it reflects as the reference distribution. The reference population can be taken by mean and the standard deviation (SD). Z-scores are also comparable across age, sex and also is a measure of dimensionless quantity. Z-score group can be subjected to a summary of statistics such mean and SD, and both can be studied as continuous variable. As discussed above, the main limitation of this process that they are easy to explain to the public eye and also limited in clinical settings.

They are also called as standard scores, where the z-score transformation is considered to be useful when comparing the relative values of different measures such as height vs. BMI from distribution of different standard deviations or means.

The following graph illustrates Z-score and the corresponding cumulative probability and percentile



Source: Wang and Chen 2012

The transformed values of Z-score distribution will have a zero mean value or a standard deviation value of 1. This conversion process is called as normalizing or standardizing.

1.2.3 Height-for-age

This is the index that is used for evaluating stunting that is the presence of chronic malnutrition in children. Children who are stunted have poor physical and intellectual performance, thus the less work output leads to less productivity at the individual level and poor socio-economic status at the community/society level. If there is a presence of stunting in a child for provided population, shows that the children are suffering from the chronic malnutrition, thus affecting their linear growth.

Stunting is a child's low height-for-age when compared to the standard child having from the same age group or same age. Child who is suffering from stunting is found to have the lower mental and the physical productivity capacity.

1.2.4 Weight-for-age

Weight-for-age is an index that is used for monitoring the growth for the purpose of assessing and evaluating the status of underweight children. By carrying out the community-based nutrition (CBN) activities every year, an analyst can assess the weight-for-age of all children who are less than 2 years of age. This index determines the body size and also reflects the levels of food intake and it is also assessing the acute and short-term under-nutrition.

$$\text{Weight for age} = \frac{\text{Weight of the child}}{\text{Weight of the reference child of the same age}} \times 100$$

Did you realize how important these concepts in the study of human growth and development are? Let's learn about others to have more insight about it.

1.2.5 BMI for Age

Body Mass Index (BMI) – This is measured when the weight of an individual (in kg) is divided by the height of same individual in meters squared.

$$BMI = \frac{\text{Weight (kg)}}{\text{Height (meters)}^2}$$

BMI is considered as a good indicator of undernutrition in relation to a chronic energy deficiency (CED) and is a non-invasive and inexpensive approach that is used for wide scale surveys for the assessment of malnutrition (WHO 2004).

Table: BMI cut-off values for the assessment of malnutrition status

Malnutrition Status	BMI
CED Grade III	BMI < 16.00 Kg/m^2
CED Grade II	BMI 16.00 Kg/m^2 – 16.99 Kg/m^2
CED Grade I	BMI 16.00 Kg/m^2 – 16.99 Kg/m^2
Normal	BMI 18.50 Kg/m^2 – 24.99 Kg/m^2
Overweight	BMI 25.00 Kg/m^2 – 24.99 Kg/m^2
Obese	BMI $\geq$ 30.00 Kg/m^2

Source: WHO, 2004

Practice 2

Take stature and weight of five subjects and calculate their BMI.

Sl. No.	Name of the Subject	Weight of the Subject (Kg)	Stature (cms)	BMI Kg/ m^2
1				
2				
3				
4				
5				

1.3 OBESITY ASSESSMENT

Overweight and obesity have reached a level of epidemic in various countries and possess number of serious health and socio-economic consequences. Moreover, obesity has negative consequences related to psychological, medical and quality of life, it has drained all the health resources and also decreases the life expectancy. In various developing countries, there are different type of weight associated diseases such as obesity, overweight and underweight coexists simultaneously in different components of their populations (Uzogara, 2016) (Fontela,et al 2017).

There are various methods which helps determine obesity such as body mass index (BMI), skin fold caliper which are used to evaluate the body fat percentage. All these methods are simple and effective.

1.3.1 General – Body Mass Index

As mentioned above, BMI is measured when the weight of an individual (in kg) is divided by the height of same individual in meters squared. In case of adults, BMI estimates the clinical diseases such as type 2 diabetes, however, its prediction for children and adolescents is not that much. BMI is a global index that measures the nutritional status of an individual and is used to categorize individuals both on the basis of overweight/obesity and eating disorders in combination with the psychological standards. The drawback of BMI is that it does not differentiate the fat and lean masses.

$$\text{BMI} = \frac{\text{Weight (kg)}}{\text{Height (meters)}^2}$$

For information BMI $\geq$30 indicates obesity and BMI $\geq$40 indicates morbid obesity, hence we need to be very careful. High value of BMI is indicative of high potential risk of getting diabetes, heart diseases and premature death.

1.3.2 Body Fat %

Body Fat % is the total mass of fat of human or other living divided by total body mass and then multiplied by 100.

1.3.3 Conicity Index

It is the simple anthropometric measure that is used to determine the central obesity (Shenoy & Jagadamba 2017)

$$\text{CI} = \frac{\text{waist circumference (m)}}{0.109\sqrt{\frac{weight\,(kg)}{height\,(m)}}}$$

1.3.4 Body Adiposity Indices

Let's have a look at commonly used Body Adiposity Indices. BMI is used quite commonly.

Waist Circumference –Waist circumference measures the minimum circumference of the torso which is the level of normal waist. This central fatness is of great importance in assessing deep adipose tissue.

Instrument: Flexible Steel Tape

Method: The subject stands erect with the weight uniformly balanced on both the feet that are placed about 25-30 cms apart from each other. While measuring, mark the level of the lowest rib (margin) and the iliac crest in the mid axillary line. Pass the measuring tape the waist in the horizontal direction in midway between the margins of lowest rib and iliac crest. Measure the circumference in cm up to the nearest mm., ideally the investigator that he/she should sit on a stool in front of the participant.

Precautions:

- ✓ The tape should neither be tightly nor loosely held
- ✓ Stand up straight with body relaxed
- ✓ Keep your feet together

Waist-Hip-Ratio (WHR)

Waist-Hip Ratio (WHR) is defined as the ratio of the circumference of the waist to the circumference of hip. It is commonly used technique for defining body fat distribution. In other words it is a useful measure for assessing the abdominal obesity and has very limited accuracy.

$$\text{Waist-Hip Ratio (WHR)} = \frac{\text{Waist Circumference (in cm)}}{\text{Hip Circumference (in cm)}}$$

Waist-Hip ratio is found to be a good indicator of stroke and ischemic heart disease. WHR value > 0.90 in males, WHR value > 0.80 in females are considered to high risk of diseases such as diabetes.

In adults, the ratio of waist hip is independently related with the risk of morbidity after performing adjustments for relative weight, such that the use of body shape and relative weight at the same time provides a good prediction about the morbidity risk.

Instrument: Flexible Steel Tape

Waist Circumference – Waist circumference measures the minimum circumference of the torso which is the level of normal waist as mentioned above.

Hip Circumference (HC) - This is the distance round the hip measured through the largest part of the buttock's region using a tape.

Method: The subject stands straight and breathe out. Flexible tape is used to measure the distance around minimum waist, just above the belly button. Similarly for hip circumference, the tape is placed horizontally over the buttock's region. The circumference is measured at the point for obtaining the maximum circumference.

Precautions

- ✓ The feet should touch each other
- ✓ Weight of the body should fall equally on both the feet
- ✓ The tape should neither be tightly nor loosely held
- ✓ Stand up straight with body relaxed
- ✓ Keep both feet together
- ✓ Both circumferences must be measured on standing subjects at the end of a gentle expiration.

Minimum Upper Arm Circumference

Refer to earlier section (P-174).

1.3.5 Regional Adiposity Indices

Waist Circumference (WC)

Waist Circumference –Waist circumference measures the central fatness that is an indicative of lipid profile or insulin resistance than total fat.

Waist Circumference	Adiposity Status
WC $\geq$ 35 inches for women	Obesity
WC $\geq$ 31.5 inches for Asian Women	Obesity
WC $\leq$ 35 inches for women	Overweight
WC $\geq$ 40 inches for men	Obese
WC $\geq$ 35.5 inches for Asian men	Obesity
WC $\leq$ 40 inches for men	Overweight

Source: WHO 2008

Waist-Hip-Ratio (WHR)

Refer to earlier section.

Waist-to-Height Ratio (WHtR)

It is measured when WC divided by Ht i.e., height. All are measured in same units. This is a simplest method than BMI (Fontela, 2017, Uzogara, 2016). We have learnt in the earlier section about waist circumference and stature/Height.

Reference to understand is

WHtR > 0.5 for men or women indicates obesity

WHtR < 0.5 for men or women indicates healthy weight

Practice 3

Calculate WC of five subjects and identify their adiposity status.

S.No	Name of the Subject	Waist Circumference (cms)	Adiposity Status
1			
2			
3			
4			
5			

1.4 ESTIMATION OF BODY COMPOSITON

Body composition is the percentage of fat and non-fat mass present in your body. Body that has a desirable lower percentage of body fat is referred as healthy body composition and a higher percentage of non-fat mass includes organs, muscles and bones. There are many approaches to assess body composition like densitometry, ultrasound, bioelectric impedance, anthropometry, CAT scanning, etc. As the name suggests some of the methods are invasive, expensive and time

consuming, whereas anthropometry is non-invasive, affordable and subject friendly.

Anthropometric measurements and indices are also used such as weight, height, skinfold thickness, diameter, length and circumference that involves mathematical components. All these indices are the main components in estimating body segments (Lee et al, 2015).

Let us understand some of them.

1.4.1 Fat Percentage and Muscle Mass with Skinfold Thickness

Body composition and growth are the key aspects of health in populations. These factors can be assessed by measuring the fat percentage and the muscle mass. Skin fold thickness methods have been used to determine the subcutaneous fat. As discussed above, our body is mainly composed of two types of fat: Body fat, and Non-fat mass.

Body fat is found in muscle tissue, under the subcutaneous fat deposit or skin, and are also present around the visceral fat i.e., organs. These are the essential fats that helps protect body's internal organs, stores energy that act as fuel and also normalizes body hormones which are important for our body. Whereas, Non-fat mass areas (also called as lean tissues) include muscle, organs, tissues, water and bone. These tissues are metabolically active as they help burn calories while body fat cannot do that.

Body fat percentage is used to estimate the total body fat on the basis of specific measurements and there are several ways to estimate it such as bio-electric impedance and Skinfold measurements. A skinfold caliper is used for the determination of skinfold thickness through which a prediction can be made of total body fat mass.

Harpenden Caliper
Source: www.harpendenskinfoldcaliper.com

Four skinfolds are generally used for determining total body fat:

Biceps Skinfold- It measures the skinfold thickness at the front of the upper arm at the level marked for taking the upper arm circumference. The landmark is

when the skinfold is picked up with your thumb and index finger directly above the centre of cubical fossa.

Instrument: Skinfold caliper

Method: The subject stands with the arms hanging freely on the sides of the body. The vertical fold with your thumb and index finger one centimeter above the upper arm circumference is lifted. The jaws of the caliber are placed on the folds and the reading in mm is recorded. The reading is noted when needle is at standstill approximately seconds of applying caliper.

Precautions

- ✓ Take care not to prolong the time of the application of the caliper to the skin because prolonging causes the displacement of the fat, hence erroneous reading.
- ✓ The hold of the pinch above the skinfold should not be loosened while taking the measurements.
- ✓ With the caliper, if the subject feels pain, this happens when muscle is also pinched along with subcutaneous fat.

Triceps Skinfold: It is measured in the midline of the posterior surface of the arm, over the triceps muscle in vertical direction at a point half way on the line connecting the lateral projection of acromion process of the scapula and interior margin of the olecranon process of the ulna

Instrument: Skinfold' caliper

Method: The subject is asked to stand erect with arms in standard arm hanging position. Remember this is the skinfold thickness measured over the triceps in the middle of the posterior aspect of the arm at the level of the upper arm circumference or the biceps skinfold, in the line with the olecranon process. The skinfold over the triceps muscle of the right arm, one cm above and one cm below the marked point on of the upper arm midway between the acromion process and the superior border of the radius in line with the olecranon process is picked. Keep the jaws of the calipers at the marked level and note the value. The folds should be parallel to the long axis of the arm.

Source: www.KinanthrEometric_Asses.pdf

Precautions

- ✓ The arms should be hanging loosely and freely at the side of the subject.
- ✓ The caliper should be placed parallel to the mid-circumference line.
- ✓ While taking the measurement the pressure of the caliper should be released slowly.
- ✓ The reading should be taken in 4 seconds and the reading recorded to the nearest 4> millimeter

Subscapular skinfold – It is measured as the fold inferior to the inferior angle of scapula, at natural cleavage. The subscapular skinfold is lifted at 45 degrees to the horizontal plane.

Source: www.KinanthrEometric_Asses.pdf

Instrument: Skinfold caliper

Method: The subject stands erect with shoulders relaxed so that the upper extremity is hanging loosely. Standing behind the subject, palpate the vertebral border of the scapula with fingertip running down laterally until the inferior angle is identified. If the subject is obese, the subject is asked to fold hand at the back, this way it it is easier to pick the fold. The subscapular skinfold thickness is measured below the inferior angle of the scapula. Using thumb and index finger, skinfold lightly below the most inferior angle of the right scapula is picked. The skinfold usually is slightly inclined' pointing downward and laterally in the natural cleavage of the skin. The jaws of the calipers are applied at the marked level and note the reading.

Precautions

- ✓ The subject should stand comfortably erect with loosely hanging upper extremity.
- ✓ The caliper should be placed parallel to the mid-circumference line.
- ✓ While taking the measurement the pressure of the caliper should be released slowly.
- ✓ The reading should be taken in 4 seconds and the reading recorded to the nearest millimeter
- ✓ For all these measurements, subject is required to sit or stand in an upright position.

It is quite interesting to note that for all these measurements, subject is required to sit or stand in an upright position.

Practice 4

What precautions are required for taking biceps skinfold?

Mid Upper Arm Circumference (MUAC), the accurate and a reliable way to measure fat-free mass, is the upper arm circumference at the midway between the tip of shoulder and the tip of elbow on the left side of arm. The mid arm point is assessed by measuring the distance from the tip of the shoulder to the elbow and then dividing it by 2.

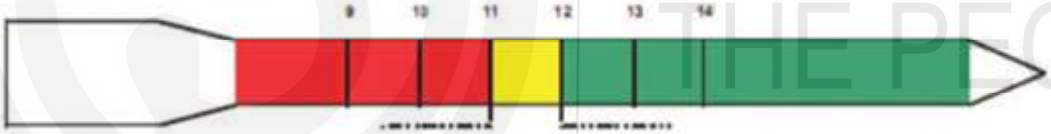
What to do in case you want to screen large number of populations? MUAC helps in the screening of large number of individuals (majorly at the community level) for community – based nutrition involvements such as Outpatient Therapeutic Programs (OTP) or during the emergent situations/circumstances or supplementary feeding programs. This anthropometric screening tool is also used for children, pregnant women for SAM i.e., severe acute malnutrition and MAM i.e., Moderate acute malnutrition.

MUAC Measurement in Children – To measure the MUAC of children, a special tape is used that has 3 colors: red, yellow and green. Each color indicates different nutritional status.

Red: Severe acute malnutrition

Yellow: Moderate acute malnutrition

Green: normal nutritional status



MUAC Measuring Tape

Source: Unicef Technical Bulletin No. 13

There are some specific cut-off values which are used for the screening purposes in the community-based interventions for SAM and MAM using MUAC

Target Groups	MUAC	Malnutrition
Children - < 5 years	11-11.9	Moderate acute malnutrition (MAM)
	<11 cm	Severe acute malnutrition (SAM)
Pregnant women/adults	17-21 cm	Moderate Malnutrition
	18-21 cm (with current loss in weight)	Moderate Malnutrition
	<17 cm	Severe Malnutrition
	<18 cm (with current loss in weight)	Severe Malnutrition

***Source*:** WHO, 2009

1.4.2 Bioelectric Impedance

This approach is used in the measurement of body composition and in the assessments of healthcare system. The fundamental principles and the wide variety of methods in case of bioelectric impedance are used to interpret the obtained information. A large spectrum of utilization of bio-impedance is in healthcare system and facilities such as prediction of disease and the monitoring and keeping the status of all your body vitals. Biological tissues possess electrical properties which are categorized on the basis of electricity source which are:

- Active response - In case of bio-electricity, active response occurs when the biological tissue aggravates the electricity from ionic activities inside the cells in the form of ECG i.e., electrocardiograph signal from the heart and EEG i.e.; Electroencephalograph signals from the brain.

- Passive response - It arises when the simulation of biological tissues starts through an external source of electric current.

The biological impedance and the bioimpedance is the ability of a biological tissue to obstruct the electric current. Number of studies have been conducted on the analysis of bio impedance and related to its applications in assessing the composition of body and estimating the clinical conditions. This is due to its intrusiveness, the low cost and portability of bioimpedance analysis. The bioimpedance is measured from the entire body and its segments individually through the use of single and multiple frequencies, and analysis of bioimpedance spectrograph.

Application of Bioimpedance analysis

Let's have a look at significance of bioimpedance analysis. In healthcare facilities, bioimpedance helps in estimating the body sections to evaluate and monitor the consistent changes in nutritional status in in-patients and also observing the risk related to their nutritional status in out-patients. Various techniques such as BMI, skin fold and weight measurement in water are used for assessing the body composition. All these methods are used to estimate the fat mass and fat free mass, thus bioimpedance analysis can predict the total number of body fluids that is considered very useful for the prognosis of diseases/illnesses (Khalil, S et al, 2014).

1.5 NUTRITIONAL ASSESSMENT

In the above section, you learned majorly about nutritional assessment using the somatometry approach. This section discusses about the different methods of evaluating the nutritional status using dietary patterns and anthropometric indices.

Nutrition is considered as an important concept for preventive healthcare. An ideal nutrition level is the amount of food intake that promotes a good health. The nutritional level of individuals is interrelated to the status of diseases/illnesses and health. However, the calorie intake in excess amount leads to obesity whereas a small intake of calories results in the decrease of essential nutrients. All these changes results in biochemical alterations and eventually to clinical signs and symptoms. The requirements of nutritional intake are influenced by number of factors such as age, gender, physical activity, drugs, physiological status and

alcohol consumption. Nutritional status is considered as the main and important health indicator to determine individual's health.

The main and the direct causes of malnutrition are:

- poor consumption of food and
- regular attack of diseases and infections, thus low defense system.

There are various indirect causes of malnutrition as well, they are:

- Low production
- Lack of awareness
- Less power of purchasing
- Poor sanitation and personal hygiene
- Highly prone to infections and diseases

Remember malnutrition is both undernutrition and over nutrition.

Importance of Assessing Nutritional Status

Assessment of nutritional status is imperative for the purpose of screening and identifying and also for the population that are majorly affected by malnutrition. This concept is found to be very useful in formulation and the development of nutritional involvements and awareness and they also help in evaluating the impact of these program at a community based and individual level.

As per the reports of World Health Organization (WHO), the main objective of assessing nutritional status is the improvement in the human health quality. There are two approaches which can be used for assessing the nutritional status: Direct and Indirect methods.

- Direct Methods: The assessment of nutritional status is conducted using different methods/approaches which are:

  Anthropometry - A

  Biochemical methods – B

  Clinical methods, and - C

  Dietary methods - D

Remember this as 'ABCD'

- Indirect Methods: These methods involve the statistical data that are obtained from the demographic and census data, and from other important sources such as population density and per capita income.

Here we will consider Anthropometry – A and Dietary methods – D. We have already dealt with Anthropometry-A in earlier section. Refer to the section and here will go through very briefly.

1.5.1 Anthropometric Indices

Anthropometry that we discussed earlier, originates from two words: *Anthropo* means human and *metry* means measurement. Anthropometric measurements are used to assess the nutritional status in community by recording growth or

changes in the composition of body. All methods are useful, however, no single method provides a comprehensive view about the nutritional status of the population and thus, it sometimes becomes important to use a mixture of methods. At the time of using combination of approaches, one should always keep in mind the objectives and accessibility of resources (Omage and Omeuemu, 1890-1897).

Anthropometry is an effective, non-invasive and quite inexpensive method that is available to determine the body size, proportions and human body composition. The most important and utilized measurements are:

- Height/Weight
- Weight
- Mid Upper arm circumference (MUAC)
- Head Circumference
- Chest Circumference
- Waist circumference

Most of the measurements have been discussed in the above section. Go through the section carefully for Height/stature, weight, circumferences at mid upper arm and waist. In this section we will learn about Head and Chest circumference.

Head circumference – It is the maximum circumference of the head taken just above brow ridges. It is the measurement of head done along with the supra orbital ridges i.e., the forehead anteriorly and occipital prominence posteriorly. Occipital prominence is the bulging and protruding part on the back part of the human head that you must have noticed.

Instrument used: Flexible steel tape

Method: The subject sits down and the tape is placed around the head above brow ridges and adjusted on the back of the head such that maximum circumference is recorded.

In case of assessing the chronic problems related to nutritional status in children below than 2 years of age, head circumference measurement is helpful because brain grows faster during the initial 2 years of life. But after completing 2 years, the brain's growth becomes more inactive and at that time head circumference is not found to be useful.

Precautions

- ✓ Measurement tape should not be too loose or too tight
- ✓ Keep the head straight.
- ✓ Tape should be kept horizontal

Chest circumference (CC) – It is the circumference of the chest measured at the level of union of third and fourth sternebrae. The measurement should be taken at the end of normal expiration

Instrument used: Flexible steel tape

Method: The subject should stand erect with tape running around the landmark mentioned above. Care is taken to keep the tape horizontal.

Measuring chest circumference is of great value for determining growth in the 2nd and 3rd years of life.

Precautions

- ✓ Measurement tape should not be too loose or too tight
- ✓ Tape should be kept horizontal
- ✓ Tape should be touching the body.

Indicator is an index or a scale that shows weight-for-age or weight-for-height. When all these scales combined with a particular cut -off values, then in that case it helps determine the nutritional status of a child (whether the child is undernourished or malnourished).

Let's understand this with an example.

A child whose weight for height or weight for age, falls below the specific cut-off values as shown here in the following table.

CC ratio <1 in children (6 months to 5 years)	Under-nutrition
CC ratio > Head Circumference for children (1 year to 5 years)	Protein energy malnutrition

Source: WHO 2006

This table represents whether the child is undernourished or malnourished. All these anthropometric indicators are used for the assessment of nutritional status, to determine the involvement or to enroll children to an involvement program i.e., the treatment package and then to discharge them from a program. If you got to understand how to use all the indicators then, planning an effective intervention will be easy.

Similarly, table below illustrates the use of indicators for individuals and children who are underweight, or suffering from wasting and malnutrition on the basis of weight and height of children relative to their age.

Specific cut offs of BMI in Kg/m^2	Nutritional status
>40.0	Very Obese
30.0-40.0	Obese
25-29.9	Overweight
18.5-24.9	Normal
17-18.49	Mild chronic energy deficiency
16-16.9	Moderate chronic energy deficiency
<16.0	Severe chronic energy deficiency

If an adult is having BMI < 16 $Kg/m^{2,}$ then he/she cannot perform a vigorous physical activity or exercise because of their low energy storage. Moreover, they will be more prone or susceptible to infections/diseases due to their low immunity.

1.5.2 Dietary Methods

It is important to identify the energy and nutrient requirement by studying the changes in body growth and maturation. Nutrition and the dietary practices pose

a major influence on the development of an individual from infancy to old age. As we all know, a sufficient amount of food intake and nutrient (i.e., the basic nutrients such as proteins, fats, vitamins, carbohydrates, and minerals) is important for a normal growth (American Dietetic Association, 2005). Taking inadequate and improper nutrition at any phase of life affects the body adversely. Because of not having sufficient diet, various communities are suffering from several diseases – overnutrition in adults (majorly in old aged individuals), and under-nutrition in infants, children, and in women. Anthropometric assessment is one of the most common approach to determine the nutritional status of a population because of its ease in comparison to other methods, reproducibility, and obtainability of standards on the basis of normal population for the purpose of comparison and forming association between clinical illnesses and abnormal measurements.

Genetic and environmental factors involving the dietary intake influences the height. Stunting reflects the cumulative impact of under nutrition in the past.

To assess the dietary methods for determining the nutritional status, one should always include the analysis of past or current food intakes, or the nutrient consumption by an individual or a group of population. A questionnaire is prepared in which you can ask about the family, (mother or the child) members dietary history like what have eaten over the past 24 hours. Then, after recording all the data, calculate the dietary diversity score (Kapoor et al 2012; Popkin 2002; WHO,1966).

Dietary Diversity- It is measured by the number of food groups which are consumed over a period of 24 hours i.e., reference period. Usually, there are six type of food groups which are required by our body on a daily basis.

Requirement of Nutrients at different stages of life

It is very important to consume healthy food at every stage of life. Most importantly, a pregnant woman should have a good nutritional intake that helps both: the mother and the fetus. The adequate supply of nutrients ensure that the baby grow well in infancy time and after that as well. At the time of pregnancy, a women's requirements for certain nutrients increases in comparison to other and lack of those nutrients in her diet results in the low body weight. In the 2nd and 3rd trimester, pregnant ladies must have a good intake of calories and nutrients (WHO, 2010).

Dietary History

The data about the history of dietary practices can be collected from individual/ or families depending on their requirements. This method is of prime importance as nutritionists has reported that nutrition plays a vital role in the incidence of obesity, heart diseases and diabetes. Dietary surveys, are used in estimating the population and assessments of an individual, which is defined as the planned and a systematic study of the dietary consumption of individuals/population or communities. The methods can be both quantitative and qualitative.

The qualitative method includes the use of the food pyramid as discussed above to predict the requirements of food and its serving and intake, whereas the quantitative method evaluates the amount of energy and particular nutrients required for each food by using the tables of food consumptions. These kinds of

surveys are increasing in the nutritional epidemiology areas, clinical assessment, and population surveillance. Surveys are quite advantageous such as they are not that expensive, comparatively easy and objective.

Types of dietary surveys

- Twenty-four-hour recall
- Weight intake
- Food frequency questionnaire
- Food diary
- Dietary history

Twenty-four-hour recall: In this method, all the food articles are recorded which are consumed during the 24 hours and is used in wide scale nutritional surveys. This method involves the interview or questionnaire where the participant is asked to recall and is required to describe his/her food consumption in detail during the last twenty-four hours.

One of the most widely preferred participant for this method is housewife because she generally knows everything about the dietary practices of her family members. The investigator questions her to remember the type and amount of food intake, how the food is prepared and in what proportion the food is getting distributed to family members. Some of the measuring cylinders in the kitchen such as glasses, cups, spoons and bowls are used to help the participants in recalling the details.

This method has various advantages which are:

- ❖ Inexpensive
- ❖ Quick and easy
- ❖ Depends on short-term memory

The 24-hour recall method should be repeated two to three times where the individual who is being interviewed may be telling the truth is definite or not.

Weighed Intake Method: This method requires the involvement of investigator, when the subject is consuming food and the amounts of food are weighed before, during and after serving. The amount of food is also measured that is not eaten by the subject i.e., left-over food. Then the difference is calculated between the amounts of food that is served and not consumed that gives the amount of food that is actually consumed by the individual. One of the advantages of this method is its intensiveness whereas the disadvantage is that it is time consuming.

Food Frequency Questionnaire: This method is used to collect information about the long-term dietary practices. Individual is allowed to complete the questionnaire by themselves and then the filled form is sent to the investigator. In India, it is generally advisable to fill all the questions by the investigator by interviewing the subjects where the subject is asked about how often he/she consumes special food items. The responses are standardized so that the subject is only required to tick mark the correct answer. The frequency of eating food items is generally calculated as week/fortnight/month. The list of food should not exceed 150 items. The main merit of this approach is that this method is quick and inexpensive and also involves the coverage of more respondents.

Food Diary

Food diary is required to keep the records in a documented form about the dietary practices such as what all food and beverages are being consumed by the subject over a certain period of time. A time period of about 1 week can be used in the diary to predict the dietary intake. The method is reliable as sufficient number of days is covered by each subject. The subjects also take interest in filling up the diary.

The main disadvantage is that individuals are sometimes not able to estimate the quantity of food consumed accurately. The subject concerned can also be illiterate. Moreover, diary making can be a cumbersome process.

Dietary History

In this, the dietary practices are recorded of the participants over a longer period of time. The investigator obtains a retrospective estimate of the food intake using this method. The time duration covered is 3 months to one year. The information is recorded either through interviews and/or questionnaires addressed to the subject. This method is not used in large scale epidemiological surveys.

Practice

What is the importance of nutritional assessment?

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