International Journal of Innovative Research in Medical Science (IJIRMS)
Volume 03 Issue 02 February 2018, ISSN No. - 2455-8737
Available online at - www.ijirms.in

Open Access Journal | Research Article | DOI: 10.23958/ijirms/vol03-i02/03

Anthropometric Assessment of Nutritional Status of Medical Students (Adolescents)

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Abstract:

Aims: *Anthropometric Assessment of Nutritional Status of Medical Students.* ***Material and Method:*** *The present study is carried out on 100 1st M.B.B.S. students of GSMC and tertiary care hospital (50 males and 50 females) not suffering from any major illness. Weighing scale for weight measurement, A scale to measure height (stadiometer), Calipers to measure skin fold thickness.* ***Conclusion:*** *According to BMI: 72% of females and 78% of males are well nourished; 8% of females and 6% of males are over nourished and 20% of females and 16% of males are under-nourished. Considering the consequences or morbidity and mortality associated with undernourishment; corrective steps in the form of improvement in dietary pattern should be undertaken and for over-nourishment; in addition to rectification of diet, more stress should also be laid on doing physical activity. Broca's Index does not take build into consideration. It therefore gives high values for weight. On the other hand Metropolitan Life Insurance Tables give more accurate estimate of person's nutritional status and they should be used as a reliable indicator for nutritional assessment. For Adolescent: BMI- Cutt off points as suggested by WHO should be followed rather than following the adult BMI values as the adult BMI value give a high estimate prevalence of malnutrition*

Keywords: ***PEM, WHO, Overweight, Obesity, Morbidity, NIDDM, Osteorthritis, BMI, Lliac crest***

Introduction

Nutritional status of the population depends on food consumption and not solely on production and availability of food. Protein energy malnutrition (PEM) is an imbalance between the supply of protein and energy and the bodies demand for them to optimal growth and function. Such an imbalance leads to wasting, stunting and underweight when energy intake is inadequate and to overweight and obesity, when it is excessive.

WHO estimates that in developing countries about 245 million adults are moderately underweight and 93 million severely underweight. At the same time, there are over 200 million adults who are moderately of severely overweight of whom 58 million are in developing countries. For adults, even the most optimistic trend gives a global value for 2025 of 82 million for severely underweight and 131 million for moderately underweight, severe overweight prevalence in 2025 is estimated at 300 million adults. Growth in the number of severely overweight adults is expected to be double that of underweight adults during 1995-2025.[1]

Adolescence begins with pubescence the earliest signs of development of secondary sexual characteristics and continue until morphological and physiological changes approximate adult status usually near the end of second decade of life which considers individuals of about 10-24 years of age, which includes both those considered by WHO as adolescent" (10-19 years) and those defined as youth" (15-24 years) by the United Nations. Human growth and maturation are continuous processes of adolescence encompasses rapid changes in physical growth and maturation and in psychosocial development.

Adolescence is also a period of increased requirements. Rapid accretion of new tissue and other wide spread developmental changes are accompanied by increased nutrition requirement relative to childhood years. For example, more than 20% of total growth in stature and upto 50% of adult bone mass are achieved during adolescence, resulting in a 50% increased in the calcium requirement. In addition to increased iron needs of the expanding red cell mass and myoglobin in newly gained muscle tissue; adolescence girls have a further iron requirement - upto 15% compensate for menstrual blood looses.

Many important changes a psychological and social development take place during adolescence - a period that signals the entrance of individuals into the world of adults. Potential for pregnancy and parenthood, education choice, occupational commitment, interpersonal relationship are only a few concerns and responsibilities that challenge adolescence and that may confusing. Many of the responses to the transition to adulthood may include behavior that direct implications for health; eg. Dieting, smoking, alcohol

consumption, sexual activity, substance abuse, violence. Sometimes, the lack of opportunities associated with poverty of the choice concerning education and occupation may have indirect long term effect on health.[2]

The prevalence of under nutrition in adolescents is considerably lower than that early childhood, and the need for anthropometry has seemed less pressing. Historically; the rapid changes in somatic growth in adolescence; the problems of dealing with variations in maturation and the difficulties involved in separating normal variation from those associated with health risk have all discouraged from developing a body of knowledge about adolescence that would link it directly with health determinates and outcomes. As a result clinicians and public health workers have been left with relatively few tools meeting the need to evaluate adolescence.

Anthropometry is especially important during adolescence because it allows the monitoring and evaluation of the hormone – mediated changes in growth and malnutrition during this period. Moreover, because growth may be indicators of nutritional status and health risk and may be diagnostic of obesity and underweight.[2]

An attempt is made in the present study to assess the nutritional status of adolescence to identify obesity and underweight so that corrective steps could be taken to rectify the problems. Also an attempt has been made to find out a reliable tool for clinicians, and nutritionist for their easy reference by comparing the Broca's Index and Metropolitan Life Insurance Table.

Overweight and Obesity - Overweight is a major public health issue. Grade 2 overweight is relatively common in most industrialized societies and also in many less modernized cultures. Prevalence of overweight within countries can vary substantially. This can largely be linked to variations in variations in socio-economic status and/ or degree of urbanization: for instance the prevalence of overweight has been found to be relatively high in certain professional groups in Bombay 2.Overweight is always, the product of a energy balance resulting from relatively low energy expenditure and/ or relatively high energy intake. Social, culture and behavior factor of important determinates of both the components, but it is also clear that excess weight gain in affluent circumstances may result from a genetic predisposition. What remains unclear is the mechanism through which genetic factors exert their influence: it is probable that many genes are involved: affecting both energy expenditure and energy intake.[2]

Overweight and Morbidity[3]:

- ***Overweight and coronary heart disease:*** Overweight is associated with an increased prevalence of cardiovascular risk factor such as hypertension, unfavorable blood lipid concentration and diabetes mellitus.
- ***Overweight and stroke:*** Clear relationship exists between overweight and stroke.
- ***Overweight and hypertension:*** Increased body weight is associated with elevated blood pressure and weight loss in hypertensive individuals is generally accompanied by reduction in blood pressure.
- ***Overweight and NIDDM:*** Overweight is a well established risk factor for non-insulin dependent diabetes mellitus
- ***Overweight and Gall bladder disease:*** Overweight is a major risk factor for the development of gallstones, particularly those made of cholesterol rather than pigmented stones containing bilirubin.
- ***Overweight and Osteorthritis:*** There is increased evidence that overweight is associated with ostreoarthritis of several joints.
- ***Overweight and Cancer:*** Overweight and the risk of endometrial cancer increased in direct proportion. Overweight probably increased the risk of post menopausal breast cancer.
- ***Overweight and other disorders:*** Overweight is positively and abdominal fatness negatively associated with the presence of Varicose veins. Abdominal fatness and overweight have been associated with some endocrine disorders and infertility. Overweight amy also lead to important social and economic disadvantage as well as psychosocial problem.

Anthropometry[4]: This deals with the physical characters of a person and states the condition of health of the subject. Following are the components of anthropometry.

a) **Weight:** It represents size of cell mass of the body to determine the BMR and thus the metabolic cost of physical activity. Weight is taken on a weighing scale with mineral or no clothing; barefooted in kgs.
b) **Height:** It gives an idea about the proportion of the weight and height in an individual for particular age. It also provides the information about the BMI if computed with the weight. Height is taken with the help of a stadiometer or scale used for the same in cms/ inches.
c) **BMI:** With the help of height and weight, Body mass index (BMI) can be calculated which gives an accurate estimation of body size and body compassion and helps in diagnosing presence / absence of obesity/ under nutrition.

$$BM = \frac{Wt.in\ kg}{(Hf\ in\ meter)^2} \} \ also\ known\ as\ Quetelet's\ Index$$

These BMI cut-off values are for adults. Application of adults reference data; to adolescents is inappropriate the distribution of weight for categories of stature are very different for adults than for adolescents, even at the same stature. For example; at a stature of 165-167 cm, median weight of adult men exceeds that of adolescent female by almost 7 kg^2. Therefore for adolescent different cut-off point for BMI have been established in order to identify the problem of overweight and under nutrition.

Materials and Methods

Sample Size: The present study is carried out on 100 1st M.B.B.S. students of GSMC and tertiary care hospital (50 males and 50 females) not suffering from any major illness.

Materials:
Weighing scale for weight measurement, A scale to measure height (stadiometer), Calipers to measure skin fold thickness.

Methods:

1) **Standing Height:** Body height is measures on a stadiometer. Subject stands erect without shoes and his back close to the calibrated stand. The top piece is pressed firmly on to subjects head. Height recorded in centimeters; correct to ½ cms.
2) **Resting pulse rate:**By palpating the pulse and counting the rate for 1 minute, when the subject is in a relaxed state and lying down position.
3) **Resting systolic and diastolic blood pressure:** Measured with sphygmomanometer by palpatory and auscultatory method when the subject is in a relaxed state and lying down position.
4) **Body weight:** On a weighing machine, subject stands in his normal clothing with shoes off the legs, recorded in kgs; correct to ½ kg.
5) **Body fat percentage:** This was assessed by the skin fold thickness technique by using Lange skin calipers (Pressure calipers)

For accurate skin fold measurments[5]; following instructions were followed:

- Measurement taken directly on skin, not through clothing.
- Skin fold picked up with one and measurement with skin calipers taken with the other hand.

Sites chosen in female's are[5]**:**

1. Lliac crest
2. Triceps

Lliac crest: Locate a point over the top of the hip at the mid – axillary line (middle of armpit) and use a skin – fold that is in the diagonal plane.

Triceps: Locate a point halfway between the tip of the acromial process (bony projection on top of shoulder) and on the tip of the olecranon process (tip of elbow) with the elbow at 90 – degree angle. Then measure the skin – fold with the arm relaxed and hanging in extension.

Sites chosen in males are[5]**:**

1. Thigh
2. Scapula

Thigh: Locate a point in the anterior midline of the thigh, midway between the hip and knee joint. Place the body weight on the opposite leg so that the thigh muscle is in a relaxed state and use a vertical skin - fold.

Scapula: This skin fold is taken at the tip of scapula on a diagonal plane.

Statistical Analysis

Calculation of percentage of body fat: For females:

Body density:

1.764 - [0.00081 x skin fold thickness at iliac crest]
[0.00088 x skin fold thickness at triceps]

$$\left(\frac{4.570}{\text{Body density}} - 4.12 \right) \times 100$$

For males:

Body density:

1.1043 - [0.001327 x skin fold thickness at thigh]
- [0.001310 x skin fold thickness at scapulas]

Percentage of body fat:

$$\left(\frac{4.570}{\text{Body density}} - 4.12 \right) \times 100$$

6) **Body Mass Index:**
With the help of height and weight; Body Mass Index (BMI) can be calculated which gives an accurate estimation of body size and body composition and helps in diagnosing presence/ absence of obesity/ under nutrition.

$$BMI\ \frac{Wt.in\ kg}{(Ht\ in\ meter)^2}$$

Cut-off points used for adolescents.

1) For under nutrition[6]: in females <16.87
   In males <17.80
2) For under nutrition[6]: in females >25.85 but <30.72
   Grade I In males >26.36 but <30.66
3) For under nutrition[6]: in females >30.72
   Grade II In males >30.66

7) **Broca's Index:** Many methods of expressing body weight have been devised. One such index is Broca's Index.[7]
   Standard weight in kg = Height in cms - 100
   This does not take body build into consideration.

8) **Weight according to Metropolitan Life Insurance Table:**
   Weight calculated by referring to the Tables.[8]

Result and Discussion

Table I: Profile of physical characters of Males:

	Male	Female
Mean age	**18 years 6 months**	**18 years 6 months**
Mean height	168.95 ± 5.335 cm	159.3 ± 7.08 cm
Mean weight	59.76 ± 9.15 kg	52.65± 8.51 kg
Mean % body fat	16.716 ± 6.21 %	26.03 ± 4.082 %

Table I shows the following:

1. Mean height for males is 168.95 which is much below the 50th percentile value of 176.8, as suggested by NCHS and in females is 52.65% which is also much below the 50th percentile value of 56.62 kg as suggested by NCHS.[9] Mean height for males is more than for females
2. Mean weight for males is 59.76% which is also much below the 50th percentile value of 68.88 kg and for females is 52.65% which is also much below the 50th percentile value of 56.62 kg as suggested by NCHS. Mean weight for males is more than for females.
3. Mean % body fat is 16.716% which is above the suggested upper limit for males i.e. 15% and Mean body fat % is 26.03% which is above the suggested upper limit for males i.e. 20%. [5] Mean % body fat is more in females than that in males.

Joshi S.B., Kanade A.N.[10] on their study of Growth patterns of India boys age 8-18 years showed that the mean height and weight if Indians adolescents is below the 50th percentile value of NCHS. The reason they cited was that the children's are continually exposed to lower intakes of food and subclinical infections; apart from childhood malnutrition. Therefore the catch-up growth is unlikely during adolescents. The findings in present study correlated well with the findings of ***Joshi S.B., Kanade A.N.*** It is probable that lower nutritional intakes during adolescents and also widespread childhood malnutrition lead to mean height and weight below the 50th percentile value of NCHS but also certain aspects of adolescents behavior like the extremes of nutritional intakes in from of dieting can lead to mean height and weight below the standard value. Also may be food faddism, improper selection of food, eating junk food etc leads to a diet which is deficient in nutrients which in turn may lead to growth retardation. ***James WPT and Francois PJ***[11]on their study of determining the cut-off points of BMI for CED showed that women have less weight as compared to males. They suggested that women's work capacity is less than that of males and even they smaller muscle mass therefore they tend to be shorter than men and therefore at equivalent BMI's will be of lower body weight as well. The findings in the present study correlates well with the findings of ***James WPT and Francois PJ***[11] in addition to be above cited reason probably the other reason for females to be shorter and lighter than males are as follows:-

- Inequal distribution of food: Male being the earning member gets the major share of food and females they pay less attention towards their nutritional intakes.
- Certain belief and customs: like religious fasting etc can also lead to underweight and growth retardation in females.
- During menstruation, pregnancy etc there is drawing in of the nutrients and if proper diet is not taken it leads to malnutrition.

Luzzi AF and James W.P.T.[12] in their study on Definition of chronic energy deficiency is adults, showed that women have body fat % more than that in males. They found out that women have a greater fat mass than men at each level of BMI and the proportion of fat rises progressively in proportion to the BMI. Women, may however require greater energy stores since they have to sustain their reproductive functions. The findings in the present study correlates well with the findings of ***Luzzi AF and James W.P.T.*** study. In addition to be reason cited above probably women also have smaller muscle mass because their work capacity is less therefore they tend to develop more body fat than the lean muscle mass.

Table II: profile of physiological characteristics of Males:

	Male	Female
Mean Pulse Rate	78.7 ± 7.27 beast/ min	80.2 ± 6.82 beast/ min
Mean Systolic blood pressure	123 ± 10.27 mm of Hg	115.4 ± 9.766 mm of Hg
Mean Diastolic blood pressure	76.8 ± 6.27 mm of Hg	75.96 ± 6.92 mm of Hg

Table II shows the average pulse, systolic and diastolic blood pressure of males and Females.

James WPT[13] in his study of challenge of chronic energy deficiency showed that under-nourished people have unusual body composition. He proposed that the compositional change in the form of more body fat may prove to be partial composition for a poor growth in lean body mass during adolescents. Mc Neill studying adults in Tamil Nadu; found a higher % body fat in Indian women at a BMI of 19.1 than in UK women with a BMI of 24.5. Similar finding are reported by Shetty who found out that Indians have an unusual body composition and that they seem to have an surprising amounts of fat at even low BMI values.

The finding in the present study also show that body fat percentage is more on both males and females; probably this is done as a partial compensation of poor lean body mass by the body and it can serve as a reservoir of energy in time of needs.

Table III: Profile of mean weight in males and females by Broca's Index and Metropolitan Life Insurance.[7,8]

	Broca's Index		Metropolitan Life Insurance	
	Weight	**SD**	**Weight**	**SD**
Male	68.36	5.32	59.87	3.99
Female	59.28	7.04	52.54	4.28

Table III shows the mean weight in males and females by Broca's Index which is calculated as

Standard weight in kg = Height in Centimeters – 100, and shows the mean weight in males and females by referring to the Metropolitan Life Insurance.

Table IV: Comparison of mean weight in males and female between Broca's Index and by Metropolitan Life Insurance Tables.

	Male		Female	
	weight	**SD**	**weight**	**SD**
Broca's Index	68.36	5.32	59.28	7.040
LIC	59.87	3.99	52.54	4.28

Z = 9.031 [Standard error of difference of 2 mean]

∴ *P < 0.001*

∴ *Highly significant*

Thus there is highly significantly difference between Broca's Index and Metropolitan Life Insurance Tables.

Naidu AN and ***Roa PN***[14] in their study of Nutritional status of Indian Rural population, showed that the order of energy deficiency is more or less the same in all the stature groups. In other words it clearly indicates that persons with better height are also suffering from various grades of energy deficiency. In the present study we found out that Metropolitan Life Insurance Tables give a good estimate of persons nutritional status than Broca's Index. Broca's Index, it just takes into account the height of the person which simply implies that if the height of person is more he is better nourished, which is not be case. Also Broca's Index does not take into account the person build. Metropolitan Life Insurance Table on the other hand they consider the persons build and give weight for height chart which is a sensitive tool for assessing the nutritional status of the population.

Table V: Profile of BMI of females according to cut-off values for adolescents, as suggested by WHO.[15,16]

Well nourished	72%
Over nourished	8%
Under nourished	20%

Table V shows 72% of females to be well nourished, 8% to be over nourished and 20% to be undernourished.

Various studies have been done on BMI as an Index of undernourishment or overnourishment. Some of the studies with their results are as follows: ***Awasthi P.***[17] on their study of Nutritional status assessment using Anthropometric measurement in Adolescents Girls of College of Home Science in Pantnagar, showed that only 4.3% of subjects were severe CED i.e. grade III CED. None of the subjects was found to be obese. Gordon AM in his study of Cuban refugees showed that 25% of the subjects suffered from undernourishment mostly of Grade I. second grade CED was rare and cases of Grade III CED were not found. Obesity was found in 20% of subjects. ***Naidu AM and Rao PM***[14] in their study of BMI as measure of Nutritional Status of Indian Population, showed that nearly one-half of Indian population is suffering from grade of chronic energy deficiency.

In the present study re have found out that obesity is present is 6% of males and 8% of females whereas undernourishment is found in 16% of males and 20% of females. Thus the major concern is still undernutrition and not overnutrition. Major concern now days is gives on obesity and its related morbidity but little attention is paid towards under nourishment which is still most prevalent even in urban population like the one studies hare.

Table VI: Profile of BMI for females, according to adult BMI values.

Well nourished	60%	12% Over nourished
Grade I Obese	10%	
Grade II Obese	2%	
Grade I CED	10%	28% Under nourished
Grade II CED	14%	
Grade III CED	4%	

Table VI shows 60% of females to be Well nourished 12% to be Over nourished and 28% to be Under nourished. Comparison of BMI between adolescent and adult cut-off values (Refer Table IX and X) shows that adult BMI value give high estimate of prevalence of malnutrition.

Table VII: Profile of BMI for males, according to cut-off values for adolescents as suggested by WHO.[15,16]

Well nourished	78%
Over nourished	6%
Under nourished	16%

Table VII shows 78% of females to be well nourished, 6% to be over nourished and 16% to be undernourished.

Table VIII: Profile of BMI for females, according to adult BMI values.

Well nourished	76%	
Grade I Obese	8%	8% Over nourished
Grade II Obese	0%	
Grade I CED	10%	
Grade II CED	2%	16% Under nourished
Grade III CED	4%	

Table VIII shows 76% of males to be Well nourished 8% to be Over nourished and 16% to be Under nourished. Comparison of BMI between adolescent and adult cut-off values (Refer Table XI and XII) shows that adult BMI value give higher estimate of prevalence of malnutrition.

BMI cut-off values for adults are as follows:

<16.0	:	Grade III CED
16.0 – 16.9	:	Grade II CED
17.0 – 18.4	:	Grade I CED
18.5 – 24.9	:	Well nourished
25 +- 29.9	:	Grade I Obese
>30	:	Grade II Obese

BMI cut-off value for adolescents, according to WHO are:-

- >85th percentile BMI for age but <95th percentile BMI for age – person is possibly obese. This value for males corresponds to >26.36 but <30.66 and for females corresponds to <30.72.[6,7]
- >95th percentile BMI for age: person is obese. This value for females according to >30.66 and for females corresponds to >30.72.[15,16]
- >5th percentile BMI for age: person is under nourished. This value for females according to >17.80 and for females corresponds to <16.87.[6]

Thus it is seen that adult BMI value give a high estimate of prevalence of malnutrition. Therefore the cut-off value as suggested by WHO for adolescents should be followed because application of adult reference data to adolescents gives distribution of weight for categories of stature to be different for adults than for adolescents even at the same stature. For eg. At a stature of 165-167 cm median weight of adult men exceeds that of adolescent males by 15kg and median weight of adult women exceeds that of adolescent female by almost 7kg.

Conclusion

From the present study it is seen:

- ❖ According to BMI: 72% of females and 78% of males are well nourished; 8% of females and 6% of males are over nourished and 20% of females and 16% of males are under-nourished.
  Considering the consequences or morbidity and mortality associated with undernourishment; corrective steps in the form of improvement in dietary pattern should be undertaken and for over-nourishment; in addition to rectification of diet, more stress should also be laid on doing physical activity.
- ❖ Broca's Index does not take build into consideration. It therefore gives high values for weight. On the other hand Metropolitan Life Insurance Tables give more accurate estimate of person's nutritional status and they should be used as a reliable indicator for nutritional assessment.
- ❖ For Adolescent: BMI- Cutt off points as suggested by WHO should be followed rather than following the adult BMI values as the adult BMI value give a high estimate prevalence of malnutrition.

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