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Module : 5 Factors affecting growth

ज्ञान-विज्ञान विमुक्तये

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Subject Name	Anthropology
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Content:

Objective: To study the factors affecting the growth in Humans and their relationship

1. Introduction

The term "Growth" denotes a net increase in the size, or mass of the tissue. It is largely attributed to multiplication of cells and increase in the intracellular substance. According to Hurlock, "growth is the change in size, in proportion, disappearance of old features and acquisition of new ones. Growth pattern of every individual is unique and different patterns in the body grow at different rates. From the earliest moments of life, the interaction of heredity and environment works to influence the growth of an individual. In the current scenario, lifestyle factors are playing an effective role on growth. Pre and post-natal growth is based on both hereditary and environmental factors which include lifestyle factors as well. Each factor must be in optimal state for the normal growth of a child. Also, some fetal conditions may affect postnatal growth too.

The genetic instructions a child inherits from his parents may set out a road map for development, the environment can influence how these directions are expressed, shaped and event silenced. The complex interaction of heredity and environment does not just occur at definite moments or at a definite periods of time; it is persistent and lifelong. This unit consists of three major factors influencing the growth including biological, environmental and lifestyle.

2. Biological factors influencing Growth

The height, weight and body-build of an individual always represent the subsequent of both environmental and genetic factors, together with their interaction. From the possession of a gene, it is a long way to the acquisition of a trait for instance the height of 2m. For its expression first gene depends upon the internal environment shaped by all other genes and secondly on the external environment. Throughout the growth period, genetic material seems to be operative.

2.1 Genetics of Size and Shape

Size and shape of an individual is independently controlled by genetical and environmental factors. The genetical mechanism of shape is too difficult than that of the size, because shape signifies primarily how the cells are distributed, while size characterizes more the sum of sizes of the various cells. The number of the cells is fixed early, in comparative safety of uterus; their size continues to change during most of the childhood, and in some cases, such as the fat cell, all through life.

2.1.1 Genetics of Size

From the Louisville data of Wilson, it has been shown in the table 1.1 that dizygotic same-sexed twins resemble each other genetically no more closely than any other brothers and sisters, since they arise each from a different fertilized ovum. The monozygotic pairs were in fact less similar than dizygotic at birth, but then this state quickly changed. Asymmetrical division of the original ovum, one twin getting just a little more cytoplasm than the other, and somewhat to their different positions in an overcrowded uterus could be responsible for differences between pairs at birth. The twin, who is smaller at birth, even if very little, ordinarily remains smaller throughout life. But if difference is large in size at birth, signifying some real intrauterine distress to the smaller twin, then the differences later are quite large.

Table 1.1 Mean differences between lengths of monozygotic twin pairs (140 pairs) and same-sexed dizygotic twin pairs (90 pairs) from birth to 4 years, and within pair correlation coefficient.

	Mean difference in length (cm) M Z pairs	D Z pairs	Correlation coefficient M Z pairs	D Z pairs
Birth	1.8	1.6	0.58	0.82
3 months	1.4	1.6	0.75	0.72
6 months	1.3	1.9	0.78	0.65
1 year	1.3	1.8	0.85	0.69
2 years	1.1	2.4	0.89	0.58
3 years	1.1	2.9	0.92	0.55
4 years	1.1	3.2	0.94	0.6

Source: Wilson, R. S. Concordance in Physical Growth for Monozygotic and Dizygotic Twins. Annals of Human Biology, 3:1-10.

The level to which height is under genetic control is revealed in the variation within families compared with the variation amongst a population when environmental conditions are suitable. Height is usually said to be controlled by many genes and hence it is a polygene effect.

2.1.2 Genetics of Shape:

Correlation of body measurements between parents and their children is higher than others as shown by many studies. For instance, in a study of 125 Belgain families, comprising 282 grown-up children, Sussane (1975) found the correlation displayed in table 1.2. in height each parent contributes equally to each offspring ;despite the belief that daughters resemble more to their mothers and son to their fathers. Interpretation of all these correlation is not entirely straightforward. Measurements which are affected by environment have low correlations. These differences cannot be understood until the development of each measurement is studied and the physiological factor =s controlling its growth are clarified (Tanner, 1990).

Table 1.2: Correlation between measurements of parents and offspring: 125 Belgain families.

Measurements	Parent-Child	Brother-Brother	Sister-Sister	Father-Son	Mother-Daughter	Father-Daughter	Mother-Son
Height	0.51	0.53	0.57	0.54	0.47	0.52	0.53
Arm length	0.49	0.37	0.51	0.47	0.57	0.53	0.39
Sitting height	0.37	0.21	0.35	0.41	0.39	0.29	0.38
Biacromial	0.33	0.42	0.46	0.09	0.5	0.33	0.41

diameter							
Bi-illiac diameter	0.49	0.49	0.45	0.51	0.53	0.43	0.49
Head breadth	0.35	0.37	0.32	0.42	0.33	0.41	0.22
Head length	0.28	0.36	0.44	0.18	0.40	0.17	0.37
Nose length	0.31	0.00	0.44	0.32	0.26	0.34	0.35
Interpupillary breadth	0.38	0.34	0.43	0.32	0.40	0.42	0.38
Ear height	0.31	0.26	0.43	0.24	0.33	0.32	0.39

Source: Sussane, C. 1975. Genetic and Environmetal Influence on Morphological Characterstics. Annals of Human Biology,2: 279-288.

2.2 Effect of Hormones on Growth

Endocrine glands are pool of cells that manufacture chemical agents and release them into the blood stream-the hormones. The endocrine system is one of the chief agents for translating the instructions of the genes into the reality of the adult form, at the pace, and with the result, permitted by the available environment (Tanner 1990). Some hormones act on cells very close to their origin and do not enter the blood; some enter the blood but only in a special portion of the circulation designed to carry them a short distance to their target; and some enter the general blood-stream and are carried in it all over the body. Hormones play an important role in the control of human growth. Some of them are discussed below:

2.2.1 Growth Hormone (GH)

Growth hormone is one of the most essential hormones for normal growth from birth to adulthood. Deficiency of GH ends in children ends up as adult in shorter height than their normal counterparts. Nowadays Growth hormone can be extracted from pituitary glands and can be administer to such children by injection, after that they can grow normally. GH is distinctly species-specific. Majority of the time the secretion of GH in the blood of children as well as adults are so low that it is scarcely detectable, but few times in each 24 hours the levels escalates for periods of the order of 30 or 60 minutes. GH habitually secreted some 60 to 90 minutes after sleep begins, and usually in response to anxiety and exercise.

The secretion of GH is different in different individual. Differences between normally large and normally small children and adults are perhaps due to receptors in the cartilage cells which control size. Besides, normal small children have plenty of GH and they are not turned into normal big ones by being given GH in excess. In healthy children blood levels of somatomedin do not reduce with age to parallel the velocity curve, but, amazingly, increase from infancy to puberty. Thus, the normal velocity of growth depends on a more elaborate level of control.

2.2.2 Adrenal Hormones:

The adrenal gland secretes a wide variety of hormones. This gland comprises of an inner core, the medulla and an outer shell, the cortex. The two are distinct from a functional point of view, and the medulla, which secretes mostly adrenalin, contributing little to growth. The adrenal cortex secrets three groups of hormones:

Glucocorticoids (corticoids): This cortisol raises the formation of glucose from protein and has an anti-inflammatory and anti-stress action. Normal amount of cortisol may not play ant role in controlling rate of growth, but if given in excess of normal, it slows up growth in height and retards skeletal maturity, and causing an increase in fat reflecting an antigrowth action.

Mineralocorticoids: These are aldosterone and to a smaller extent II-deoxycorticosterone. Aldosterone is necessary to life, but then has no direct bearing on growth.

Androgens: These are responsible for some changes of puberty and may maintain the presence and size of some secondary sex characters, including muscle bulk. The peak levels in the blood are in early adulthood; after which the amount declines and by ages 60 to 70 returns to pre-pubertal values. The main hormone of this group isdehydroepiandrosterone. In girls they are responsible for adolescent growth spurt and for the growth of pubic and axillary hair.

2.2.3 Testosterone and Oestrogens

These are sex hormones. Testosterone is a male sex hormone and secreted by the Leydig cells of testis. On the other hand, oestrogens are known to be female sex hormone and secreted by ovaries. The first is in the fetus, where the rise begins at about 11 postmenstrual weeks and last probably till birth. During this time the testosterone first causes differentiation of the external genitalia to form a penis and scrotum, and then sustains the further growth of the penis. It may also have an action on brain, differentiating the hypothalamus irreversibly to the male, non-cyclic, type(Tanner, 1990). Oestrogen level is low till puberty in females. A large increase occurs then resulting in growth of the breasts, uterus and vagina, and development of the associated vaginal glands. It is also responsible for growth of parts of the pelvis. During menstruation oestradiol levels fluctuate regularly with the phase of the cycle, the secretion of Oestradiol is controlled by pituitary FSH (follicle-stimulating hormone).

2.2.4 Gonadotropins

FSH (follicle stimulating hormone) and LH (Leydig-cell-stimulating hormone) are the two pituitary hormones. Both secrete at low level in childhood and increase sharply at puberty. FSH in males causes growth of the seminiferous tubules, the sperm-producing parts of the testis. FSH is necessary for the growth of sperm, just as it is for the growth of the eggs. On the other hand, in females LH interacts with FSH to control the menstrual cycle. The egg grows under the influence of FSH and is shed. LH stimulates the body to produce the hormone progesterone, which maintains the uterus in a state receptive to the implantation and growth of the ovum should it be fertilized; if not fertilization and implantation occurs, LH levels decline, the uterus sheds its lining in menstruation and cycle starts again (Tanner, 1990).

3. Environmental factors affecting Growth:

The prolonged period of biological immaturity, has keen sensitivity to the environment resulting in a plasticity of growth as a consequence of environmental interactions. The growth responses to the environment are part of

the adaptive potentials of human beings. In the past, demographic parameters were appropriate to the conditions of the environment and, when disease and malnutrition occurred though acute, they tended to be short-term. But in the current scenario, many populations exist under conditions of great social and economic disadvantages, with overcrowding, poverty, malnutrition and disease. Under these circumstances, environmental stress and deprivation, while ranging from moderate to acute, are chronic and intractable in the short term. This situation is exacerbated by the forces of acculturation in which cultural values alter in response to changing norms.

3.1 Effect of Nutrition:

The growth of an individual to its inborn potential exponentially depends on adequate supply of nutrition. In includes total energy intake and intake of energy yielding vitamins, micronutrients and minerals which we required for the growth, maintenance, repair and work during the course of human life. A child with nutritional growth retardation reaches a new energy equilibrium phase between genetically determined growth potential and the present energy intake. Thus, growth deceleration is the adaptive response to suboptimal energy intake but inadequate energy intake for a longer period of time evidently results into energy disequilibrium.(Rogol et al, 2000).

The deficiency of essential nutrients results in growth retardation, but chronic undernutrition in children retards the growth in height and weight and delay rate of maturation towards adulthood. However the delayed maturation may allow for some "catch up growth". Since improvement on diet also followed the same path, it is likely that the growth recovery was, in large part is due to better nutrition. For example , the rural Indian boys with severe growth retardation in early life achieved a peak height velocity (6.9cm/yr) similar to British boys (7.3cm/yr), though the event was postponed by 2 years from 14 years to 16 years. Despite their longer period of growth, the malnourished boys were significantly shorter than the better nourished British boys at the age of 18 years (Satyanarayan et al., 1980). Similarly micronutrients malnutrition which is characterized by the lack of essential vitamins and minerals affects children's immune system as well as their physical and cognitive development during formative years of growth. For instance, Bhat (2009) evaluated the casual link between the access to iodized salt and child health and proposed the positive effect of access to ionized salt on children's height for age, especially for children living in rural areas. Also Bhatia and Seshadri (1993) evaluated the effect of iron supplementation on growth status of anemic and normal preschool children aged 3-5 years. They found that iron supplementation resulted into weight gain and significantly higher weigh for height, among anemic children than anemic children on normal diet.

According to a study by Mamidi et al. (2011), in which they used the WHO growth standards 2006 from the available datasheets of NHFS-1 and 3. This survey provide information on three indices of children's nutritional status: height-for-age(reflect long term malnutrition), weight-for-height (reflect short term malnutrition) and weight-for-age(reflect both acute and chronic malnutrition). The study revealed that about half of the total faltering that had taken place by the end of first three years of life was present at birth and much of the growth faltering in early life could be attributed to faltering in height-for age i.e. stunting

3.2 Effect of Climate and Seasonal Variation:

The effect of climate on Human growth and development is often measured by variation in body size and proportion. There are two basic ecological rule of biological adaptation to thermal environment: Allen and Bergmann. The Bergmann rule states that, "within the same species of warm blooded animals, populations

having less bulky individuals are more often found in warm climates nearer to the equator, while those with greater bulk, or mass, are found farther from the equator in colder regions."

According to Allen's rule among warm blooded animals, individuals in populations of the same species living in warm climates near the equator tend to have shorter limbs than do populations living farther away from the equator in colder environment.

Schreider (1964) on the basis of height and weight data from populations residing at different latitudes found that body surface area increases from colder to hotter climate. Similarly based on world-wide sample, Roberts (1953) found a negative correlation between body weights and mean annual temperature that is, higher body weight in colder regions as stated in Bergmann rule.

As the climatic variation influences the growth rate, similarly the seasonal variations also have subsequent effect on growth.at temperate latitudes; healthy well-nourished children grow more quickly in height during the spring and summer while fall or winter is the season of maximum weight gain. The sunlight synchronizes the body's fluctuations in growth regulating hormone activity so that all the necessary hormones are working simultaneously to speed-up or slow-down the rate of skeletal growth.in an experiment Nylin (1929) tested the sunlight effect on a sample of Swedish boys of Stockholm. He exposed 45 boys to sunlamp during winter and compared them with the normal sunlight taking population of 292 boys. He found that experimental group averaged 1.5 cm more growth in height than the control group.

The seasonal variation in the rate of growth in weight could be explained by seasonal food shortages and disease experienced by Gambian population. Weight growth is clearly due to increases and decreases in energy balance during the year. There has been considerably more agreement regarding the significance of seasonal variation in the intake of fat and carbohydrates. Carbohydrates and fat have a peak intake during winter and minimum in the summer. In both China and India variability in micronutrients, such as beta carotene, was larger than macronutrients (Hebert et al.,2000; Cai et al., 2004).

3.3 Effect of Socio-economic status on Growth:

An individual's growth is the reflection of the bio-cultural environment in which the individual conceived and developed. This environment is associated with the socio-economic status included educational background, purchasing power for food in turn nutrition, access to and use of health care facilities and programs, and lifestyle. Among all mother's education plays an important role during pregnancy and also child rearing which can affect the children's nutritional status, well-being and survival.

Verma et al. (1980) carried out the nutritional anthropometry of preschool children of poor socioeconomic status in rural setting of Uttar Pradesh, India. Weight for height for age of the boys and girls were below the international standard. Also, height fro age indicates the past nutritional history, these underweight children had suffered growth failure either for a short period at an early age or for longer period at a later age. According to Hunshul et al.(2010) there is a positive relation between family income and physical growth imply inaccessibility of the economically deprived parents to provide quality nutrition, medical care and opportunities necessary for proper physical growth of children.

In a study by Johnston et al.(1980), it was found that w and parents with smaller linear dimensions than better nourished children. Since small body size is likely to be the result of poor living conditions, the effect of

parental linear dimensions may itself be due to the low SES environment of the parents when they were children. Garn et al. (1983) called this Transgenerational influence of ow SES the effect of "recycling of poverty".

Also there are evidences that a girl's age at menarche is effected by the environmental condition of growth and girls from higher SES usually have an early age at menarche as compared to the girls with low SES.

3.4 Effect of pollutants on growth:

A pollutant can be defined as a material or energy that is unwanted to some degree, is thought to interfere with health and well-being, and is produced by human activity either in part or entirely. Human physical growth may be adversely effected by pollutants, even at low to moderate doses. For instance, lead as a pollutant is very common these days especially in industrialized countries. It has been observed that lead effects the post-natal physical growth of the child. Among 5-13 years old children in the American Hispanic Health and Nutrition Examination Survey, those with lead levels between 11-40 micrograms per deciliter had a one cm deficit in stature compared to children with lower led level. Similarly polychlorinated biphenyls are another pollutant affecting the growth.

Studies in Netherlands, United States and Japan, it was observed that exposure during pregnancy to airport noise (a kind of energy) has a negative effect on the size of the baby at birth (Knipschild et al., 1981; Schell, 1981 and Wu et al., 1996). The fetus may be affected by the mother's reaction to noise stress, and the child could be affected directly.

4. Lifestyle Factors Affecting Growth:

Lifestyle is an individual's way of living or the style a person possesses in a particular set of attitudes, values, habits etc. lifestyle is multifaceted, it is multidimensional comprising of behavioral, socio-cultural and economic dimension of living. Due to urbanization and modernization in the developing countries, changes have been witnessed from traditional to modern way of life. When there is a movement from rural to urban, there are subsequent changes in the dietary and activity pattern. Consequently, affects the biological profile of individual and population in terms of health status and growth pattern.

4.1 Impact of lifestyle factors on prenatal growth:

Effect of lifestyle on prenatal growth is another way of saying the lifestyle of pregnant women. The environment of the woman's womb in which the fetus grows has to be favorable for survival and normal growth. Lifestyle of a pregnant woman may affect the fetus in many ways. For instance, in a recent study in Netherlands, it was observed that the mothers who smoked and did not consume appropriate folic acid supplements during first-trimester of pregnancy had fetus with shorter crown-to- rump length compared to those who did not smoke and had optimal use of folic acid supplements (Mook-Kananori et al., 2010). Also first-trimester fetal growth retardation is associated with increased risk of adverse birth outcomes, measured in terms of low birth weight.

The low birth weight babies can be of two types: (1) Infants who are 'preterm' (2) infants having low birth weight are "small-for-date" or "small-for-gestational-age" these infants have birth weights that are smaller than what is expected for their gestational age. This phenomenon is generally known as intrauterine growth retardation or fetal growth restriction (Malina et al., 2004). A variety of factors are held responsible for

intrauterine growth retardation. For developing countries like India tobacco use (smoking or chewing) and maternal malnutrition portrayed by low energy intake, together with insufficient consumption of micronutrients, and consequent low weight gain are the most important.

Consumption of alcohol is another important lifestyle factor which affects the fetus in several ways including restriction of fetal growth to a considerable extent. Roche (1999) observed that while consumption of 2 or less drinks a day by pregnant mothers led to a deficit of on an average 65 g in birth weight of their children, the same for the pregnant mothers consuming more than 2 drinks were found to deficit 150 g. it was also observed that higher the alcohol consumption by pregnant mothers, greater the prenatal growth restriction.

Other chemicals substances like caffeine, cocaine, heroin, methadone and the like have adverse effect on intrauterine growth. Substances abuse in the form of cocaine, heroin and methadone can lead to estimated deficit of 500g, 600g and 350g respectively in birth weight and 2.0 cm, 2.4 cm and 1.5 cm respectively in birth height (Roche et al., 1999). It is well stated that most of the factors responsible for influencing intra-uterine outcome as depicted by birth weight are linked to maternal lifestyles, exemplified by maternal nutrition status, maternal substance use status etc.

Physical activity including non-strenuous physical exercise is considered important to pregnant women for the benefit of fetal health and growth especially during first 6 to 7 months. However, some evidences exist on association between strenuous exercise and reduced birth weight in humans (Pivarnik, 1998).

4.2 Impact of lifestyle factors on post-natal growth:

After birth the fetus gets exposed to external environment and the new born starts adjusting and adapting newly introduced external environment. Human growth process is a product of intricate interaction among biological endowment and physical environment in which they are living and the socio-economic and political environment that humans create as a cultural being.

Demographic, economic and political reasons force people to migrate from one place to another. This naturally leads to changes in biological, physical and social environment and consequently lead to changes in many facets of life leading to changes in growth patterns. Several studies were undertaken to demonstrate urban-rural difference in growth profiles in terms of height and other anthropometric variables. Studies by Shapiro (1939) among Japanese children in Japan and in Hawaii by Goldstein (1943) and Lasker (1952) among Mexicans in Mexico are considered historical. They reflected the effect of migration on growth confirming contribution of developmental plasticity and its interaction with the changed environment settings. Shapiro's study demonstrated that improvements in diet regimen , health care opportunities and overall socio-economic status were result of migration and that these factors are associated with urban lifestyle and contributes to growth changes.

Diet and nutrition also plays important role in human physical growth and development. According to Bogin (1999) the growth and development of infants, children and adolescents are dependent on balanced nutritional intake. Rich nutrient food will undisputedly help human grow faster. Jenkin's (1981) emphasize ethnic differences in growth pattern as a result of differential access to socioeconomic resources and cultural practices. Poorer grow at a slower rate as compared to their counterparts belonging to high socioeconomic status. It has been demonstrated beyond any doubt that breast milk is the best food for the newborns and the infant as milk has all the nutrients they acquire. A recommendation from WHO suggests that infants should have exclusive

breastfeeding from birth to 6 months of age. Stinson (2000) observed that breast-fed babies grow faster than the bottle-fed babies during the first year of life, in the developing countries.

Physical activity as a lifestyle factor showed effect on growth extensively. Regular physical activity from early childhood paves way for good health for coming years i.e. in mid- or late childhood. Parental guidance in early childhood is an important determinant of physical activity, since the attitudes and lifestyles of parents decides whether the child is regularly physically active. Sallies (2000) argued about the fact that gradual decline in physical activity between childhood and adolescence is a robust epidemiological phenomenon. Social, environmental and biological factors are working in union for such a phenomenon to occur. Technological advancements, globalization with ensuing market economy, attitudinal modernization, cash flow and consumerism and the like have been prime factors related to such a behavior.

Stress, which is not a physical factor, but psychological and emotional factor acting negatively on child growth. This condition sometime called as "psychosocial dwarfism or deprivation dwarfism". It is found that such condition can lead to stunning and delayed maturity for three years. Factor responsible for such event could be maternal deprivation, isolation of the child, disorganized or broken family life, and also physical or mental abuse. Possibly this condition leads to suppression or impairment of growth hormone production and impaired nutrient utilization (Malina et al., 2004). Hulanicka (1999) found shorter height and early age at menarche among the girls experiencing family distress and consequently living I life with psychological stress.

5. Summary:

Humans are characterized by a heightened sensitivity to the biological, cultural and environmental factors. In the same way growth is affected by them all. The resemblance in human reflects the influence of genes that parents contribute to their biological offspring. This expression of a genetically inherited pattern of growth is regulated by many proteins that genes produce, and entire process is mediated by several biological systems, especially endocrine and neurological systems. The study of human growth in relation to natural environment is one of the vital areas in the study of human variation and adaptation. The sensitivity to environment is demonstrated by the ability of the process to recover, or catch-up, following episodes of disease and malnutrition. The influence of the lifestyle related factors on pre and post-natal growth and development of human population is well studied and documented in developed and developing countries. It has been observed that socio-demographic factors that shape lifestyles of social groups such as migration, urbanization, socioeconomic condition, rural-urban residence, as well as specific lifestyle-related factors such as dietary practices, physical activity pattern, psycho-social stress have been portrayed a relation with pre and post-natal growth in humans.