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Paper No. : 06 Human Growth Development and Nutrition

Module : 12 Human Growth curves of different body parts and tissues

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Description Of Module	
Subject Name	Anthropology
Paper Name	06 Human Growth Development and Nutrition
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Contents:

Learning objectives:

To study concept of human growth

Human growth curves of different tissues

HUMAN GROWTH

Growth and development are sometimes used together. But they are not exactly the same. Growth and development are characterized and defined by the way in which humans change in size, shape and maturity relative to the passage of time. Growth and development are independent, interrelated processes e.g. an infant muscle, bones and nervous system must grow to a certain point before, the infant sit up or walk. Growth generally takes place during the first 20 years of life and development continues after that. **Growth** is the physical change and increase in size and it can be measure. Indicators of growth include height, weight, bone size and dentition. **Development** is the increase in the complexity of function and skill progression. It is the capacity and skill of a person to function. Growth and development are independent and interrelated processes. **Maturation** is the sequence of physical changes that are related to genetic influence. It is independent of environment but its timing can be influence by environmental factor. The rate of person growth and development is highly individualized however is highly predictable.

Growth is a continuous process that determine by many factors. All human follows the same pattern of growth and development. The sequence of each stage is predictable, although the time of onset, the length of stage and the effect of each stage vary with person. Learning can either help or hinder the maturation process, depending on what is learned. Each developmental stage has its own characteristics. Growth and development occur in a cephalocaudal i.e starting at the head and moving to the trunk, the leg and feet. Growth and development become increasingly different. Certain stage of growth and development are more critical than others. Growth and development occurs in proximal to the distal direction i.e. from the center of the body outward.

Growth is affected by various factors. The following are the factors which influence human growth and development:

Heredity and environment: An individual does not grow beyond his inherent potential even in spite of extremely well enivironmental conditions. Genetics is the most important factor in determining the growth of an individual. Environmental factors like temperature, humidity, altitude etc greatly influence the growth of an individual. Man is best adapted to the environment in which he lives and every part of the body grows to the extent, suitable for the environment. Although the major factor controlled on growth is the heredity of the individual it may be said that the genetic potential of an individual is expressed differentially in different environments. It is very difficult to specify quantitatively the relative importance of heridity and environment in controlling growth under any given circumstances.

Nutrition: Malnutrition delays growth. It is well known that the individual living under good dietary conditions shows better growth rate than those from families living under poor dietary conditions. Children have great recuperative powers, provided the adverse conditions are not carried too far or continued too long. During a short period of malnutrition the organism shows its growth and waits for better times. When they arrive, groeth takes place unusually fast until the genetically determine growth curve is reached or approached. The fastest growing tissue suffer most during malnutrition.

Psychological disturbance: The adverse psychological conditions might cause a degree of retardation in growth. In recent years it has been clearly established that in certain individual under emotional stress, the growth hormone is inhibited. When taken out of the stressful conditions they began to secrete growth hormone again and have the usual rapid catch up growth.

Socioeconomic: Individuals from different socio economic levels, different body sized at all ages, the upper groups always being larger. The cause of these socio economic differences are multiple. Nutrition is almost certainly one, and with all its habits of regular meals, sleep, exercise and general organization. Home conditions are more related to the growth differences than are the economic conditions of the families and home conditions reflect to the considerable degree of the intelligence and personality of the individual. Smoking may also play a part. Babies whose mothers smoked during pregnancy, average of some 100 gms and 1 cm small than the others at birth, and the height deficit, though small is apparently persistent throughout the whole of childhood.

Race: There are racial differences in rate and pattern of growth leading to the differences seen in individual. These are clearly genetically determined, while others depend perhaps on climatic differences. Differences in size must be sharply differentiated from differences in shape, for the formal or relatively easily affected by malnutrition and the latter are not. Europeans who is starved throughout childhood ends up a small adult, but his skeletal shape is little affected, though he will be lacking in fat and, if the malnutrition has been severe and prolonged enough lacking also kin muscles. Climate has little direct effect on the rate of growth.growth in height is on average fastest in spring and growth in weight is fastest in autumn.

THE HUMAN GROWTH CURVE

Slow early growth occurs from the first emergence, or birth, which is followed by a long phase of rapid increase in body mass and maturation of organs, especially structural or somatic tissue that support the individual, up to about the time of puberty or reproductive maturity. Finally grows slows after reproductive maturation. Growth continues throughout life, so that the oldest individuals in the population are generally the largest. Growth is defined as an increase in cell production in a normal tissue or organ during early life and increase in the volume of an organ or tissue due to the enlargement of its component cells during later life, although increase in volume of the organ or tissue continues throughout life. The increase in cell production which increases the mass of the cell is known as hyperplasia and increase in the volume of the cell is known as hypertrophy. The growth curve which is plotted against age is sigmoid. The pre pubertal growth curve has accelerating phase and the post pubertal growth curve has decelerating phase. There are two curves of growth: distance curve of growth and velocity curve of growth.

Distance curve of growth

The distance curve describes the height achieved at any age which is usually known as a height distance" or "height for age" curve. It is the growth attained at some point of time. And these increased in height and weight with time can be revealed at some point of time. Here, the height achieved is described by the term "distance" because it is quite easy to understand, visualize and represent the increasing height of a child at any particular age and the progression towards the adulthood can be easily find out. The distance curve of growth is smooth and continous. For instance, in stature the distance curve of growth does not shows situations of no growth and a sudden increased. So, it is clear that growth is not a linear process i.e. we do not gain the same amount of height during each calendar year. The curve of growth has four distinct phases (as per an individual) corresponding to relatively rapid growth in infancy, steady growth in childhood, rapid growth during adolescence and very slow growth as the individual approaches to adulthood. Growth represents a most dramatic increased in size. The pattern of growth that can be seen from this curve is a function of the frequency of data acquisition. The total distance curve may be represented by several mathematical functions allow mathematical models to be applied to the pattern of growth. These models are in fact, parametric functions that contains constant or parameters. Once the appropriate function that fits the raw data has been found the parameters can be analyzed revealing a good deal about the process of human growth. For example, the two variables such as age (x) and height (y) being linearly related between, say, 5 and 10 years of age, the mathematical function **y=a+bx** describes the relationship. The parameter **a** represents the point at which the straight line passes through the y-axis and is called intercept, and **b** represents the amount that x increases for each unit increase in y and is called the regression coefficient. The fitting of this function to data from different children and subsequent analysis of the parameters can provide information about the magnitude of the differences between the children and lead to further investigation of the cause of the differences. Such "time series analysis is extremely used within research on human growth because it allows the reduction of a large amount of data to only a few parameters.

Velocity curve of growth

The pattern created by changing rates of growth is more clearly seen by actually visualizing the rate of change of size with time, i.e. growth velocity or height velocity. The term height velocity was coined by Tanner and was based on the writings of Sir D'Arcy Wentworth Thompson. According to him, the curve of rate of change of height with time shows a succession of varying velocities. From the velocity curve of growth, two growth spurts can be seen. The first of these growth spurts is called the juvenile or mid-growth spurt and the second is called the adolescent growth spurt. In fact, there is another growth spurt that cannot be seen because it occurs before birth. It is the increment in growth in a unit of time. Measurement of velocity of growth is more fruitful. It helps in early assessment of retarding factors of growth as well as prediction of ultimate growth.

GROWTH CURVES OF DIFFERENT TISSUES AND DIFFERENT PARTS OF THE BODY

Growth of different parts of the body does not follow a uniform pattern. The patterns of growth of diiferent body parts are described in the form of different curves of growthy. The majority of the skeletal and muscular growth curves follows the growth curve which is described for height. The dimension of the internal organs like the liver, the spleen and the kidneys do follow the same. But the brain and skull, the reproductive organs, the lymphoid tisssue of the tonsils, adenoids, and intestines, and the subcutaneous fat are some exceptions which do not follow the same curve of growth as the growth curves of height. The curve of growth followed by body as a whole is known as the general curve. The brain and skull follows a growth curve which is called as neural curve. The growth curve followed by the reproductive organs is known as the genital curve and the growth curve followed by the lymphoid tissues are called lymphoid curve.

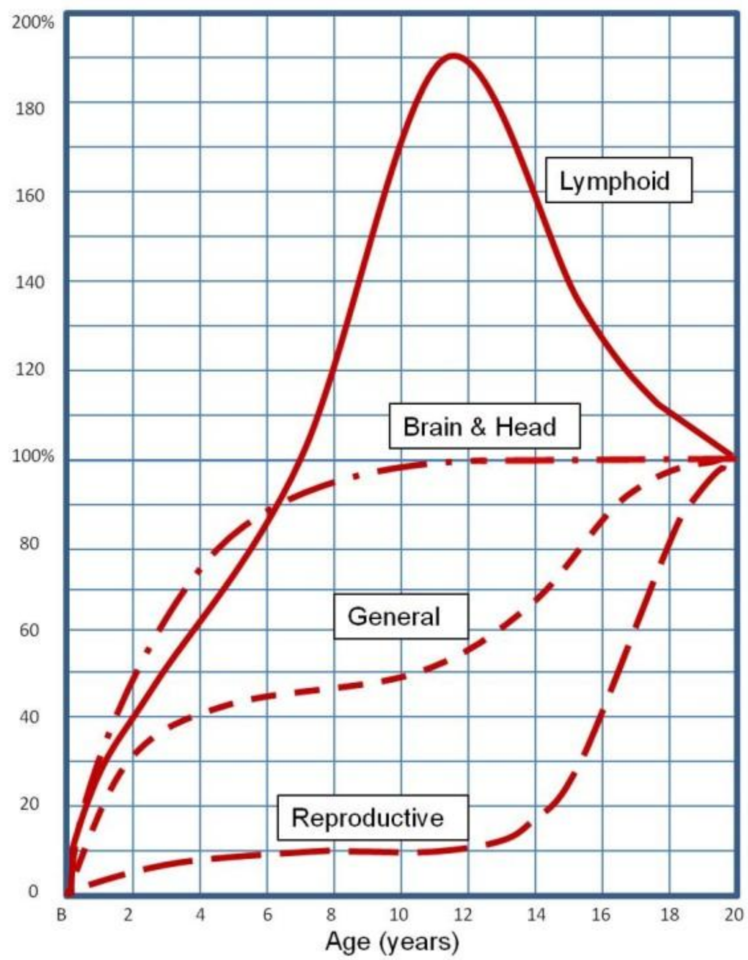

Fig 1. Developmental growth curves of different parts and tissues of human body each plotted as a percentage of the total gain from birth to 20 years of age.

General curve

The general curve of growth represents the overall changes in the dimensions of the body. They follow a curve which is perhaps not very different in principle, though strikingly so in effect. The general curve includes the growth pattern of most systems of the body, muscle mass, the skeleton (with the exception of certain parts of the skull and face), the respiratory system, the heart and blood vessels, the digestive system, and the urinary system. The general growth curve shows two growth spurts: one in infancy and another during puberty. There are usually four phases of growth pattern of the general curve which can be seen from the figure 1. They are: (1) rapid growth in infancy and early childhood, (2) steady but rather constant growth during middle childhood, (3) rapid growth during the adolescent growth spurt, and (4) slow increase and eventually cessation of growth after adolescence. The latter part of the curve continues into the third decade of life for most dimensions.

Neural curve (Brain and Head)

The neural curve shows the curve of the brain, nervous system, and associated structures, such as eyes, upper face, and parts of the skull. They developed earlier than any other part of the body and thus has a characteristic postnatal growth curve. These rapid growth of the tissues can be seen during the early phase of postnatal life. So, by the 7 years of age, almost 95% of the total increment in size of the central nervous system and the associated structures between births and 20 years of age is attained. A steady gain of the neural tissues can be seen can be seen after the age of 7 years. A small but definite spurt occurs in head length and breadth, but all or most of this is due to thickening of skull bones and the scalp together with development of air sinuses. The face follows a curve midway between that of the top portion of the skull and the remainder of the skeleton. It is nearer its mature dimensions at birth-later than is body-length, but has still a considerable adolescent spurt, which is greatest in the mandible. Thus the head as a whole is more advanced than the remainder of the body, and the upper part of it, that is, the eyes and the brain, are more advanced than the lower portion, that is, the face and the jaw. From figure 1, it is seen that the curve has an inclination till the age of 10 years and tends to stabilized afterwards.

Genital/reproductive curve

The growth pattern of the primary and secondary sex organs are characterized by the genital curve which is also called as reproductive curve. The ovaries, fallopian tubes, uterus, and vagina in females and the testes, seminal vesicle, prostrate, and penis in male are the primary sex characteristics. And the breasts in females, pubic and auxiliary hair in both sexes, and facial hair and growth of the larynx in males are the secondary sex organs. The growth of the larynx is also related to voice changes that occur during adolescence period of the male. During infancy, there is slight growth in the reproductive organs which is followed by a latent period during most of childhood stage. The extremely rapid growth and maturation of the genital tissues are experienced during the adolescent growth spurt. So in figure 1, it is seen that the curve is rapidly inclined during the age of 14-16 years.

Lymphoid curve

The growth pattern of the lymph glands, thymus gland, tonsils, appendix, and the lymphoid patches of tissue in the intestine are described by the lymphoid curves. The lymphoid tissue of the body is prominent at the time of birth, and it grows rapidly during childhood. These tissues are involved with the development of the child's immunological capacities and the resistance to the infectious diseases. During this ages, the lymphoid tissues are twice as they have in the adults. There is a decline in the curve of the lymphatic system during the second decade of life which is due to the involution of the thymus and tonsils at this time.

The subcutaneous fat layer also has a curve of its own, and is a complicated one. It can be measured by specially designed caliper applied to a fold of fat pinched up from the underlying muscle. At about 34 weeks, the subcutaneous fat layer started to grow in the foetus and increases from then until birth, and from birth until about nine months (in the average child, its peak may be reached as early as 6 months in some and as late as a year or 15 months in others). From 9 months, when the velocity is thus zero, the subcutaneous fat decreases, that is, has a negative velocity, until age 6 years, when it begins to increase once again.

Calculations from measurements of fat on X-rays show that the cross-sectional decrease is less in girls than boys, so that after age 1 year girls come to have more fat than boys. The increase from age 7 years or so occurs in both the sexes, in measurements of both limb and body fat. At adolescence, however the limb fat in boys decreases and is not gained back until the age of about 20 years. In boys, trunk-fat a much smaller loss, if any at all, occurs; there is only a temporary halt to the gradual increase. In girls there is a slight halting of the limb-fat increase, but no loss; and the trunk fat shows nothing but a steady rise until the age of discretion is reached.

Because body weight represents a mixture of these various tissues its curve of growth is often less informative than those of its component parts. In general, however, individual velocity curves of weight follow a similar course to the height curve. Though to some extent useful in following the health of a child, weight has the severe limitations that an increase may signify growth in bone and muscle, or merely an increase in fat. Similarly failure to gain weight in the older child may signify little except a better attention to diet and exercise, whereas failure to aim height or muscle would call for immediate investigation.

Richar Scammon's curve of systematic growth indicates that the nature of postnatal growth is differential which means the nature of general curve, neural curve, genital curve and lymphoid curve are not symmetrical.The rate of growth occurs in differents areas and tissues of the body are different with respect to time. Although somewhat simplified and diagrammatic, the four curves give a sense of order to the structural and functional changes that occur with the growth and maturation, however, with several exceptions. The craniofacial skeleton is one such exception. The upper part of the face, the orbits of the eyes, and the cranial vault follow the neural curve and complete a good portion of their growth when the child is about 7 years of age. The lower face, including the jaw, follows the general curve and has an adolescent growth spurt. Thus, the upper part of the face has a different growth pattern than the lower part.

The pattern of growth which was illustrated in the fig. 1 was demonstrated by De Montbellard's son and is only one of the several patterns of growth that are found within the body. It is believed that they are sufficient enough to demonstrate that lymphoid, neural and reproductive tissue have very different patterns of growth from the general growth curve that was initially observed. Neural tissue exhibits strong early growth and is almost complete by 8 years of age, whereas reproductive tissue does not really start to increase in size until the 13 or 14 years of age. The lymphatic system, which acts as a circulatory fluid demonstrates a remarkable increase in size until the early adolescent years and then declines, perhaps as a result of the activities of sex hormones during puberty.