Anthropometric Perspective on Nutritional Status

S. P. Singh

INTRODUCTION

The natural environment of the world has undergone massive deterioration because of large scale pollution where both water and air need immediate attention. Apart from clean environment, home and shelter is another basic necessity of human beings. The number of homeless individuals now roughly stand at one billion which includes those living in refugee camps, insecure and temporary accommodations. Another one billion of the global population is devoid of any water supplies. In India, there are vast areas where even safe drinking water is not available. About 600 million people worldwide live in life threatening homes. The situation of air pollution has reached such a pass that about 3 million deaths are accountable to it annually. Besides this, heart failure, asthma and other cardiovascular diseases are also attributed to air pollution by carbon monoxide, sulphur dioxide, etc. The radiation hazards of man-made nuclear reactors have been projected to be horrifying keeping in mind the Hiroshima-Nagasaki episodes of World War II and the recent Chernobyl disaster. A large number of children have suffered from thyroid cancer in Belarus and Ukraine after the Chernobyl incident. About 500 million people are being exposed to pesticides directly or indirectly as a result of agriculture spraying. The pollution of water and food with pesticides and chemicals is increasing the risks of cancers and ill health and also affecting the growth and development of children.

Food insecurity, homelessness, lack of safe drinking water and polluted air are becoming the hallmarks of the environment of third world countries of Asia, Latin America and Africa. There is widespread malnutrition, impairment of physical and intellectual development, diminished working capacity and sub-optimal health of the residents of these continents. There seems to be a clear relationship of the undesirable factors listed above with the lowered health status of these populations. Anthropometry is emerging as an important indicator to evaluate the physical status of individuals and populations which in turn highlights, the nutritional status of the populations and the history of their economic development.

NUTRITIONAL STATUS-GLOBAL PERSPECTIVE

The total food availability for the world as a whole during 1961-63 was 2300 calories per person. It has increased to 2720 calories during 1990-92. Regional availability has also increased except for sub-Saharan Africa. The projected estimates for 2010 even for developing countries stand at 2730 calories per capita (WHO 1997). These average rosy figures rather point a gloomy picture. The number of malnourished and food-insecure individuals on the globe is alarming. Those who can not meet their daily needs of calories and proteins figure beyond 800 million. Besides more than 3 billion individuals are deficient in micronutrients such as vitamin A, iron and iodine (WHO 1997). Poverty and illiteracy have been the major factors responsible for malnutrition. However, both of them can be handled with appropriate social action and a strong will of the governments. The socialist countries have demonstrated this by eradicating atleast these two factors with grit and determination improving the health and nutrition of its population.

Acute malnutrition occurs also in emergency situations such as drought, warfare and mass migration of populations. The newspapers are full of poverty, squalor and malnutrition in areas under drought, in countries engaged in armed conflicts and situations of mass migration of populations as has happened during 1947 when millions of people lost their homes and had to start afresh. Overnutrition occurs in many situations of new found richness, in fast growing economies, as a result of acculturation, green revolution, etc. Expanding technology and modernization brings with it new values, new foods, new directions, social freedom and thrilling ways of enjoying life, which naturally had to take its toll in the form of overnutrition and obesity in its initial phases. While acute undernutrition brings with it lower levels of health and susceptibility to infections, overnutrition and obesity are generally inviting non-insulin dependent diabetes mellitus, hypertension and cardiovascular disease.

Optimal nutrition is essential for a perfectly healthy child whose growth and development is guaranteed. This is of paramount importance for the development of a healthy adult having optimal working capacity and normal reproductive performance. Such a person can lead happy life as he is protected from the infections by virtue of his healthy immune system. The consequences of an inadequate diet in a child would result in a subaltern work capacity and stunted growth, lowering of mental faculties and increased risk of mortality and morbidity.

Insufficient diet results in two types of metabolic nutritional disorders: protein-energy malnutrition (PEM) and micronutrient disorders (deficiencies). Long term inadequate food consumption cannot meet the daily energy requirements and results in thinness in adults and stunting in children. When there is a sudden and severe drop in food consumption, acute malnutrition in the form of wasting occurs. These two forms of nutritional deficiencies are called chronic undernutrition. Its causes include unavailability of sufficient food or access to food, inadequate care of mothers and children and recurrent infections.

The prevalence of micronutrient malnutrition is more severe than the PEM. Pregnant and lactating women and young children under 5 years of age are most vulnerable sections of society having the risk of iron deficiency. This is assessed from serum ferritin levels and is about twice as common as anaemia which is a late sign. On a global level, 3.6 billion people are iron-deficient and about 2 billion are anaemic (Table 1).

In children, even mild form of anaemia can affect intellectual development, limiting the physical, recreational and exploratory activities. However, iron deficiency is easy to correct by a combination of iron supplementation, iron fortification and dietary improvement.

Iodine deficiency is another important situation to be tackled. Constant iodine intakes less than 150 μg per person per day over a long period produces goitre and other metabolic disorders. Iodine deficiency cause the enlargement of thyroid and also brain damage to the foetus and the infant. It results in cretinism in severe cases with mental retardation. Iodine deficiency is spread in 118 countries affecting 760 million people. Iodine fortification in common salt has worked as a panacea in case of goitre and the world scenario is likely to present a happy situation in the near future.

Table 1: Frequency of world population affected by nutritional deficiencies (WHO 1997)

S. No.	*Condition*	*People affected*
1.	PEM	800 million
2.	Micronutrients' deficiency	3000 million
3.	Iron deficiency	3600 million
4.	Anaemia	2000 million
5.	Iodine deficiency	760 million
6.	Vit A deficiency	258 million

Vitamin A deficiency occurs when breastfeeding is reduced, or when food intake of dark green leafy vegetables, orange-coloured vegetables and fruits is low. It results in nightblindness and eventual blinding conditions. An alarming number of 258 million people are affected with Vit A deficiency and the highest prevalence occurs in South-East Asia. Dietary improvements and fortification of fats and sugars with Vit A and its supplementation are required to eliminate this deficiency.

Rickets in young children and osteomalacia in adults results from the deficiency of Vit D. Asia and Africa have a widespread prevalence of this deficiency besides scurvy, beri beri and pellagra, which are due to the deficiency of ascorbic acid, thiamine and niacin, respectively.

ANTHROPOMETRIC HISTORY AND ECONOMIC DEVELOPMENT

Today, the anthropometric historians claim that the mean heights of populations can be used as a proxy for the living standards of the people. As Tanner (1994) puts it

> the variation between the heights of individuals within a subpopulation is indeed largely dependent on differences in their genetic endowment ; but the variation between the means of groups of individuals (atleast within an ethnically homogeneous population) reflects the cumulative nutritional, hygienic, disease and stress experience of each of the groups.

Data on heights and weights has illuminated the relationship between industrialization and demographic processes and the role played by food consumption in the industrial revolution (Komlos 1994). The nutritional status of a population undoubtedly is influenced by the food intake which consequently depends on the family income and the price of food. A well known economist Steckel (1991) and Steckel and Haurin (1994) have found a positive correlation between height and income in many populations. While addressing the question whether height be regarded as an index of well-being superior to the other measures, Engerman (1994) opined, that modern living style is neither a pointer towards maximizing life expectency (prevalence of risk taking) nor increased per capita income leads to increased nutrition (atleast in rapidly changing societies) maximizing individual heights.

Steckel (1979) and Eltis (1982) found that the nutritional status of adult American slaves was relatively high than their compatriots left behind in Africa and the former were also taller than the latter. It reflects that even the most disadvantaged members of American society benefited to some extent from the resource abundance of the affluent America. They also shared a relatively favourable disease environment with their masters but were somewhat shorter than them. Another example of the indication of American richness during the eighteenth century came from the results of Sokoloff and Villaflor (1982) who found that the Americans of European descent were taller than their European counterparts.

Urban-rural differentiation in height which is obtaining in the present day industrialized societies (Eveleth and Tanner, 1990) has not been so during the preindustrial societies. Actually in the preindustrial societies the self sufficient farmers were generally taller than their urban counterparts and fared better than them nutritionally. It was only when the urban environment became better and hygienic were the urbanites taller than their rural counterparts. A self sufficient farmer is likely to consume more quantity of food and more varied in nature than an urbanite who is not only confronted with rising prices of food but also a deteriorating overall urban environment of that period. But generally children in most of the developed countries and in some of the developing world have shown tendencies of getting bigger and maturing faster during the last one hundred and fifty years (Eveleth and Tanner, 1990). These tendencies are popularly known as secular trends and have been well documented in different countries of Europe and America. These tendencies have coincided with the improved standard of living including good and nutritious diet, decreasing of the infectious load and the overall improvement in hygienic conditions.

Second half of the eighteenth century witnessed rapid economic growth in Great Britain, East-Central Europe and Sweden (Komlos, 1993). Similar type of situation emerged in the nineteenth century in Montreal and America (Ward, 1993; Ward and Ward, 1984). These were the great historic and economic milestones in human history and it is during these episodes that the human height has witnessed declines. It is here that the biological processes and the material standard of living has gone haywire and in opposite directions, diverging from each other. Fogel (1986) discovered that in the United States, the male birth Cohorts of 1830s as adults were more than two centimetres shorter than their counterparts. The male cadets in their late teens were also quite underweight during this period, when actually the economy was being refurbished and the net national product per capita increased by about 40% (Komlos, 1987). In the second half of 18th century in Habsburg, height declined by three to five centimetres (Komlos, 1985) and the birthweight was also falling in Montreal during this period (Ward and Ward, 1984).

These discoveries of cycles in human height has fascinated the biologists and economic historians equally. Komlos (1990, 1994) observed in Europe a widespread downturn in height in the second half of the eighteenth century and suggested it might have occurred in the American slaves at the same time. Another decline in stature occurred in the rather resource abundant America during 1830s. Both these downturns coincided with rapid urbanization and industrialization. The economic historians got clues to this downturn and were surprised to find a really functional indicator of such events in the form of height which has undergone declines. The reasons could include highly strenuous work, a tiring work schedule, shifting of the economic priorities from food to infrastructural development especially during the period of transition.

The consumption of goods is generally linked to the real wages of the people. But whether the quantities of food consumed are real indicators of the intake of quality of food or not is debatable. Sen (1981, 1987) emphasized that the standard of living be gauged in terms of functioning rather than the mere quantities of goods purchased or consumed. For instance, some measure of net nourishment would be preferable to food intake which may be adequate in quantity but lacking quality by means of micronutrients.

These findings need deep probing if the role of height as an indicator of economic development is to be seriously considered. Most of the economic historians consider that these periods of rapid industrialization were accompanied by a deteriorating overall epidemiological environment and the per capita nutrient intake had also shown declines (Cuff, 1992). So, the expanding economic scenario is rather putting the human organism to a biological stress. Though it seems paradoxical at first sight but its role in disentangling the situations of economic development on one hand and the lower food consumption associated with deteriorating urban environment, on the other hand, seems extremely useful in constructing the economic history.

CONTROL OF ENERGY HOMEOSTASIS

The present global situation of energy intake presents a picture where the number of people suffering from hunger and undernourished is almost equal to the number of obese and overnourished. Thus the problem of nutrition has posed two-way consequences to be combated (Campbell, 2000).

Biologically speaking it is assumed that the intake of energy equals the output of energy in living organisms in stable body weight situations. However, the consumption of food varies greatly not only from one meal to the next but also from one day to another. The factors involved in food intake seem to be numerous from the emotional state of the individual to the availability of food and the economic status besides the cultural milieau in which the person lives. Edholm (1977) revealed that the daily energy intake among individuals is highly variable and bears little, if any, correlation with daily energy expenditure. But if the energy balance in an individual is judged over a considerable period of time then the energy intake matches nicely with the energy expenditure. There seems to be an extremely efficient regulatory system which helps maintaining the stability of the amount of fat in the body (stored energy) and is usually termed as 'energy homeostasis'.

How this system operates ? It is a well known fact that a period of starvation is usually followed by an increased food intake or hyperphagia. The reduced body weight is redeemed as also the normal levels of energy intake, within a short span of time. Earlier it was postulated that the fat stores send inhibitory signals to the brain to limit food intake (Kennedy, 1953). But this hypothesis failed to account for the regulation of dietary intake between the meals. Gibbs et al. (1973) proposed that the peptides secreted in the gastrointestinal tract during a meal supply necessary information to the brain to stop eating.

Insulin secreted by pancreas acts on brain to limit energy intake and consequently the central nervous system controls the body weight (Woods et al., 1979) Leptin is another hormone secreted by adipocytes which participates in regulating adiposity among organisms. It is now accepted that both these hormones, viz., insulin and leptin circulate in blood in levels proportional to body fat content and subsequently percolate to the CNS in concentration equal to those in plasma (Bagdade et al., 1967; Baskin et al., 1999). The direct administration of these hormones to the brain inhibit food intake whereas their deficiency does the reverse (Porte et al., 1998). If weight increases, insulin must also increase in order to maintain normal glucose homeostasis which would put a check on further weight gain. But in case of failure of insulin secretion, type 2 diabetes with obesity is the usual outcome. On the other hand, the relationship of leptin secretion to body fat mass is governed by the glucose uptake and metabolism by the adipocytes through insulin stimulation (Wang et al., 1998).

Friedman (2000) has presented in detail the working of the hormone leptin in the arcuate nucleus of the hypothalamus for its expression on different neurons. Thus in the absence of leptin, one group of neurons (neuropeptide Y - NPY and agouti-related protein - AGRP) become maximally active and food intake increases whereas in the presence of leptin another group of neurons (proopiomelanocortin- POMC, cocaine-and amphetamine-regulated transcript CART) become active and the food intake decreases. The cloning of the first obesity gene, ***ob*** can be considered as a big breakthrough in obesity research. Several genes have now been identified which are related to obesity and diabetes in the ***ob*** pathway related to energy expenditure and satiety. With the completion of the entire human genome the functional genomics will open new vistas to the understanding and treatment of human disorders including obesity (Dhand, 2000).

Kopelman (2000) highlighted obesity as a major health problem in the new millennium which is related to numerous diseases. It results from a combination of genetic susceptibility, increased availability of high energy foods and decreased requirements for physical activity.

According to Barsh et al. (2000), the role of genetics in obesity is two fold, studying rare mutations in humans and model organisms provides fundamental insights into a complex physiological process, and complements population-based studies that seek to reveal primary causes. Approaches based on mendelian and quantitative genetics may well converge, and lead ultimately to more rational and selective therapies.

Studies have indicated that the signals for energy homeostasis regulate food intake by monitoring the meal size which require modulation of the responses to satiety signals in the brain (Woods and Strubbe, 1994; Flynn et al., 1998; Schwartz et al., 2000). The above biological systems seem to work under normal deviations in food intake. But if a person keeps on eating inspite of the satiety signals, then this system becomes taxed and gives in. Our modernised settings of social parties force the guests to consume extra quantities of eatables. On the other hand, the patients of *anorexia nervosa* simply refuse to eat as they always feel panicky about becoming overweight although they are not so and thus become thin, skinny and underweight. Therefore, not all deviations are caused by the failure of the biological system of 'energy homeostasis', but the onus of responsibility falls on the individuals themselves in many cases.

MATERNAL ANTHROPOMETRY AND BIRTH OUTCOME

Maternal anthropometric status has emerged as a good indicator of the birth outcome of the baby. It is a generally accepted fact that overweight women with excessive weight gain during pregnancy give birth to large-for-date babies. Among the various parameters of the pregnant mothers influencing birth outcome include the prepregnancy weight, weight gain during pregnancy, pregnancy weight gain at each trimester, skinfold thicknesses and limb circumferences (Alberman, 1984; Kramer, 1987, 1988; Defe and Partin, 1993; Vega et al., 1993; WHO, 1995; Backstrand, 1995). A prepregnancy weight of 40 kg is usually taken as a cut-off value in developing countries where the women carry a large risk of delivering low birth weight babies (Karim, 1998). In his meta-analysis, Kramer (1987) predicted an effect on birth weight of 20.3 grams per kilogram of pregnancy weight gain, in an average woman. Low pregnancy weight gain is also linked to foetal and neonatal mortality. WHO has given a standard of 2500 gm as the birth weight below which the baby is termed as low birth weight (LBW) irrespective of gestational age. But if gestational age is taken into consideration, then the cases of prematurity can be distinguished from intrauterine growth retardation.

The studies indicate that women with less than 40 kg of body weight at the end of 2nd trimester (6 months) had 2.1 times the risk of delivering severely low birth weight infants and 3.5 times the risk of severe stunting in their infants. It has also been shown that women with a prepregnancy weight of 38 kg or less delivered infants with an average birth weight of 2467 grams as compared to 2595 grams for women with a prepregnancy weight of 41 kg and more. The prevalence of low birth weight (LBW) babies as a percentage of all live births is not only interesting but an eye opener to us. China has only 4% of LBW babies of all live births compared to 28% of lower socio-economic strata of India. India's performance in this area is really dismal. Even African countries like Botswana, Nigeria, Lesotho and Gambia have reported the incidence of LBW babies between 10-12% of all live births.

Amongst a large number of indices, the Body Mass Index (BMI) has been really important in pregnant mothers in order to find out the pregnancy outcome. BMI of mothers has shown a linear relationship with birth weight of the newborn. In other words, it can be stated that the lower BMI of mothers is associated with lower birth weight of babies and a higher BMI with higher birth weight. Perhaps, BMI of mothers is a pointer towards identifying small for date, average-for-date or large-for-date babies.

The skinfold thicknesses and arm circumference are generally regarded as good indicators of nutritional status in pregnant mothers. These often find their usage in pregnant women while predicting birth outcome. Some studies have provided a cut-off of 23.5 cm of arm circumference below which the risk of low birth weight baby is considerable. Studies from Bangladesh indicate that arm circumference is slightly better than height, weight and pregnancy weight-gain in predicting the infant and foetal mortality.

The weight gain during pregnancy may not be considered as a one-way preposition. It rather requires a healthy and normal range; while a lower weight gain during pregnancy is invariably linked to low birth weight baby, the higher weight gain, on the other hand, is linked to unfavourable birth outcomes including labour abnormalities, caesarian section, macrosomia, meconium staining, etc.

ANTHROPOMETRIC INDICATORS OF NUTRITIONAL STATUS

Information about the nutritional status of an individual can be obtained from his body measurements. The minimum list of recommended measurements as given by Chumlea and Roche (1988) is as follows:

Healthy children and adults	*Handicapped adults*
Stature	Weight
Weight	Triceps skinfold
Triceps skinfold	Subscapular skinfold
Subscapular skinfold	Arm circumference
Arm circumference	Calf circumference
Calf circumference	Knee height

Weight for age, height for age and weight-height standards are available on numerous world populations through which the children can be screened for malnutrition. Children with deficit in height and weight carry health risks and it is now well understood that they have a greater chance of morbidity and mortality (Jelliffe, 1966; Vella et al., 1992; Schroeder and Brown, 1994). Cut-off lines have also been standardized for height-age and weight-age of children not only to distinguish between normal and undernourished ones but also to discriminate between acute and chronic under-nourished children (Waterlow et al., 1977; WHO, 1986, 1995). It is important to note that the age of the child should be precisely known for using the height-age and weight-age standards. But weight-height standards can be used even if the accurate age of the child is not known.

The weight-height standards can be used in identifying *wasted* children as well as acutely undernourished ones. Height-age standards are suitable in identifying *stunted* children but are not helpful in categorising wasted children. Detailed surveys of nutrient intakes in Himalayan regions have indicated nutritional inadequacies resulting in stunted growth of children (Singh and Sidhu, 1980; Singh, 1999). Weight-age standards fall in between height-age and weight-height standards in judging stunting, wasting and acute undernutrition.

A combination of weight and height, which is very popular in public health screening, is the Body Mass Index (BMI), which can be expressed as follows:

$$BMI = Weight (kg) / Height (m)^2$$

Reference standards of BMI on some populations are available for monitoring growth and development and also for judging normal, thin and obese adults (Cronk et al., 1982, Rolland-Cachera et al., 1982, 1991; Frisancho, 1990). There is a good likelihood that low values of BMI indicate undernutrition and higher the overnutrition.

WHO (1995) has provided standards of BMI with cut-offs for designating underweight, normal and overweight adults which are presented in table 2.

Table 2: Cutt off points proposed by WHO (1995) for the classification of overweight

BMI (kg/m^2)	*WHO classification*	*Popular description*
< 18.5	Underweight	Thin
18.5 - 24.9	Normal	Healthy, acceptable
25.0 - 29.9	Grade 1 overweight	Overweight
30.0 - 39.9	Grade 2 overweight	Obesity
> 40.0	Grade 3 overweight	Morbid Obesity

Underweight with BMI less than 18.5 has been further split up into three categories of chronic energy deficiency (CED) as mild, moderate and severe with cut-offs of BMI at 18.5, 17.0 and 16.0, respectively (James et al., 1988; Ferro-Luzzi et al., 1992).

Interestingly, the BMI values on the lower side in case of *anorexia nervosa* patients touch 15 or below. The heaviest reported men on earth have values of BMI around an unbelievable figure of 150. Generally speaking, very low values of BMI and very high values of BMI carry an increased mortality risk almost in all cultures (Waaler 1984; Bray, 1987). It seems as if nature is pruning the undesirable body weights which carry functional handicaps. While the role of BMI in diagnosing both undernutrition and overnutrition is indisputable, nevertheless, the cut-offs would vary from culture to culture (Campbell and Ulijaszek, 1994; Kennedy and Garcia, 1994). With advancing age, the BMI even among the normal population shows an uptrend and opinion is building to have age-based BMI statistics from adulthood to old age (James and Francois, 1994).

Gorstein et al. (1994) graded the weight-age, height-age and weight-height indicators from 1 to 4 indicating the best (1) and the least (4) usefulness of these standards (Table 3).

Table 3: The usefulness of weight and height measures.

Situations	*Weight for age*	*Height for age*	*Weight for height*
Usefulness in population where age is unknown	4	4	1
Usefulness in identifying wasted children	3	4	1
Usefulness in identifying stunted children	2	1	4
Sensitivity to weight change over a short time	2	4	1

Skin and subcutaneous tissue fold thicknesses reflect the amount of stored fat and energy reserves. The usefulness of skinfolds as indicators of malnutrition is based on the fact that the adipose fat storage is a function of positive energy balance. If the energy balance is negative then this storage depletes which is reflected in smaller thicknesses of the fatfolds. The subcutaneous tissue is compressible and a universal protocol of taking the skinfolds at a pressure of 10g/mm^2 is being followed. The intra and inter-observer measurement errors are generally considerable in taking skinfolds in comparisons to those of other body measurements. Insight into the actual amounts of body fat in babies and in adults has been provided by 42 cadaver dissections conducted during 19th and 20th century (Cameron, 1998). The information available from this direct assessment of body fat is presented in the box below. It highlights that the adult fat deposition is proportionally enormous as compared to that of the babies in both the sexes. It also highlights the sexual differentiation in the amount of fat where females have more than double the amount of fat possessed by men.

Life cycle stage	*% of fat*
Adult : Male	19.2
Adult : Female	38.2
Baby : Male	5.0
Baby : Female	15.0

Fat patterning reflects the sites on which the body has more amounts of adipose tissue. This is very different in the two sexes. Not only does it reflect the grey and bad areas but also carries association with cardiovascular diseases, hypertension and NIDDM. The role of 'centripetal fat patterning' is generally highlighted in the above mentioned diseases. Waist circumference and its ratio with hip circumference are good indicators of centripetal fat.

The upper arm circumference incorporates, muscle, fat and bone. The thickness of bone remains almost similar from 1 to 5 years of age. There is some decrease in the thickness of fat ring in the mid upper-arm whereas there is some increase in the muscle size. The effects of these two components seem to annual each other. It is fairly reasonable therefore to generalize that the mid upper arm circumference more or less remains similar during 1 to 5 years of age and hence can be used as an indicator for undernutrition during this age. This age-independence of arm circumference is useful in situation where ages are not known and also under emergency situations. Frisancho (1990) and Strickland (1990) have given this rationale alongwith the standards to use mid arm circumference for the purpose of identifying children who are undernourished.

Mid upper arm circumference and skinfolds at biceps and triceps find their usage in calculating the arm muscle area and arm fat area (Ulijaszek, 1997).

Arm muscle Area (AMA cm^2) = [(Arm circ.- π (Biceps + Triceps)/2]^2/ 4 π

Frisancho (1990) and Norgan and Jones (1990) have recommended the use of only triceps skinfold in calculating the arm muscle area and Arm Fat Area:

Arm Muscle Area (AMA cm^2) = Arm circ.- (π x Triceps skinfold)^2/ 4 π

Arm Fat Area (AFA cm^2) = (Arm circ.^{2}/ 4 π) - AMA

Vague et al. (1971) devised formulae to estimate adipose mass and muscle mass in arm and thigh and consequently adipo-muscular ratios in these regions of the body from body measurements.

The procedure for calculating the fat area and muscle area is similar to that used by Frisancho (1990). The only difference is that instead of using only the triceps skinfold, Vague et al. (1971) have used four skinfolds, viz., anterior, posterior, lateral and medial for the arm as also for the thigh. Thereafter, a ratio of adipo-muscular areas is calculated for arm (brachial) and thigh (femoral) and are called brachial adipo-muscular ratio and femoral adipo-muscular ratio. These two are used to obtain a mean adipo-muscular ratio. The percentage of adipose mass can be calculated as follows (Vague et al., 1971):

% Adipose Mass = Mean Adipo-Muscular Ratio
x Mean % age of fat in adipose tissue (0.80)
x Density of adipose mass (0.92)
x 100

Strickland and Ulijaszek (1994) found Arm Muscle Area as a very sensitive index of health in Sarawak, Malaysian adults and it emerged as a stronger index than Body Mass Index (BMI). But in the case of Calcuttans, Arm Fat Area (AFA), Arm Muscle Area (AMA) or percent of body fat were not as good in relation to BMI when morbidity risks were evaluated (Campbell and Ulijaszek, 1994).

Calf circumference and medial calf skinfold have also been tried to gauge the effect of under-nutrition. Study by Visweswara et al. (1978) on Indian children has demonstrated that calf circumference in association with calf skinfold really emerge as good indicators of protein-energy malnutrition especially when clinical signs of it are apparent and score better than arm circumference. The utility of calf circumference is also emphasised in older children engaged in physical and productive work where measurements on the upper part of the body alone may not be representative (Strickland, 1990). This has a greater significance in the developing world because even the young children take part in productive work and activities.

Apart from height, weight, skinfolds and BMI, waist-hip circumference ratios are being pressed into service to diagnose obesity and over-nutrition. This is also being associated with higher risks of non-insulin dependent diabetes mellitus (NIDDM), cardiovascular diseases and hypertension (Lev-Ran and Hill, 1987; Gerber et al., 1990, 1995; Yao et al., 1991, Freedman et al., 1995; Colman et al., 1995). Grading of waist circumference in men and women for increased risk and substantially increased risk of NIDDM, hypertension and cardiovascular disease have been provided by Kopelman (2000) and is given in table 4.

Table 4: Grading of waist circumference for risk of NIDDM, hypertension and cardiovascular disease.

Sex risk	*Increased risk*	*Substantially Increased*
Male	> 94 cm	> 102 cm
Female	> 80 cm	> 88 cm

Paediatricians use head circumference to detect pathological situations such as hydrocephalus, microcephaly or macrocephaly (Sullivan et al., 1991). Judged in the context of reference standards, it is important in diagnosing chronic undernutrition especially during the first two years of life (Hamill et al., 1979; Gibson, 1990). A relatively large head circumference as compared to length or arm circumference at birth is indicative of intra-uterine growth retardation especially in case of full-term babies. Head circumference is generally larger than chest circumference at birth. Since the growth of head circumference is slow as compared to that of chest circumference, therefore the latter overtakes the former in absolute terms sometime after birth. A ratio of head-chest circumferences is of great significance in detecting PEM. The Indian children (ICMR, 1972) on average, reach an equality between these two parameters at the age of about two years whereas the American children achieve this equality around 3 to 9 months (Sharma 1992). This shows a slow growth of Indian children where malnutrition is highly prevalent.

KEY WORDS Anthropometry. Energy Homeostasis. Nutritional Status. Malnutrition. Birth Outcome.

ABSTRACT Anthropometry is emerging as an important indicator of the physical status of individuals and populations which in turn highlights their nutritional status and the history of their economic development. A number of economic historians, sociologists, anthropologists and medical doctors have come together to address these issues where height cycles (upturn and downturns) have lots of information to offer on the economics of the nations. The human body grows naturally as a result of positive energy balance during childhood and adolescence but the body weight is generally maintained after that. The role of insulin and leptin alongwith a number of other molecules in their pathway to regulate energy homeostasis has been discussed. The anthropometric indicators of nutritional status include height-age, weight-age and weight-height standards. The importance of arm circumference, head circumference, chest circumference, skinfolds and waist-hip circumference ratio in judging the growth of children, malnutrition, overnutrition and obesity has been put in its proper perspective. The anthropometric indicators of the pregnant mothers serve the purpose of forecasting about the birth outcome too. The tendencies of present day generations of growing taller and bigger over their predecessors as a result of modernization and economic development during the last two centuries are being warmly welcomed indicating overall improvement in the general living standards of the people. But this skewed development cry for urgent attention of the people and the governments of the third world countries to redefine their priorities of economic development so that the health, nutrition and living standards of people is uplifted.

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Author's Address: **S. P. Singh,** Department of Human Biology, Punjabi University, Patiala 147 002, Punjab, India