BASAL METABOLIC RATE OF ADOLESCENT GIRLS AND YOUNG ADULT WOMEN

By

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I INTRODUCTION

The science of nutrition as we now understand owes its foundation to the Lavoisier's epoch making discovery on combustion in living beings. The fundamental purpose for which people eat food is to use it as fuel to keep their bodies going. The body needs energy to work. It must work to live (Pyke,1975).

The determination of the energy requirements for the population group is important in the field of nutrition science. Since energy expenditure for basal metabolism forms a considerable proportion of total daily calorie expenditure, it deserves special consideration. The results of determination of basal calorie requirements can be taken as a guide for a rational basis of recommendation of dietary calorie allowances of the population groups (De and Nagchaudhuri,1976). Several other research workers in different parts of this country, at different times, attempted to compute the calorie requirements in various population groups by measuring the basal metabolic rate (BMR) (Banerjee et al.,1963; Banerjee & Bhattacharyan,1964,1967 and Devadas et al,1975).

The energy needed by the body when it is at complete rest is known as the basal energy requirement or energy at rest (Apfebaun,1971; Fulton,1972; Robinson,1972; Deguzman et al, 1973; Swaminathan, 1974; Varley,1975; Antia,1975 and Pyke,1975). Basal metabolism is the term used to describe biochemical changes which takes place while the individual is lying down still, relaxed and warm. The rate at which energy is used up while the body is in this condition is defined as the basal metabolic rate (BMR).

Malhotra et al (1972) and Bogert et al (1973) put forth that the basal energy needs are generally constant for an individual but vary slightly at different times.

Many factors influence the internal work of the body even when at rest. Body composition, shapre and size, age, sex and growth, specific dynamic action, physiological state, environmental temperature, food intake and degree of muscle tension are a few examples (Dagley and Nicholson, 1970; Pike and Brown, 1970 and Haisman, 1972).

Adolescense has been pointed out by many as a cause for nutritional concern (Thomas & David, 1973). The health related problem of adolescents have been so late in attracting attention (World Health, 1976). The nutrient requirements of adolescents are greater, particularly during the period of accelerated growth that precedes puberty because of the increased energy expenditure (Reddy, 1976). Energy consumption of adolescents appear to vary widely. Banerjee et al (1963) reported that calorie consumption per day by 12 girl students aged 18 to 22 years was poor (1,438 K.cals). Devadas et al (1976) also reported inadequate intake of energy by present day college women.

We must ask ourselves how the young people of today and tomorrow are to be assured of a sound and healthy life. When all is said and done we should not forget that adolescents who in many parts of the world constitute a majority of the population today - represent the adult society of tomorrow (World Health, 1976).

The present investigation is an attempt to measure the BMR of adolescent girls and young adult women residing in school and college hostels. Since the determination of basal energy requirement is a guide for recommendation of total energy requirement and also since not much data are available regarding the BMR in different years in adolescence and adulthood, this study was geared towards the same.

II REVIEW OF LITERATURE

The literature pertaining to this study is given under the following headings:

A. Historical review on energy metabolism

B. Need for energy

C. Energy at rest

D. Factors affecting basal metabolism

E. Energy expenditure at various activities

F. Relation between energy metabolism and food intake

A. Historical review on energy metabolism:

Lavoisier (1743-1794) was the first to discover the importance of oxygen gas and to enuciate the principles of combustion both outside and within the body (Wilson *et al*, 1965). Von Lie big's studies published in 1842 showed that it was not carbon and hydrogen which burned in the body but carbohydrates, fats and proteins (Beaton and Mc Henry, 1964).

Reynault and Reiset in 1849 definitely showed that the value of the respiratory quitient depends on the nature of the foods being oxidized and not on the species of animal. They planned to construct a human respiration chamber but did not succeed (Davidson *et al*, 1973).

Boussigault (1802-1887) originated experimentation in balance studies. Pettenkofer (1818-1901) constructed the first respiration chamber in which a man could work, eat, or sleep without discomfort. He and Voit performed many experiments and contributed much to establish the fundamentals of energy metabolism in Munich (Swaminathan, 1974).

Atwater (1944-1907) a pupil of Voit constructed the first human respiration calorimeter at Middle town, Connecticut (Beaten and Mc Henry, 1964). Rubner in Berlin, and Johnson in Sweden (1880) extended the work of the Munich school and laid many of the foundations of modern nutrtional science (Davidson et al, 1973).

Rubner (1902) described the specific dynamic effect of food. Lusk, after Rubner studied the metabolism of the foodstuffs and on the specific dynamic effect of foods in U.S.A. (Pike and Brown, 1970).

The names of Voit and Rubner symbolize the outstanding progress during the last half of the nineteenth century in the field of nutrition and energy metabolism in particular (Beaton and Mc Henry, 1964).

In the early part of the present century, Benedict carried out many studies on the energy metabolism in man and in various species of animals at the Nutrition Laboratory of the Carnegie Institute of Washington at Boston, Massachusetts (Beaton and McHenry, 1964).

The Douglas bag was introduced by Douglas in 1911. It is an instrument in which all the air expired by a subject could be collected and kept for subsequent analysis and for the measurement of volume. This bag is cumbersome for experiments in the field and a new, light, portable respirometer-a gas meter with a by-pass to take samples, something like the original calorimeter of Voit-was developed in Germany (Davidson et al, 1973). It has been used in a number of experiment studies on energy expenditure, e.g., that on miners and clerks in Fife. A different type of instrument, known as the Integrating Motor Pneumotachograph (IMP) has been developed in the Division of Human Physiology of the National Institute for Medical Research, London by Wolff for use over long periods. Its introduction had made possible the systemic measurement of the energy used in a variety of normal occupations as diverse as housework and coalmining. It is more expensive and not so reliable under field conditions (Hutchison, 1969 and Davidson et al, 1973).

Among the prominent contributors to the many aspects of energy metabolism during the past few decades are Sherman, Mitchell, Forbes, Mendel, Kriss, Mc Collum and Mayard (Beaton and McHenry, 1964).

B. Need for energy:

Energy is defined as the power to do work. Energy is continuously available in the body. Potential energy transfered to other forms accomplish the work of the body; for example, mechanical energy for muscle contraction; osmotic energy to maintain the transport of fluids and nutrients, electrical energy for the transmission of nerve impulses; chemical energy as in the synthesis of new compunds; and thermal energy for heat regulation (Robinson, 1972 and Mathew, 1973).

In the body much energy is stored in the form of chemical energy. This stored chemical energy is locked up in the tissues of the body during its period of growth (Bulletin, 1973) and comes from the oxidation of body tissues (Oser, 1971). This process of biological 'combustion' forms part of the enormously complicated series of changes which together comprise metabolism by which tissues grow and repair themselves and also supplies energy for all work done by the body (Wilson et al, 1965; Aman, 1969 and Pyke, 1975).

The internal work of the body never stops. The body needs materials and energy for repairing wear and tear of its tissues, for the continuous up keep of the other vital internal activities (Bogert et al, 1973) and for the heat necessary to maintain body temperature (Brooke and Green, 1973 and Rutishauser and Ingrid, 1973).

The immediate source of energy for muscle contraction is generally held to be the splitting of Adenosine Triphosphate (ATP) which in turn can be quickly resynthesised by the breakdown of Creatine Triphosphate (cp) (Park, 1970; Dagley and Nicholson, 1970; Leroy, 1971; Howard and Bengt, 1972 and Intengan, 1973). ATP is an energy rich compund. During exercise, the turnover of these compunds in the muscle cell is increased markedly. Energy in the form of ATP is obtained from the oxidation of the carbohydrates, fats and proteins of the diet.

C. Energy at rest:

The heat production under resting, fasting conditions (BMR) is a measure of the rate at which body substance is oxidized in order to support the continued maintenance of life. (FAO/WHO, 1973). Durnin and Passmore (1967) reported that much of the energy is utilized by the body in the basal or in the resting metabolism.

Studies on the BMR of Indians have been carried out by Banerjee (1962) in different parts of India. His values have been found to be lower by 7 to 25 per cent when compared to the western standards. Banerjee et al (1963) reported the BMR of normal healthy girl students of Rajesthan, of ages varying between 9 and 20 years. He found, there was a low BMR in these girls when compared to the Maye foundation. BMR expressed in terms of unit body surface area of the Indians was lower than the western standards. Patwardhan (1960) viewed BMR of Indians, as only 'apparent' and 'not real'. However the BMR of Indians works out to be the same as that of the westerners, if the body cell mass or lean body mass is taken as the biometric unit of expression.

D. Factors affecting basal metabolism:

1. Physiological Factors:

a. Age and Sex:

Rabinson (1972) says that the basal metabolic rate of human subjects varies greatly with age and sex.

Wilson *et al* (1965) says periods of rapid growth are associated with an increase in the basal metabolism. The period of most rapid growth in childhood is in infancy. At the end of the second year of life or in the early part of the third, the basal metabolic rate per square metre of body surface is the highest in the lifetime of an individual. Best and Taylor (1969) stated the heat production per square metre of body surface diminishes progressively from infancy to old age, being about 50 cals. per square metre per hour at the age of ten to tweleve and about 32 cal. at 90 years. The metabolism of the new born is much lower than that of infants, a few weeks older premature infants have a lower rate than those born at full term. Hutchison (1969) determined, the basal metabolism of infants, children and adolescents which showed a very different picture. It starts at about 30 calories per metre and rapidly rises till at 6 years it reaches a peak of 60 calories per square metre-a rate 50 per cent greater than that of the adult. Thence forth it falls fairly rapidly at first and then more slowly till it reaches the adult figure of 40.

The BMR showed a progressive decline from 7 to 18 years. At all ages BMR of girls was lower than that of boys by 5-8 per cent (ICMR-Annual report, 1972). The basal metabolic rate was determined by De and Nagchaudhuri (1976) in boys and girls belonging to the age group of 7-18 years. The period of puberty was found to be between 10-15 years in girls. The growth rate (height and weight) during this period in girls are found to be less than that observed in the preceding as well as succeeding years of adolescence. According to Du Bois, there is a sound peak at or about the age of puberty. When, some where in middle or advancing age, the effect of diminishing muscular activity is added to that of the slow decline in basal metabolism, the result is significant decrease in the number of food calories needed per day (Sherman, 1958).

Sex and age influence basal metabolism. It is lower in the adult female, namely 37 calories per square metre per hour or 1350 calories for a women of 1.5 square metres of skin area, though it makes no difference whether the lean body belongs to a man or a woman, since women generally have more body fat than men (Krause, and Hunscher, 1972). De and Nagachaudhuri (1976) reported that BMR progressively decreased with the increase in age in both the sexes.

Once a person has reached adult age the figure remains very nearly constant. It does, however, fall gradually, till in old age it has decreased by 10 per cent. This is true of both women and men and it presumably reflects that strophy of muscle with advancing age (Durnin and Passmore, 1967). Gopalan and Narasinga Rao (1971); Beck (1972) and Davindson et al (1973) point out that the expenditure of energy per unit of body weight decreases slowly after the early twenties in the basal metabolic state and in the resting condition.

Antia (1975) reported with increasing age there is: (i) a decline in physical activity and less strenuous employment; (ii) decrease in the basal metabolic rate. It is therefore recommended that beyond 25 years there should be decrease in calories by 3 per cent per decade up to 45 years and 7.5 percent there after upto 65 years.

b. Body Surface Area:

Heat is continously lost through the skin by radiation. Since the heat loss is proportional to the skin surface, the basal heat production is directly proportional to the surface area. (Shanmugam, 1972). A tall, thin person has a greater surface area than an individual of the same weight who is short and fat, and the former therefore will have a higher basal metabolism (Robinson, 1972).

Rubner is responsible for the concept that basal metabolism is directly proportional to body surface (Crampton and Lloyd, 1959). Matheson (1975) has pointed out differences in metablic body size must be taken into account in relating the energy. Malhotra et al (1972) reported that there is a linear relationship between energy expenditure and body weight. Cramption and Lloyd(1959) say heat produced by small animals is greater than that produced by larger animals. William (1973) says, smaller persons of each sex tend to have a higher rate of metabolism per unit of surface area than larger persons.

C. Body size and lean body mass:

As Matheson (1975) has pointed out differences in metabolic body size must be taken into account in relating the energy requirements of 100 gram rats to those of 10 kilogram children. Pyke (1975) says, that basal metabolism is related to lean body mass. Wilson et al (1965) opines that the basal metabolism of individuals of the same height and age or people of the same weight and age may differ or be influneced by the variation in the body form of the individuals. The kinds of tissue that make up the body have a direct influence on the basal metabolism.

Ljunggren et al (1961) and Bogert et al (1973) say that in the adult skeletal muscle is the largest component of the non-bone lean mass and muscle has a relatively low resting rate of metabolism. The brain, a very active tissue, increases little in weight from infancy to adulthood. For purposes of nutritional planning, it is sufficient to remember that the basal energy requirement is greater in persons of large size then in smaller persons of the same age and sex. Dagley and Nicholson (1970), Gopalan and Narisingarao (1971), Apfebaun etal (1971) and WHO (1973) explain that women have a larger proportion of fat in their bodies and hence their BMR is lower than men.

d. Pregnancy and Lactation:

Studies by Sunderman and Boener (1950) and Thompson and Billewicz (1957) show that pregnancy and lactation involve considerable increase of metabolically active tissues along with other changes of the maternal system. The growth of the fetus and placenta, the enlargement and hypertrophy of the organs of reproduction and lactation, the increase in the volume of circulating blood and body fluids are important physiological changes during the period of gestation, whereas the milk secreting organ becomes hyperactive during the period of lactation.

The rapid increase in lean tissue mass of the developing fetus was the chief cause for gain in weight during the third trimester of pregnancy (Gruenwald, 1966 and Holliday, 1971). BMR increased 5 to 6 per cent during the third trimester (Dakshayani and Ramamurthy, 1964). This rise in the BMR, probably is explained by the rapid physiological changes occuring in both maternal and fetal tissue (Fee and Well, 1963; Parlow, 1966; Toassin et al, 1967, Kaplan and Goumbach, 1967; Berg, 1967 and Riee and Pontheir, 1968).

Basal energy expenditure of women has been reported to increase by 13 to 37 per cent during pregnancy. The data on pregnant adolescents given by Seitchik (1967) and adult women by Juen et al (1970) indicate that while basal energy expenditure increases per unit time, the rate per unit body weight is unchanged. It was found that the activity patterns of pregnant-teen age women studied by Blackburn and Calloway in 1974 to be similar to those reported earlier by Huenemann et al (1967) for

for non-pregnant girls in California.

Banerjee found (1971) found basal rate to be 27 per cent higher but body weight only 13 per cent higher in pregnant than in non-pregnant woman. As the composition of tissue deposited throughout pregnancy is not constant (Hytten and Leitch, 1971), differences between studies may reflect the stage of gestation when measurements were made or differences in fat and fluid accumulation. Banerjee (1971) determined the oxygen consumption remained significantly higher even after delivery.

William (1973) says that the BMR rises during the lactation period, because milk production utilizes energy. For a women producing 500 to 600 calories in milk, the provision of about 600 calories as available dietary energy should be adequate (Thomson et al, 1970).

e. Chemical substances:

Best and Taylor (1969) reported that caffeine, adrenaline, thyroid extract or thyroxine, benedrine, and dinitrophenol raise the basal metabolic rate. Smoking a cigarette, especially if the smoke is inhaled, increases the metabolism of most subjects, the average increase being around 9 per cent.

f. Climate:

Pyke (1975) found that basal metabolism is increased in cold climates, resulting in increased heat production which helps to maintain body temperature. Nakamura et al (1969) determined that there was a characteristic lowering of basal metabolic rate in the severe cold season and a rise in the spring. The basal metabolic rate of the physical workers might be influenced by the grade of their performance. It seems possible, then that heavy physical work changes the pattern of seasonal variation in basal metabolic rate. Mason and Jacob (1972) reported there was no significant fall in the BMR between tropical and temperate climates.

2. Pathological factors:

Guyton (1966), Pike and Brown (1970) Oser (1971), Wright (1971) and Varley (1975), discussed some of the pathological factors which affect the basal metabolic rate. In that, the conditions which increase the basal metabolic rate are,

1. Hyperthyrodidism
2. Other endocrine disorders
3. Pregnancy
4. Fever
5. Hypertension
6. Myocardial insufficiency and
7. Diabetes insipidus

The conditions which decrease the basal metabolic rate are,

1. Hypothyroidism
2. Endocrine Disorders
3. Nephrotic syndrome
4. Shock
5. Malnutrition and
6. Sleep.

E. Energy expenditure at various activities:

Beaton and McHenry (1964) pointed that an individual's energy expenditure for a specific physical activity or period of work involves three factors; the energy cost of the activity; the time spent in pursuit of the activity; and the body size of the individual.

Gopalan (1970), Holmer (1972) and Howard and Bengt (1972) have shown that the energy cost of a physical activity is related to three factors; the amount of work done, the intensity of the work performed and the body size of the individual. Different kinds of activity require different amounts of energy.

Work in India on energy expenditure in different activities has been reviewed by Whedon (1959) and Banerjee *et al* (1959, 1970 and 1972). Durnin and Passmore (1967) measured the energy cost of different activities for Indians and found them different from those reported for western subjects. Deguzman *et al* (1973) and Joseph *et al* (1973) point out that total energy expenditure are determined by internal and external work of the body. Konishi (1965), Bradifield (1971), Villegas *et al* (1971), Montoye (1971) and Astrand *et al* (1973) explain that when external work is performed, energy expenditure is equivalent to the heat produced plus the work done. Study on energy intake and expenditure of selected manual labourers engaged in building work was conducted by Devadas *et al* (1975). They found that occupational activities like carrying a bowl of stones consumed maximum energy per minute. Among non occupational activities walking caused the maximum energy expenditure per minute.

De Guzman *et al* (1974) studied the energy expenditure for basic activities (sitting, standing and walking) of the farmers, the shoemakers and the Jeepney drivers. The results showed that the three groups have indentical mean expenditure during sitting and standing. However, for walking, the mean energy expenditure of the Jeepney drivers which was 0.056 kg/min; was found to be very much lower in comparison with the mean energy expenditure of the shoemakers and the farmers which was 0.071 and 0.072 k cal/kg/min; respectively. Dhesi *et al* (1975) conducted experiments on energy expenditure while sweeping with different types of brooms held in different postures. They found that the energy expenditure was higher in the standing-cum-bending posture and it was lowest in the standing posture. Out of the three types of brooms, the energy expenditure was the lowest while sweeping with a brush, followed by the grass broom and bamboo-stick broom.

Devadas *et al* (1977) studied the energy expenditure of adolescent girls doing the Home Science Course. They found that during the foods practical, activities like grinding involved the maximum energy. Outside the class, activities like ascending stairs involved maximum energy expenditure.

F. <u>Relation between energy metabolism and food intake</u>:

Determination of the basal metabolic rate requires that the subject be in the post absorptive state, that is, without food for at least 12 hours prior to the test. The reason for without holding food is that following ingestion of food, heat production increases above the resting state. This effect was first recognized by Rubner in 1902 and was called the Specific Dynamic effect of Food (SDA)(Pike and Brown, 1970).

Food has an important effect on energy expenditure in that when taken by an individual at rest, there is an increase in the production of energy (Joint FAO/WHO committee, 1973 and Mathews and Wells, 1973). Pyke (1975) stated that the food has the effect of stimulating the metabolic rate, while it is being metabolised, thus causing increased utilisation of calories.

Miller and Mumford (1967) and Miller <u>et al</u>(1967) have suggested that enhanced dietary thermogenesis following ingestion of food was the regulatory mechanism for increased heat loss during period of over eating. In their studies, Miller and his collaborators have used both experimental animals and human subjects. A study by Bray <u>et al</u>(1974) reveal that the thermic effect of food on the resting metabolism of normal young men was 10 per cent of their resting (not basal) metabolism without food.

In similar studies on humans Miller et al (1967) demonstrated that normal subjects on a low protein diet could ingest large numbers of calories above their basal diet without gaining the predicted amount of weight. When diets were high in protein, however, the weight gained was much closer to that expected from the number of extra calories ingested. In an attempt to explain the difference between a high and low protein diet, Miller et al (1967) have proposed that calories are wasted during activity in the post prandial state.

Anderson (1972) points out that not all kinds of food are oxidized with an equal effect on metabolism. Protein stimulates, so that greater amount of heat is produced in its metabolism than in that of similar quantities of fats and carbohydrates. High protein diet containing 40 percent of protein showed the largest SDA (Bourne, 1959).

III EXPERIMENTAL PROCEDURE

The present study was designed to measure the BMR of adolescent girls (13 to 16 years) and young adult women (19 to 22 years).

The experimental procedure for the study included the following steps:

A. Selection of the subjects

B. Determination of BMR of the selected subjects

C. Measuring the skinfold thickness of the selected subjects

D. Analysis of creatinine in urine of the selected subjects

E. Recording of the food intake of the selected subjects

and F. Calculation of the energy and protein intake of the selected subjects

A. <u>Selection of the subjects</u>:

Adolescent girls and young adult women residing in high school and college hostel were selected for the study. Ten age groups-13 years to 22 years were considered. Six subjects were chosen for each age group. On a total, 60 subjects were chosen, after ensuring that the subjects were free from any clinical symptoms and respiratory troubles.

B. <u>Determination of BMR of the selected subjects</u>:

The BMR was determined for three consecutive days by the closed circuit method using Benedict Roth apparatus adopting the procedure of Oser (1971). This method which was selected as 'Indirect calorimetry' is simple and relatively inexpensive in operation (Shanmugam, 1972; Prabavathy, 1974 and Varley, 1975).

To ensure success, the procedure and discipline involved was explained to the subjects. The height of the subjects was taken (using a stadiometer) nearest to 0.1 centimeter at the beginning of the determination of basal metabolic rate. Weight was taken using the Avery weighing balance nearest to 0.5 kg. The subject was tested before breakfast after a 12 hour fast. The subject was made to rest for half an hour before actually conducting the experiment. To begin with, the subject's mouth temperature and pulse rate were observed. The apparatus was tested for leaks and the spirometer was filled with oxygen. The mouth piece and nose clip were applied and kymograph was started. The temperature of the spirometer and barometric pressure were recorded. The experiment was conducted for six minutes. The body surface area was determined using the nomogram for Indian females given by Banerjee (1962).

C. Measuring the skinfold thickness of the selected subjects:

Body fat is one of the important factor which affects basal metabolic rate (Jelliffe, 1966). Skinfold thickness is a reliable index of total body fat (Speckman et al, 1967). Harpenden caliper was used to measure the triceps skinfold. A pinch at the skin, clear from the subcutaneous musculature was made at a spot chosen for mid arm circumference parallel to the axis and held between the thumb and fore fingures of left hand. This is the most practical measurement (Jelliffe, 1966). The caliper was applied below the site of the pinch releasing the handle of calipers to permit full pressure.

The reading was noted to the nearest point of 0.1 millimetre .

D. Analysis of Creatinine in urine of the selected subjects:

Exeretion of urinary creatinine is determined principally by lean body mass and since basal oxygen consumption is related to active muscle (Arroyave 1963), the creatinine excretion was determined for the study.

Urinary creatinine was analysed by Folin's method (Oser, 1965). The procedure followed is given in Appendix {I}.

E. Recording of the food intake of the selected subjects:

The intake of food by the selected subjects were weighed and noted for those three consecutive days, when the subjects' basal metabolic rate was determined. The subjects were allowed to eat at ad libitum and their food intakes were recorded.

F. Calculation of the energy and protein intake of the selected subjects:

Energy and protein intake of the subjects were calculated from raw equivalents using the food composition table of Gopalan et al (1976).

IV RESULTS AND DISCUSSION

The results of the study are discussed under the following headings:

A. Mean surface area of the selected subjects

B. Mean energy expenditure by the selected subjects in the basal condition

C. Mean skinfold thickness and urinary creatinine levels of the selected subjects

D. Mean daily food intake of the selected subjects

and E. Mean daily energy and protein intake of the selected subjects

A. Mean surface area of the selected subjects:

The surface area of the selected subjects (60) was determined knowing their heights and weights. The nomogram for Indian females set by Banerjee (1962) was used for calculating the surface area. Nomograms based on the femal set by Banerjee and co-workers should be used for finding out the body surface area (BSA) of children, adult males and adult females (Banerjee, 1962). The mean surface area obtained for adolescents (13-18 years) and young adults (19-20 years) is given in Table. I.

TABLE I

MEAN SURFACE AREA OF THE SELECTED SUBJECTS

Age (years)	Height (cm)	Weight (kg)	Surface Area (m^2)
Adolescent girls			
13	153.6±2.234	39.67±4.81	1.48±0.105
14	152.5±2.580	40.50±1.32	1.49±0.566
15	155.8±1.817	42.33±1.47	1.53±0.176
16	161.3±5.476	46.0 ±6.58	1.63±0.045
17	154.6±5.476	45.83±2.45	1.57±0.134
18	160.4±5.291	47.83±3.77	1.48±0.276
Mean	156.4±3.812	43.69±3.35	1.51±0.217
Young adult women			
19	149.05±5.476	34.92±1.37	1.45±0
20	148.98±0	38.33±4.95	1.42±0.123
21	150.28±5.163	39.83±1.87	1.60±0.089
22	160.01±4.198	44.50±4.81	1.34±0.276
Mean	152.08±3.709	39.39±3.25	1.45±0.122

Comparison between adolescent girls and young adult women for surface area (m^2) } t = 0.2828

The table indicates that the mean surface area of adolescents aged 13-18 years ranged from 1.48 - 1.63 square metres, the mean being 1.51±0.217. The mean surface area of adolescent girls aged 17 years is 1.57±0.134. Devadas *et al* 1977) studied the surface area of adolescent college girls aged 17 years and they found the surface area to range from 1.42 to 1.60 square metres. The mean surface area of adolescent girls ages 18 years (in the present study) was 1.48±0.105. Devadas *et al* (1975) found the surface area of girls aged 18 years engaged in building work to range from 1.40 to 1.78 square metres.

The mean surface area of the young adult college women (19.22 years) ranged from 1.34±0.276 to 1.60±0.089 the mean being 1.45 ±0.122 square metres. Mason *et al* (1963) obtained similar values (1.426 square metres) when they measured the BMR of young women in Bombay. Banerjee (1962) found the surface area of young adult women of 19-22 years to range from 1.43 to 1.64 square metres. Probavathi (1974) found the surface area of women to range from 1.38 to 1.54 square metres.

When the surface area of the adolescent girls and young adult women were compared, the difference was not statistically significant.

B. Mean energy expenditure by the selected subjects in the basal condition:

The mean energy expenditure or the actual test calories was expressed in terms of kilocalories per minute, kilocalories per hour and in terms of kilocalories per square metre per hour.

The mean values for the different age groups is given in Table II and the individual values are given in Appendix.II.

TABLE II

MEAN ENERGY EXPENDITURE BY THE SELECTED SUBJECTS IN THE BASAL CONDITION

Age (years)	K.cal/min.	K.cal/kg/hour	K.cal/m²/ hour	Basal me abolism (k.cals)
Adolescent Girls				
13	0.704±0.436	0.924±0.063	27.17±1.015	1089
14	0.0662±0.020	0.978±0.059	26.86±1.004	957
15	0.687± 0.022	0.973±0.277	26.83±1.000	985
16	0.699± 0.109	0.909±0.158	26.14±1.030	1025
17	0.680± 0.069	0.881±0.181	26.01±1.007	1017
18.	0.621±0.092	0.935±0.053	25.71±1.010	919
Mean	0.676±0.125	0.934±0.132	26.45±1.006	998
Young adult women				
19	0.611±0.059	0.841±0.184	25.56±1.004	889
20	0.582±0.812	0.889±0.087	25.32±1.010	694
21	0.653±0.064	0.733±0.640	25.26±1.008	97[illegible]
22	0.576±0.036	0.985±0.119	25.18±1.001	82[illegible]
Mean	0.605±0.243	0.862±0.258	25.43±1.006	84[illegible]

Comparison between adolescent girls and young adult women for BMR (Kcal/m²/hr) } t = 4.867*

* Significant at one per cent level.

Banerjee (1962) studied the energy cost of the college girls (18-23 years). He found that the mean energy expenditure in the basal condition per minute to be 0.752±0.014. In the present study per minute to be ~~0.752±0.014. In the present~~ study the mean energy expenditure in the basal condition for college girls aged 18-22 years ranged from 0.576±0.036 to 0.653±0.064 and this is a little lower than the values reported by Banerjee (1962). Banerjee (1962) found the mean energy expenditure in the basal condition for 24 college girls (18-23 years) when expressed in terms of body weight to be 0.912±0.060. The present study indicates a mean expenditure in basal condition in terms of kilocalories per kilogram per hour to range from 0.733 ±0.640 to 0.978±0.059.

The mean BMR of the college girls (18-22 years) when expressed in terms of surface area ranged from 35.18 ± 1.00 to 35.71 ± 1.010. Banerjee (1962) reported the mean BMR of 24 college girls to be 28.75 ±0.47. Devadas et al (1977)reported the BMR of adolescent college girls to be 35.08 kcals per square metre per hour. When the BMR (interms of surface area) of adolescent girls and young adult women were compared the difference was significant at one per cent level. The adolescent girls had higher BMR than the adult women Dakshayani et al (1962) compared the BMR of adolecent girls with those of adult women and they found the BMR to be higher in adolescent girls than in adult women.

The mean BMR of the selected subjects were compared with the figures set by Mayo Foundation (formulatedby Boothby et al) and is given in Table.III.

TABLE III

COMPARISON OF BMR WITH THE VALUES SET BY MAYO FOUNDATION

Age	Present study ($K.cal/m^2/hr$)	Mayo Foundation ($k.cal/m^2/hr$)	Deviation Per cent.
Adolescent girls			
13-18	26.45±1.006	39.90	-31.56
Young adult women			
19 - 22	25.43±1.006	36.46	-30.25

The BMR of the adolescent girls and young adult women deviated from that set by Mayo Foundation by 31.56 and 30.25 per cent respectively. Banerjee (1962) found their values to deviate from Mayo Foundation for adolescent girls and adult women by only 12.2 and 12.5 per cent respectively.

C. Mean skinfold thickness and urinary creatinine levels of the selected subjects:

The mean values for skinfold thickness and urinary creatinine levels of the selected subjects is given in Table IV and the individual values are given in Appendix III.

TABLE IV

MEAN SKINFOLD THICKNESS AND URINARY CREATININE LEVELS OF THE SELECTED SUBJECTS

Age (years)	Mean skinfold thickness(mm)	't' value	Mean levels of creatinine (mg/100ml)	't' value
Adolescent girls				
13	8.38±0.64		37.87±1.140	
14	8.16±0.57		41.75±0.985	
15	8.36±0.74		41.24±1.382	
16	7.25±3.46		36.40±1.682	
17	8.30±1.25		34.10±1.077	
18	7.53±1.55		40.08±2.731	
Mean	7.99±1.36		38.57±1.499	
Young adult women		0.850		1.176
19	6.25±0.71		35.75±0.707	
20	6.28±1.10		35.58±0	
21	8.4 ±0.28		34.40±1.368	
22	7.68±1.55		42.91±5.458	
Mean	7.15±1.40		37.16±1.883	

Jelliffe (1966) has estimated the skinfold thickness of girls aged 13-15 years. The values obtained for adolescent girls 13-15 years in the present study is 70 per cent of the standards set by Jelliffe.

The values reported by Jelliffe for adult women is 16.5 mm. The value obtained in the present study is only 50 per cent of the above. When the skinfold thickness of adolescent girls and young adult women were compared, there was no significant difference. The urinary creatinine level is low when compared with the standard set by Oser (1971). The difference in urinary creatinine levels between adolescent girls and young adult women was not significant.

D. Mean daily food intake of the selected subjects:

The food intake of all the selected adolescent girls and young adult women was studied for three consecutive days when their BMR was measured (Appendix IV). The mean daily food intake is given in table V and the same is illustrated in figures 1 and 2.

TABLE V

MEAN DAILY FOOD INTAKE OF THE ADOLESCENT GIRLS AND YOUNG ADULT WOMEN (IN GRAMS)

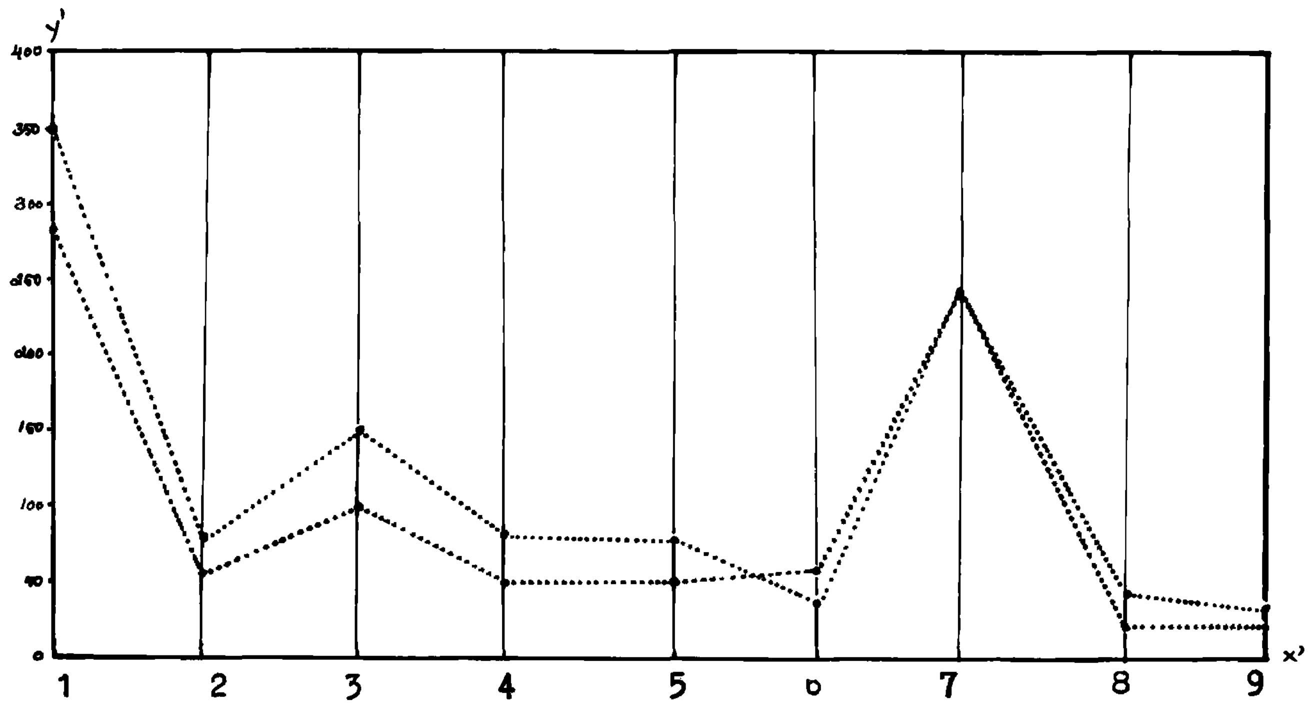
	Cereals	Pulses	Green leafy vegetables	Other vegetables	Roots and tubers	Fruits	Milk	Fats and oils	Sugar and jaggery
	g	g	g	g	g	g	g	g	g
Adolescent girls									
13	300	60	100	54	50	45	250	20	20
14	280	56	115	53	48	40	250	20	20
15	275	50	105	45	52	50	250	15	15
16	260	49	89	36	50	55	250	20	15
17	270	60	110	60	45	45	250	20	20
18	300	52	95	46	43	55	250	20	20
Mean	281	55	102	49	48	48	250	20	19
R.A*	350	70	150	75	75	30	250	35	30
Young Adult women									
19	225	52	50	45	20	55	300	20	25
20	185	45	45	40	32	50	425	25	20
21	210	48	60	38	28	55	300	20	20
22	200	55	35	35	30	60	250	15	20
Mean	205	50	47	40	28	55	319	20	21
R.A*	300	60	125	75	50	30	200	30	30

R.A* Recommended Allowance of ICMR (1968) as cited by Gopalan *et al* (1976).

The table indicates that all the selected subjects were on a vegetarian diet. None of the subjects who belonged to the different age group of adolescence consumed adequate amount of food except for milk and milk products. Similar findings were reported by Nirmala _et al_ (1968) and Devadas _et al_ (1976) who studied food intake of hostel students of the same college.

The food intake of the adult college women were poorer than the adolescents. But they all consumed adequate amounts of milk.

MEAN DAILY FOOD INTAKE OF THE ADOLESCENT GIRLS



Scale :
Y Axis 1cm = 50 g

FIGURE.1

1. Cereals
2. Pulses
3. Green leafy vegetables
4. Other vegetables
5. Roots and Tubers
6. Fruits
7. Milk
8. Fats and oils
9. Sugar and Jaggery

——Recommended Allowance

—— Actual intake

MEAN DAILY FOOD INTAKE OF THE YOUNG ADULT WOMEN

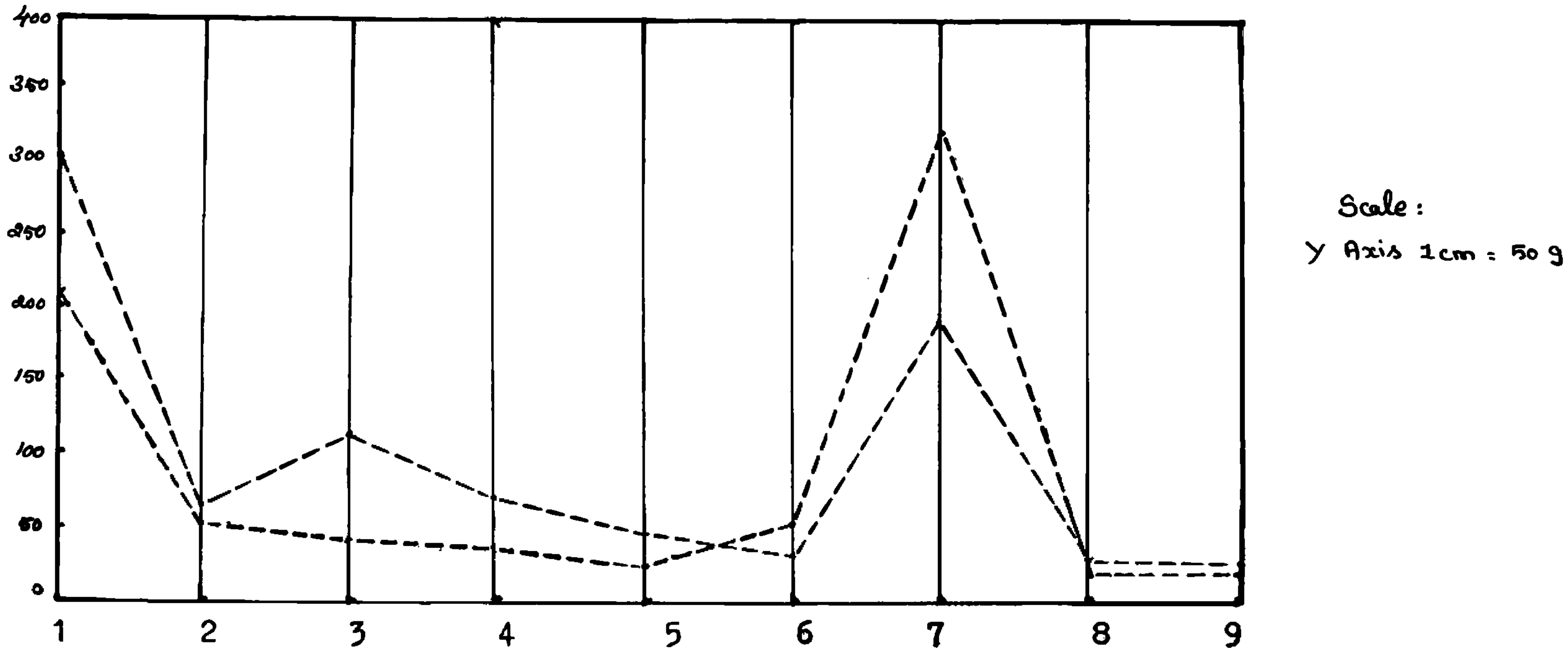


FIGURE.2

1. Cereals
2. Figures
3. Green leafy vegetables
4. Other vegetables
5. Roots and Tubers
6. Fruits
7. Milk
8. Fats and oils
9. Sugar and Jaggery

——— Recommended Allowance

——— Actual Intake

E. Mean daily energy and protein intake of the selected subjects:

The daily energy and protein intake of the selected subjects was calculated and is presented in Appendix.V. The mean values are given in table VI and the same is illustrated in figures 3 and 4.

TABLE VI

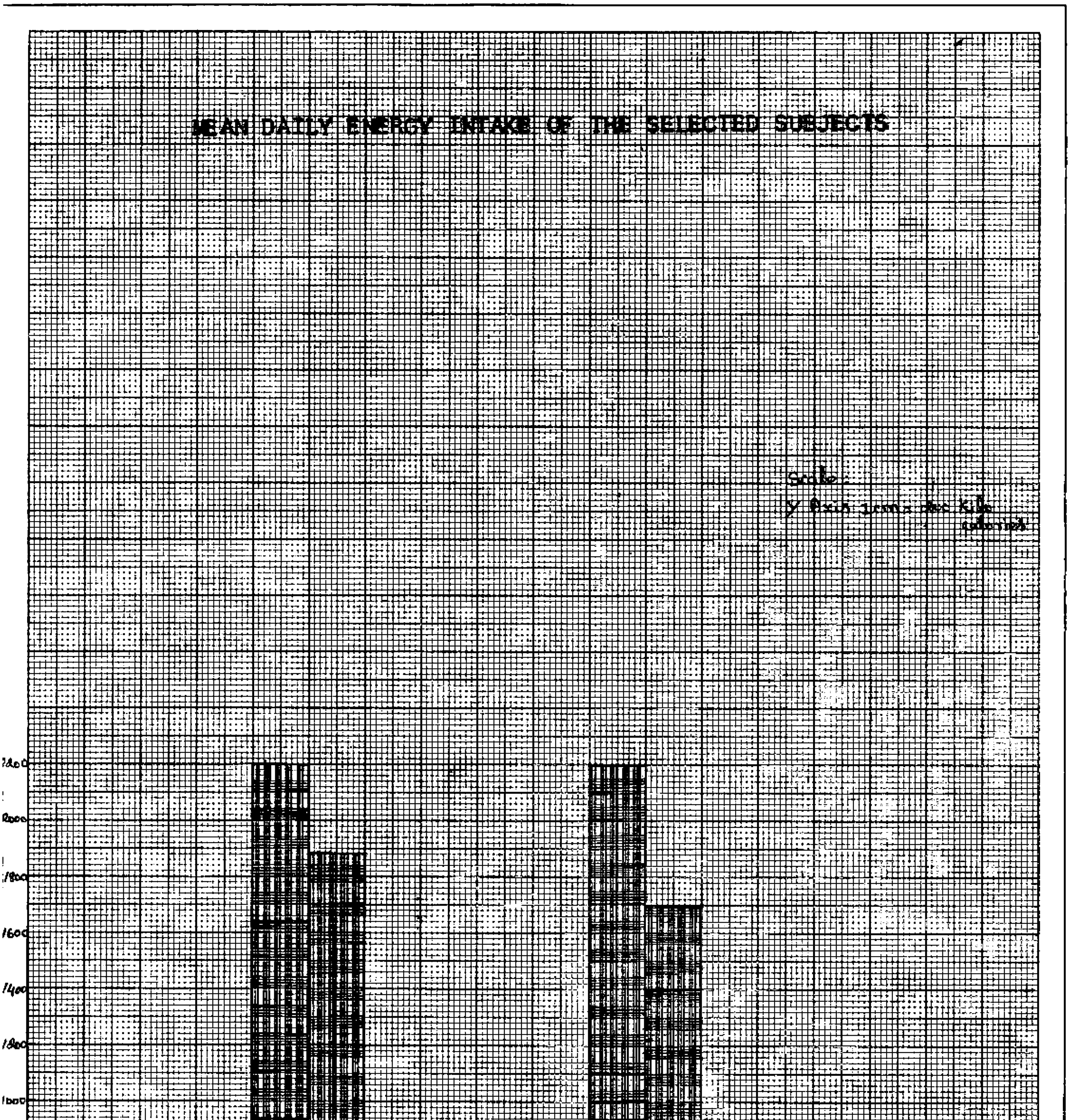
MEAN DAILY ENERGY AND PROTEIN INTAKE OF THE SELECTED SUBJECTS

Age (Years)	Energy (Kcals)	R.A*	Protein	R.A*
Adolescent Girls				
13	2013±263		52.6±2.6	
14	1781± 53		52.3±5.6	
15	1916±118		38.6±6.5	
16	1846±136		41.4±4.1	
17	1916± 84		30.7±8.6	
18	1837±161		34.8±2.5	
Mean	1885±136	2200	41.7±5.0	50
Young Adult women				
19	1769+417		39.6±2.4	
20	1848±152		31.6±2.0	
21	1720±166		31.9±3.1	
22	1448 ± 71		32.1±2.6	
Mean	1696±202	2200	32.4±2.5	45

*R.A.Recommended Allowance of ICMR (1968) as cited by Gopalan et al (1976).

The mean energy intake of adolescents as a group was below the recommended allowance (1885±135) and the mean protein intake was marginal (41.7±5.0). This finding is comparable to that of Nirmala et al (1968) and Devadas et al (1976) who studied nutrient intake of adolescent girls residing in the same college hostel. Nirmala et al (1968) found the mean energy intake to be 1690 kilocalories and protein to be 46 grams. Devadas et al (1976) found the mean energy intake to be 1555 kilocalories and the mean protein intake to be 46 grams. The findings of the present study is also comparable to the findings of Banerjee and Mahindran (1963) who stuided the food intake of adolescent girls in several hostels of India.

The mean energy intake of the young adult women was poor (1969±202) and the mean intake of protein (32.4±2.5) was also not upto the recommended allowance, Probhavathi (1974) has reported that adult women consume only 2000 calories per day.



Adolescents girls   Young adult women

FIGURE.3   RA Recommended Allowance
AI Actual Intake

MEAN DAILY PROTEIN INTAKE OF THE SELECTED SUBJECTS

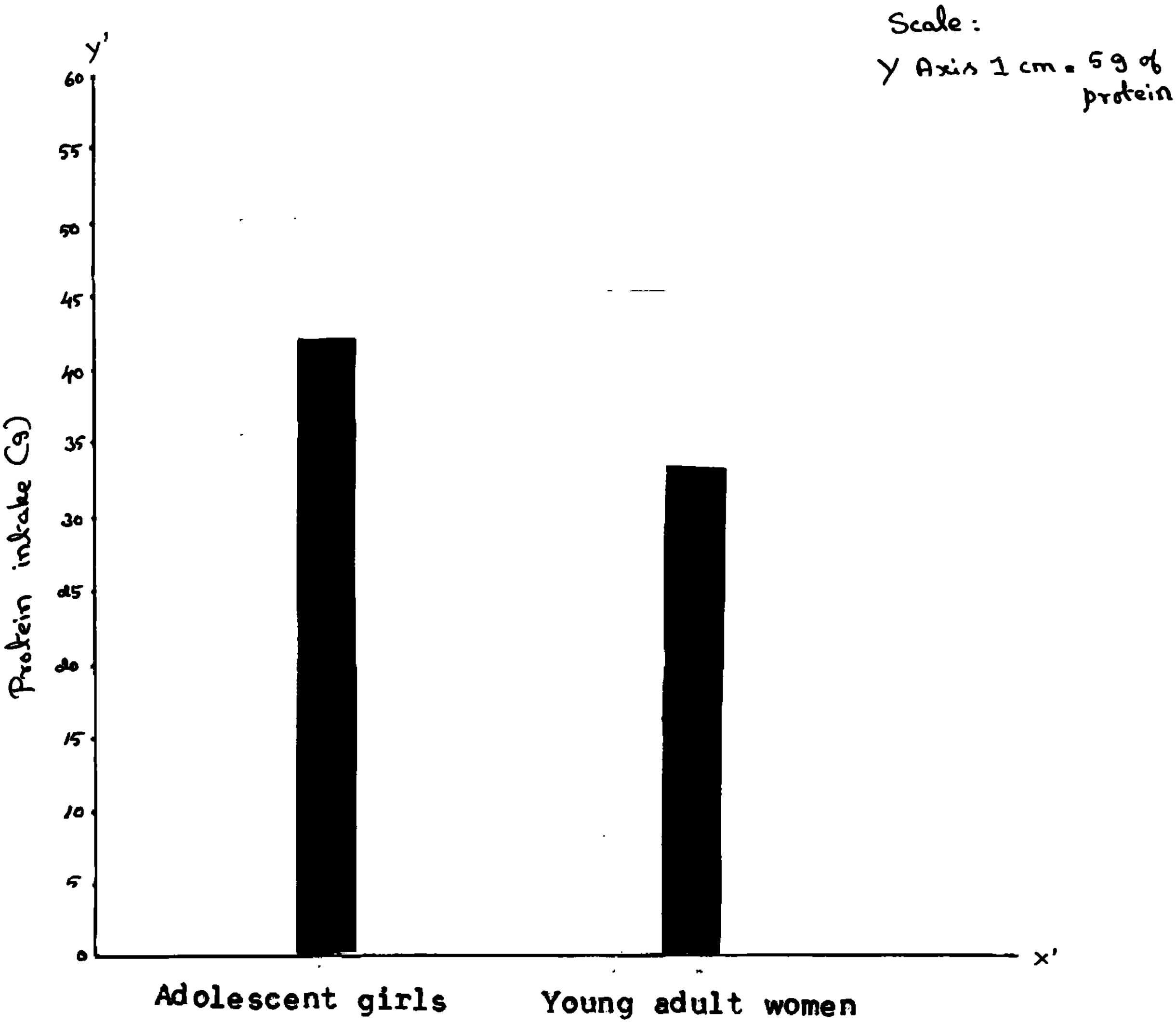


FIGURE.4

Recommended Allowance

Actual intake

V SUMMARY AND CONCLUSION

This investigation was undertaken to measure the basal metabolism of adolescent girls and young adult college women residing in school and college hostels. Adolescent girls from 13-18 years and young adult women of 19-22 years were selected. Six subjects were selected for each age group. The BMR was determined for three consecutive days. The food intake, urinary cretinine levels and skinfold thickness were determined on the days when the BMR was measured.

The findings of the investigation are as follows:

1. The mean surface area of adolescent girls was 1.51±0.217 and the mean surface area of young adult women was 1.45±0.122. The difference in surface area of adolescent girls and young adult women was not statistically significant.

2. When BMR was expressed in terms of kilocalories per minute, the values were normal. When BMR was expressed in terms of body weight, the values were slightly high. When BMR was expressed in terms of surface area, it was below the standards set by Mayo Foundation and Banerjee (1962). The mean BMR of adolescent girls was 26.43±1.006 and for young adult women 25.33±1.014. There was a significant difference between the BMR of adolescent girls and young adult women.

3. The mean values for skinfold thickness for adolescent girls was 7.991±1.36 and for young adult women was 7.150±1.41. The values obtained for adolescent girls is 70 percent of the standards set by Jellife (1966) and for young adult women, it is 50 per cent. There was no significant difference between the skinfold thickness of adolescent girls and young adult women.

4. The mean urinary creatinine per 100 millilitres for adolescent girls was 38.57±1.499 and for young adult women it was 37.16±1.883. The values obtained were low. The difference in urinary creatinine levels between both the groups was not significant.

5. The food intake of all the selected subjects were poor except for milk and milk products. The food intake of young adult women were poorer than that of the adolescent girls.

6. The mean energy intake of the young adolescent girls and young adult women were poor (1885±135 and 1969±202 respectively). The mean protein intake of the adolescent girls and young adult women were marginal (41.7±5.0 and 32.4±2.5 respectively).

7. The BMR obtained by the study for adolescent girls and young adult women are low. The energy intake of these

subjects was also low. Since all of them are residing in the hostel they have probably got accustomed to the dietary pattern and intakes.

Recommendations:

1. The BMR for the above mentioned age groups may be done during the different periods of the year to note fluctuations if any.

2. All the indices of the body composition can be dealt to give a complete picture and to establish coefficient of correlation between different variables.

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APPENDICES

APPENDIX I

ESTIMATION OF CREATININE IN URINE (FOLIN'S METHOD)

<u>Reagents:</u>

1. Picric acid: 1% solution was prepared in water using purified picric acid.

2. 10% Sodium hydroxide.

3. Stock creatinine solution: 1g of pure dry creatinine solution was dissolved in sufficient 0.1 N hydrochloric acid and the volume was made upto 1 litre (1 mg/ml).

<u>PROCEDURE:</u>

One ml of the urine was diluted with water to 100 ml, mixed well and 5 ml. (i.e. 0.05 ml.urine) aliquot was pipetted out into a test tube. To this added 2.5 ml. picric acid and 0.5 ml. of 10% sodium hydroxide. The content were made upto 10 ml. with water and the intensity of the Mahogony red colour developed was read at 520 mμ in Klett Summerson Colorimeter. A blank was prepared using 5 ml. of water instead of urine.

A standard curve was prepared by using creatinine standard solution (range 0 to 50 mg). The amount of creatinine in the sample was calculated from the standard graph.

APPENDIX II

MEAN ENERGY EXPENDITURE BY THE SELECTED SUBJECTS IN THE BASAL CONDITION

Age (years)	Subject	Height (cm)	Weight (kg)	Surface area (m^2)	K.cal/min	K.cal/kg hour	K.cal/m^2/hour	Basal metabolism k cals.
1	2	3	4	5	6	7	8	9
Adolescent girls 13	1	152.0	40	1.48	0.685	0.883	30.91	1157
	2	154.3	46	1.58	0.699	0.961	29.67	1268
	3	155.0	45	1.57	0.757	0.803	28.36	1103
	4	151.5	34	1.38	0.735	0.923	26.29	1069
	5	158.0	38	1.50	0.644	0.703	25.41	927
	6	150.4	35	1.38	0.707	0.957	26.36	1019
14	1	156.0	42	1.53	0.688	0.982	25.61	989
	2	154.2	38	1.46	0.623	0.958	26,11	897
	3	152	41	1.49	0.622	0.985	26.85	970
	4	149.9	40	1.46	0.653	0.890	26.69	941
	5	152.2	40	1.48	0.657	0.987	27.96	948
	6	149.8	42	1.49	0.689	0.980	27.66	1000
	1	157.0	45	1.59	0.734	0.978	26.65	1055
	2	154.9	42	1,52	0.683	0.977	25.65	972
	3	158.3	41	1.54	0.645	0.944	25.12	928
	4	155.0	42	1.52	0.688	0.980	27.15	987
	5	154.4	41	1.50	0.666	0.986	26.90	969
	6	155.4	43	1.58	0.706	0.935	27.50	1008

contd.....

1	2	3	4	5	6	7	8	9
	1	159.0	40	1.56	0.593	0.888	24.95	934
	2	157.2	42	1.52	0.565	0.807	22.29	813
16	3	164.2	53	1.76	0.859	0.972	28.23	1192
	4	163.4	41	1.54	0.658	0.960	25.86	958
	5	162.3	50	1.70	0.780	0.910	28.00	1142
	6	162.0	49.5	1.69	0.764	0.920	27.54	1117
	1	148.8	42.5	1.48	0.883	0.938	30.94	1220
	2	155.0	50	1.68	0.782	0.938	28.62	1127
	3	158.1	46	1.59	0.577	0.753	21.78	831
17	4	155.4	48.5	1.60	0.738	0.964	27.23	1048
	5	154.2	46	1.57	0.898	0.910	25.65	899
	6	151.3	42	1.57	0.624	0.891	23.84	898
	1	157.4	43	1.56	0.570	0.855	24.72	878
	2	165.0	55	1.19	0.754	0.984	28.64	1061
18	3	160.2	46	1.62	0.885	0.913	28.28	1064
	4	161.8	49	1.66	0.524	0.925	22.76	754
	5	160.2	48	1.65	0.622	0.980	24.94	900
	6	157.6	46	1.61	0.574	0.958	25.95	800

contd......

1	2	3	4	5	6	7	8	9
Young adult	1	144.0	38	1.46	0.604	0.885	24.82	882
women	2	151.9	33.5	1.44	0.638	0.981	26.77	928
19	3	147.0	35.	1.45	0.509	0.805	23.68	815
	4	150.0	34.5	1.44	0.607	0.923	25.30	873
	5	146.4	34.5	1.51	0.703	0.703	27.70	1004
	6	155.0	34	1.44	0.608	0.957	25.08	857
	1	150.0	37	1.38	0.422	0.683	18.33	607
	2	148.1	42	1.47	0.867	0.955	32.15	113
20	3	152.9	38	1.41	0.601	0.947	28.81	987
	4	148.0	38	1.39	0.598	0.990	25.80	861
	5	147.4	39.5	1.43	0.618	0.925	28.05	963
	6	147.5	38.5	1.47	0.580	0.840	20.80	734
	1	149.0	41	1.60	0.694	0.979	28.01	1000
	2	150.2	39	1.59	0.686	0.914	25.87	987
21	3	140.9	38	1.56	0.584	0.787	26.34	961
	4	148.8	39.5	1.61	0.644	0.805	24.02	922
	5	151.0	43.5	1.64	0.733	0.100	27.00	1063
	6	152.8	38	1.61	0.580	0.810	23.35	902
	1	162.5	42.5	1.38	0.616	0.973	27.41	908
	2	157.0	45	1.57	0.572	0.980	25.04	823
22	3	158.3	44.5	1.38	0.565	1.013	24.82	815
	4	154.8	48	1.38	0.564	0.980	26.34	794
	5	164.2	44	1.34	0.564	0.980	25.22	811
	6	163.3	45	1.40	0.580	0.990	24.29	818

APPENDIX III

MEAN SKINFOLD THICKNESS AND URINARY CREATININE LEVELS OF THE SELECTED SUBJECTS

Age (Years).	Subjects	Mean Skinfold thickness (mm)	Mean Urinary Creatinine level (mg/100ml)
Adolescent girls 13	1	8.2	39.75
	2	9.3	38.75
	3	7.5	35.00
	4	8.0	38.25
	5	8.5	40.00
	6	8.8	39.50
14	1	7.9	41.50
	2	8.0	40.00
	3	7.5	42.00
	4	8.1	41.50
	5	8.9	43.00
	6	8.3	42.50
15	1	8.6	39.75
	2	7.6	42.50
	3	9.3	40.00
	4	7.8	41.70
	5	8.1	42.00
	6	9.0	41.50
16	1	5.8	40.00
	2	7.5	38.00
	3	9.5	38.40
	4	6.9	35.00
	5	6.8	35.00
	6	7.0	36.00
	1	7.0	35.50
	2	10.0	32.00
	3	7.6	33.50
	4	9.4	33.50
	5	9.1	[illegible]
	6	6.7	34.10

contd......

Age (years)	Subjects	Mean skinfold thickness (mm)	Mean Urinary creatinine level (mg/100ml)
	1	6.2	42.50
	2	9.8	37.00
	3	8.4	38.00
18	4	7.9	45.00
	5	6.7	42.50
	6	6.5	37.50
Young	1	6.1	[illegible]
adult	2	6.7	35.00
women	3	6.0	38.00
19	4	6.9	35.50
	5	6.9	38.00
	6	4.9	37.00
	7		
	1	5.2	37.00
	2	7.7	36.00
	3	7.4	35.50
20	4	5.0	35.00
	5	6.9	35.00
	6	5.5	34.00
	1	8.4	36.00
	2	8.5	35.00
	3	7.5	37.20
21	4	8.8	32.00
	5	8.2	33.20
	6	8.9	34.00
	1	7.1	43.42
	2	6.9	43.50
	3	7.4	4[illegible].30
	4	8.4	43.70
	5	7.6	42.00
	6	9.7	42.50

APPENDIX IX

MEAN DAILY FOOD INTAKE OF THE SELECTED SUBJECTS (in grams)

Age (years)	Subject	Cereals	Pulses	Green leafy vegetables	Other vegetables	Roots and tubers	Fruits	Milk	Fats and oils	Sugar and jaggery
1	2	3	4	5	6	7	8	9	10	11
Adolescent girls 13	1	300	61	102	58	51	44	255	18	17
	2	325	58	98	55	49	46	245	22	25
	3	250	62	97	52	52	45	247	19	18
	4	300	59	105	56	48	47	258	21	22
	5	350	61	98	51	50	45	240	17	19
	6	275	59	101	57	50	46	250	25	21
14	1	280	54	114	52	47	39	256	17	18
	2	282	58	118	54	49	41	246	25	22
	3	278	55	112	53	44	38	247	18	17
	4	285	57	118	51	52	42	258	22	25
	5	275	52	115	55	41	40	241	19	20
	6	280	60	117	58	55	41	259	21	21
15	1	270	45	100	45	51	49	245	14	16
	2	280	55	110	47	55	51	255	16	14
	3	277	47	103	44	52	48	247	13	14
	4	273	53	107	46	53	52	258	17	16
	5	280	48	104	46	55	47	260	16	14
	6	270	52	106	44	51	53	240	14	16

contd........

1	2	3	4	5	6	7	8	9	10	11
	1	260	49	89	36	50	55	250	20	15
	2	250	49	88	32	45	54	245	18	14
	3	270	40	90	40	55	56	255	22	16
16	4	230	58	89	36	43	53	240	19	13
	5	290	43	86	34	57	57	260	21	17
	6	260	55	92	38	50	55	250	20	15
	1	260	58	105	58	44	43	245	17	16
	2	280	62	115	62	46	47	255	23	24
17	3	250	57	107	64	43	41	240	18	18
	4	290	63	113	56	47	49	260	22	22
	5	265	59	105	58	41	43	230	19	21
	6	275	61	115	63	49	47	270	21	19
	1	250	51	90	44	41	52	240	19	17
	2	350	53	100	48	45	58	260	22	23
	3	270	50	92	40	42	54	230	19	22
18	4	330	54	103	52	44	56	270	21	18
	5	280	48	94	45	45	50	200	23	21
	6	320	56	96	47	41	60	300	17	19

1	2	3	4	5	6	7	8	9	10	11
Young adult women	1	220	55	45	40	15	50	275	35	25
	2	230	49	55	50	25	60	325	20	20
19	3	210	50	50	45	20	56	300	25	35
	4	240	54	50	45	10	58	325	19	15
	5	230	58	48	40	25	52	300	15	30
	6	220	46	42	50	35	55	275	25	25
	1	180	45	40	35	31	56	420	22	15
	2	200	40	48	45	33	60	430	25	18
	3	175	46	45	41	35	48	418	25	25
20	4	195	44	44	39	33	40	432	28	15
	5	170	50	45	33	27	52	418	20	22
	6	190	45	50	47	31	45	435	30	25
	1	200	45	60	38	28	55	300	20	25
	2	220	40	55	35	25	50	350	15	18
	3	210	48	70	41	28	60	300	20	15
21	4	205	51	60	40	30	56	300	25	20
	5	215	56	50	38	28	52	350	22	22
	6	210	48	65	38	31	58	400	28	20
	1	150	45	33	30	30	55	240	10	15
	2	250	65	34	40	25	65	280	15	25
	3	200	55	35	32	35	60	225	20	18
22	4	200	40	35	34	28	50	250	18	20
	5	175	70	36	35	32	70	275	12	22
	6	225	85	37	38	30	60	250	15	20

APPENDIX V

MEAN ENERGY AND PROTEIN INTAKE OF THE SELECTED SUBJECTS

Age (years)	Subject	Energy k cal	Protein g	Age (years)	Subject	Energy k cal	Protein g
	1	2515	51.9		1	1485	30.4
	2	1887	53.4		2	1966	31.7
13	3	2135	51.7	18	3	1818	35.3
	4	1806	49.3		4	1866	35.3
	5	1720	56.1		5	1921	39.3
	6	2016	53.4		6	1963	36.6
	1	1779	53.0		1	1728	31.8
	2	1923	43.0		2	1703	33.4
14	3	1813	55.5	19	3	1665	38.6
	4	1790	47.7		4	1924	36.5
	5	1802	56.6		5	1805	31.6
	6	1659	58.2		6	1790	36.9
	1	1916	35.4		1	1591	28.9
	2	2083	43.1		2	1759	28.7
15	3	1950	35.0	20	3	1884	34.7
	4	1841	35.8		4	2057	35.3
	5	1974	46.6		5	1975	29.7
	6	1783	36.1		6	1822	22.0
	1	1740	43.2		1	1814	27.4
	2	1967	47.5		2	1863	31.7
16	3	1597	43.0	21	3	1727	33.3
	4	1791	31.9		4	1607	36.6
	5	2030	41.1		5	1642	31.9
	6	1960	41.3		6	1666	30.6
	1	1937	30.86		1	1473	28.6
	2	1947	35.33		2	1315	28.9
	3	1804	38.50		3	1446	30.1
17	4	1955	27.6	22	4	1455	29.7
	5	1946	24.3		5	1466	36.0
	6	1911	32.73		6	1532	33.0