ENERGY REQUIREMENTS OF INDIANS

Dr. B. S. Narasinga Rao
Former Director, National Institute of Nutrition, Hyderabad

Man needs adequate energy for maintaining body temperature, metabolic activity, supporting growth and physical activity. Lack of adequate dietary energy due to poverty, famine and other food shortages have resulted in widespread chronic energy deficiency in the developing countries of the world, particularly among young children. Currently, energy requirement is assessed in terms of energy expenditure rather than in terms of energy intakes. The principle of using energy expenditure to arrive at estimates of energy requirement must be further emphasised especially among population groups in developing countries like India where energy intake may vary widely due to the influence of factors like poverty and limited access to food.

Definition of Energy Requirement

The energy requirement of an individual can be defined as the level of energy intake from food that will balance the energy expenditure when the individual has a body size, composition and level of physical activity that is consistent with long-term good health and will allow for maintenance of economically necessary and socially desirable activity. In children, pregnant and lactating women, the energy requirement includes the energy needs for growth, deposition of tissues or the secretion of milk at rates consistent with good health.

Energy Requirement Of Indians

Historical

Energy requirement of Indians was first recommended in 1944[1] by the Nutrition Advisory Committee of the Indian Research Fund Association (now ICMR). These recommendations were essentially based on the 1936 recommendations of the Technical Commission of the Health Committee of the League of Nations[2] and the 1941 recommendations of the Food & Nutrition Board of USA[3] (Text Box 1). The basis of adapting these RDAs by Indians is not clear. The only data the Indian Committee had in 1944 were the BMR values for Indians reported during 1926-1939. Dr.Patwardhan[4] discussed the limitations of 1944 recommendations. The reference Indian man and woman at the time were defined as having body weights of 55 kg and 45 kg respectively. The next attempt to revise energy allowances for Indians was in 1958 by the Nutrition Advisory Committee of the ICMR[4]. The energy allowances for Indians in 1958 were largely based on approaches used by the FAO Committee on energy requirements in 1950[5] and 1957[6] (Table 1).

Text Box 1 ENERGY REQUIREMENT OF INDIANS

A. Historical

i) 1944 : N.A.C. IRFA (ICMR) Based on Recommendation of 1936 Technical Commission of Health Committee of League of Nations and 1941 Recommendations of Food and Nutrition Board of USA.

ii) Only data on Indians : BMR measured during 19261939.

iii) Basis of adaptation to Indians is not clear : Ref. B.Wt. Men 55 kg, Women 45 kg.

iv) Number of Limitations : Discussed by Dr.V.N.Patwardhan

B. 1958 : NAC, ICMR

Basis - FAO 1950 and 1957 proposals on Calorie Requirement. Method Factorial Activity breakup method.

Data available on Indians : BMR and energy cost of daily activities

The basis of the 1958 recommendation of energy for Indians has been fully discussed by Dr Patwardhan[4]. Daily energy requirement for Indian adult was derived by the activity break up or the factorial approach. These computations were based on data on BMR and energy cost of activities then available for Indians[7] (Text Box 2).

The assumed energy cost of several daily activities was higher than that reported by FAO by 7 to 25%. The reference body weights then recommended were also 55 kg and 45 kg for

Table 1: Computation of Energy Requirement of Indian Adult by Activity - Break-Up Method (1958)

Activity	Duration Hr.	Man (55 kg)		Women (45 kg)	
		Rate (Kcal/kg/hr)	Total For 8 hrs.	Rate (Kcal/kg/hr)	Total For 8 hrs.
Sleep	8	1.05	460	0.98	340
Non-Occupational Activity	8	2.80	1220	2.30	826
Occupational Activity	8				
Sedentary		1.7	750	1.7	610
Moderate		2.5	1100	2.5	900
Heavy		5.0	2200	5.0	1800

Average Rate of Energy Expenditure (Kcal/kg/hr)

Man :	Sedentary	1.85	Moderate	2.12	Heavy	2.95
Woman :	Sedentary	1.66	Moderate	1.93	Heavy	2.76

Totaly Daily Requirement of Energy, Kcal

	Sedentary	Moderate	Heavy
Man	2400	2800	3900
Woman	1800	2200	3000

adult men and women respectively. It must be recognised that the 1958 recommendations did not have strong support of work carried out in India on energy requirement of Indians. Dr Patwardhan himself pointed out these limitations. The 1958 recommendations suffer from the following limitations, which indicate that the 1958 figures for energy requirement of Indians appear to be an overestimate not only in the case of heavy activity category but also in the average range of expenditure assumed for moderate activity:

- The energy expenditure during non-occupational activity appears to be high due to use of higher values for some of the non-occupational activity.

Text Box 2 COMPONENT OF ENERGY REQUIREMENTS

Adults	:	Basal Metabolism + Additional energy needs for activity
Infants and Children	:	Basal Metabolism + Activity + Growth Requirement
Pregnancy	:	Basal Metabolism + Activity + Tissue (Foetal Growth)
Lactation	:	Basal Metabolism + Activity + Milk Secretion
Units of Energy		Kcal and K Joule Units of Heat and Force
1 Kcal	–	4.184 KJ (Kilo Joule)
1000 Kcal	–	4184 KJ = 4.184 MJ (Mega Joule)
KJ	–	0.239 Kcal 4.184 KJ

- The average rate of energy expenditure during heavy occupational activity namely 5 kcal/kg/hr represents an unusually high rate of energy expenditure. Measurement of coal miners[8], stone cutters[9], agricultural labour[10], labourers in a spinning mill[11] indicate that it cannot be more than 4 kcal/kg/hr. This is consistent with the observation[12] that the maximum level of sustained activity can be carried out only at 35% of VO_2 Max (4 kcal/kg/hr). VO_2 Max among Indians is also reported to be lower than among Americans and Swedes[13]. Hence the maximum work they can do is also limited.

It is surprising that in spite of the above limitations, the 1958 recommendations for energy requirements for Indian adults were not revised for thirty years until in 1989.

Energy Requirement of Indians: Current (1989) Recommendations

The energy requirement and allowances for Indians were revised in 1989 by the Expert Group of the ICMR. This Committee adopted the procedure used by 1985 FAO/WHO/UNU Expert Consultations[15] in arriving at the energy requirement of Indians. The 1989 Committee, however, used the BMR factors for arriving at the energy requirements of Indian reference man and woman. First, the energy cost of rest and physical activity was expressed as multiples of BMR, which is called the physical activity ratios (PAR). There are decided advantages of expressing energy requirement in terms of BMR Units (Text box 3):

- The energy expenditure for specific task when expressed as ratios of BMR is similar for adult men and women with different body weights and ages;
- By expressing the energy requirement in terms of BMR units, the problem of lower BMR of Indians is automatically taken care of; and
- The available data on energy cost of activities reported for Indians when expressed as BMR units are fairly close to the International data, which can be employed if Indian data is not available.

BMR of Indians

Recent careful measurements of BMR in adult Indians have shown that BMR of Indians is lower by 5% (Table 2). The FAO / WHO / UNU Consultations[15] have given prediction equations for computing BMR from the body weights. These equations have been modified to use for Indian adults, which taking into consideration the lower BMR of Indians[16].

Reference Man and Woman

Taking the body weights of well-nourished Indian adults, who had satisfactory growth during their childhood into account, the Indian Reference Man and Woman have been redefined as having body weights of 60 kg and 50 kg respectively. These body weights correspond to desirable weights for their current heights.

Text Box 3 ENERGY EXPENDITURE EXPRESSED IN BMR UNITS

PAR – Physical Activity Ratio :

$$= \frac{\text{Energy cost of an individual activity per minute}}{\text{Energy cost of BMR per minute}}$$

PAL : Physical Activity Level

Total energy expended for 24 hours
PAL x BMR (24 hr)

TEE : Total Energy Expenditure (24 hr) = PAL x BMR (24 hr)

Advantages :

The energy expenditure when expressed in BMR units is similar for

1. Adult men and women
2. Individuals with different body weights
3. Available Indian data when expressed as BMR Units (PAR) are comparable to International data (they can be used for Indians).

Table 2: Equation for predicting BMR of Indian adult from body weights base on BMR of Indians

Sex	Age (Years)	Prediction equation for Indian adults	Corr. Coeff.	SC
Male	18-30	14.5xB.Wt. (Kg)+645	0.65	15.1
	30-60	10.9xB.Wt. (Kg)+833	0.60	16.4
	>60	12.8xB.Wt. (Kg)+463	0.79	14.8
Female	18-30	14.0xB.Wt. (Kg)+471	0.72	12.1
	30-60	8.3xB.Wt. (Kg)+788	0.70	10.8
	>60	10.0xB.Wt. (Kg)+565	0.74	10.8

5% lower than that proposed by FAO/WHO/UNU (15)

Energy requirement of Indian Reference Adult Man and Woman

The energy requirements of the reference adult man and woman in terms of BMR units for three categories of lifestyles- sedentary, moderate and heavy were redefined by the 1989 ICMR Expert Group[14] (Table 3). The derived BMR factors or PAL values (TEE/BMR) arrived at by the Committee for computing the daily energy requirements of Indian adults are 1.6, 1.9 and 2.5 respectively for the three categories of activity (lifestyle) listed above. These are higher than the factors proposed by the 1985 FAO / WHO / UNU Consultations, namely, 1.55, 1.78 and 2.10 for men and 1.56, 1.64 and 1.82 for women respectively. These values are for the industrial society of the West with a fair degree of mechanization and more leisure time. However, the BMR factors for the population groups living in developing countries like India should be somewhat higher because work in these countries are less mechanized requiring more physical input and men and women in these agricultural societies work to the same extent of exertion and hence the PAL factors were assumed to be same for both. However, it was felt that even the current BMR factors recommended for Indians are on the generous side especially for heavy and moderate activity. Thus the BMR factor of 2.5 proposed for heavy activity appears to be on the rather high. This is obvious from Indian data on stonecutters[9],

Table 3: Computation of Energy Requirements of Indian Adults in BMR Units (1989)

Activity	Duration Hr.	Rate of energy expenditure in terms of BMR Units (PAR)		
		Sedentary Activity	Moderate Activity	Heavy Activity
Sleep	8	1.0	1.0	1.0
Non-occupational Activity**	8	2.1	2.0	2.0
Occupational Activity	8	1.7	2.8	4.5
Average for 24 Hr (PAL)		1.6	1.9	2.5
Total Energy Need for 24 Hr. Kcal (TEE)				
Reference Man (60 kg) BMR 1515 Kcal/24 hr.		2424	2878	3780
Reference Woman (50 Kg) BMR 1171 Kcal/24 hr.		1872	2223	2925

** Break-up of non-occupational activity	Sedentary	Moderate & Heavy
Resting and moving about and personal needs At 1.7 BMR	60% of time (4.8 hrs)	70% of time (5.6 hrs)
Household work and recreation 2.8 BMR	40% of time (3.2 hrs)	30% of time (2.4 hrs)

agricultural labour[10] and textile mill labour[11] (Table 4). The overall daily energy expenditure among these workers engaged in heavy activity is only 4.0 in PAR units during working hours and the daily average expenditure is only 2.3 in PAL units. The revised energy requirement of Indian adult with reference body weight is computed by employing the lower PAL factors computed from the prediction equation is shown in Table 5. The PAL factors for three level of activity or lifestyle are within the values suggested by recent (2001) FAO/WHO/UNU Consultations on energy requirements.

There is an urgent need to determine the amount of time spent on different activities in a day by workers engaged in work of different intensity, particularly by those engaged in moderate and heavy type of work. Time spent in actual work and off work should be determined over several days in a week and also over seasons in a year. This is necessary in the case of agricultural workers, among whom work intensity varies between agricultural and non-agricultural seasons and in the case of industrial workers between working days and holidays.

Energy requirement of other groups

Energy requirements of other groups recommended in 1989 were primarily based on those suggested by FAO/WHO/UNU Consultation of 1985, as there were no Indian data for these groups.

Infants: Energy requirement of infants are based on considerable Indian data on breast milk intake. These values are given in Table 6,

Table 4: Energy Expenditure of Indian Engaged in Heavy Activity Expressed in BMR Units

Activity	Average Body Weight Kg.	Average BMR/24 hr. Kcal	Energy expenditure in BMR Units		
			Working Hours	Non-Working Hours	Average Per day
Agricultural Labour	44.3	1287*	4.03	2.01	2.35
Textile worker	47.4	1286	3.87	2.24	2.37
Stone Cutter	46.1	1311	3.97	2.00	2.31
Mean			3.96	2.05	2.34

* Computed. Others actually measured

Table 5: Revised Suggestions for Energy Requirement of Indian Adults in BMR Units

Activity	Duration Hr.	Rate of energy expenditure in terms of BMR Units (PAR)		
		Sedentary Activity	Moderate Activity	Heavy Activity
Sleep	8	1.0	1.0	1.0
Occupational Activity	8	1.7	2.5	3.9
Non-occupational Activity	8	2.2	2.0	2.0
Average for 24 Hr (PAL)*	24	1.6	1.8	2.3
Total Energy Expenditure (Kcal) (TEE)				
Reference Man 60 kg BMR 1515 Kcal		2424	2727	3484
Reference Woman 50 Kg BMR 1171 Kcal		1874	2108	2693

*FAO/WHO/UNU (2001) PAL VALUES

Sedentary	1.40 – 1.69
Moderate	1.70 – 1.99
Heavy	2.00 – 2.40

and are not very different from the 1958 figures.

Children: Based on the energy intakes of normally growing children of 1-10 years and daily energy expenditure of normally growing boys and girls of 10-18 years, FAO / WHO / UNU Expert Consultation have computed energy requirement of children of 1-18 years. Following the suggestions of the 1985 FAO / WHO / UNU Expert Consultations, the energy needs of Indian children of 1-18 years have been computed from energy needs per kg as reported by FAO/WHO and body weights of well-to-do Indian children.

The recommended energy intakes for preschool children correspond closely to the intake values observed in well-to-do preschool children of Hyderabad[17], which were determined over a period of one year on 6 occasions, and the intake values represent the average of these observations (Table 7). The 2001 FAO/WHO/ UNU Consultation estimated energy requirement of infants and children of 1-10 years based on energy expenditure data based on DLW and heart beat monitor methods and estimates of growth requirement. Energy requirement estimate up to 10 years were found to be 18-20% lower than the earlier estimates based on dietary intake method (1985). The estimate of energy requirements from 12 years onwards was based on factorial method and estimates of growth requirement and were 12% higher than the earlier (1985) estimates. There

Table 6: Energy Requirements of Infants, Children and Adolescents per day* (1989)

Age Group	Boys		Girls	
	Body wt Kg.	Energy Kcal	Body wt Kg.	Energy Kcal
INFANTS				
0-6 months	5.4	108/Kg		
6-12 months	8.6	98/Kg		
PRESCHOOL CHILDREN (BOTH GENDERS)				
1 - 3 Yrs	12.2	1240*		
4 - 6 Yrs	19.0	1690*		
SCHOOL CHILDREN				
7 - 9 Yrs	26.9	1950		
10 - 12 Yrs	35.4	2190	31.5	1970
ADOLESCENTS				
13 - 15 Yrs	47.8	2450	46.7	2060
16 - 18 Yrs	57.1	2640	49.9	2060

Table 7: Energy intake of Indian well-to-do urban preschool children and the main sources of energy (intake/day/child)

Age group yr	Energy Kcal	Cereals		Fat		Milk		Sugar	
		g	En%	g	En%	g	En%	g	En%
2-3	1223	114	32.6	21	15.5	382	22.6	20	6.5
3-4	1467	132	31.5	17	10.4	407	23.6	14	3.8
4-5	1530	143	32.7	19	11.2	367	20.4	23	6.0
5-6	1500	149	34.8	32	19.2	360	20.4	14	3.7

Mean : 1450 Ref. Narasinga Rao *et al.* (1983)

is a need to estimate total energy expenditure using double labelled water technique in Indian children in the urban and rural areas.

Pregnancy and Lactation: There is no change in the recommended additional energy intake for pregnant and lactating women. Additional energy recommended during pregnancy is 300 kcal/d and during lactation the suggested extra energy intake is 550 and 400 kcals during 0-6 and 6-12 months of lactation respectively. Doubts have been expressed as to the applicability of the factorial approach for determining energy needs during lactation and pregnancy in the developing countries. Women in these countries may tend to conserve energy from normal activity during pregnancy and lactation. The need for determining direct energy expenditure of women during pregnancy and lactation has therefore been emphasized[18]. We have determined[19] the energy balance among Indian lactating women over a period of six months. The energy cost of daily activity and the cost of milk output of six women during six months of lactation were measured. The energy cost of daily activity corresponded to moderate activity, the mean value for work and sleep being 1775 kcal/day and the energy cost of milk output was found to be 549 Kcal/d (Table 8). This study provides a direct estimate of energy requirement during lactation in India. Such studies are required to be carried out among pregnant women and lactation among different income groups and in rural and urban areas.

Doubly labelled water method, a newer method for estimating energy expenditure

Doubly Labelled Water ($2H_2{}^{18}O$) Method for direct measurement of energy turnover in a free-living person[20] has been in use for the past two decades. Energy expenditure in a large number of individuals of different age groups has been measured by this technique. This method employs doubly labelled water with stable O^{18} and H^2. The isotope concentration has to be measured on 10-14 days and provides only an average value of energy expended; this method does not provide day-to-day variation in energy expended or energy spent in different daily activities. But it provides a total estimate of daily energy expended over 10-14 days and it is more accurate than estimates of energy requirement based on dietary intake and factorial method.

Table 8: Energy Balance in undernourished Indian Lactating Women (Kcal/D)**

Parameters	Initial	Duration of lactation (Months)						Mean
		1	2	3	4	5	6	
BMR	926	959	762	830	820	999	917	888
Energy spent in physical activity + Rest	1590	1717	1829	1776	1790	1896	1876	1775*
Energy drawn for milk production	195	559	568	501	518	593	552	549
Total energy expenditure in 24 hr	1785	2276	2397	2277	2308	2489	2428	2277

**No. of subjects 8. Average Body weight 44.8 kg. BMI (19.0).
* For 50 kg body weight woman 1981 Kcal

So far a large number of measurements on TEE of different physiological groups have been made mostly in developed countries and some in developing countries. Only two studies have been reported from India[21,22]. These studies were done on three groups of urban and one group of rural adults. The TEE obtained by the DLW method was found to be comparable to the values obtained by the factorial method by recall or by whole body calorimetry. In view of earlier criticism of the factorial method for estimating energy requirement, there is a need to carry out more studies among Indians of different physiological groups, particularly of infants, children, pregnant and lactating women. The total energy expenditure (TEE) data generated by DLW method and the heart rate monitor method (HRM) have been used by the recent 2001 FAO/WHO/UNU Energy Consultation for arriving at the energy requirement of different groups.

General guidelines for the practical use of recommendations on energy requirement for Indian population

Energy allowances represent only the average requirement and no allowance is to be made for any safety margin, unlike in case of other nutrients like proteins and vitamins. Energy requirement of adults and adolescents should be related to energy expenditure rather than to intake. In the case of children below 10 years of age, however, energy requirements may be related to intakes of normal children for satisfactory growth or more precisely determined TEE by newer methods like DLW or HRM method and requirement of growth should be separately computed. For undernourished children, the recommended intakes for the age should be used and no adjustments for the actual body weights should be made. This would help in promoting catch up growth of growth-retarded children. While judging the adequacy of energy intake of adults with body weights lower than reference body weight, the requirement should be adjusted for their current body weight which for most adult population is lower than the reference body weight, namely, 51.5 kg for adult men and 44.1 kg for adult women in the rural population according to 1996-97 survey of NNMB. These adults have BMI of 19.2. Energy requirement adjusted for most of the current population would be 2227 kcal and 1741 kcal respectively instead of 2420 and 1874 kcal respectively for reference body weight. Providing additional energy to corresponding to reference body weight for adults with lower body weight may not result in any increase in work output but may result only in increased body weight and lead to obesity. This is evident from our coal miners study[23]. The coal miners with body weight of 48 kg and normal energy intake of energy (3100 Kcal/day) were supplemented with 500 Kcal/day for 6 months. Energy supplementation did not result in any increase in coal output, but resulted only in increase in body weight.

Source of energy in the Indian dietaries

The main source of energy in Indian diets is cereals. Cereals provide 50-80% of energy of diets of different income groups. However, in the low-income groups, cereals provide nearly 80% energy. However, energy contributed by fat varies very widely. Low-income groups have only 5% or less of energy derived from the

Table 9: Desirable intake of Fat to meet the Energy needs of different age groups on a cereal-based diet

Age Group	Energy requirement Kcal/day	Fat energy per cent			Visible fat intake g/day
		Total	Invisible	Visible	
Preschool children (1-5 yrs)	1385	34	17	17	26.2
School age group (5-10 yrs)	1988	28	14	14	31.0
Adolescent Group					
Boys	2545	24	12	12	34.0
Girls	2060				23.0
Adult (Sedentary)					
Man	2424*	20	10	10	26.7
Woman	1874*				21.1

Table 10: Energy and fat intake by urban well-to-do and rural low income preschool children

Group	Energy intake Kcal/d	Invisible fat intake (g/d)		visible fat (g/dl)	Total fat	
		Animal	Vegetable		g/d	En%
Urban well-to-do	1438	21.5	6.4	22.3	50.2	31.4
Rural low income	777	5.1	5.1	5.3	15.8	18.5

visible fat. Energy inadequacy is widespread among our population belonging to low socio-economic groups both in urban and rural areas and more so in the rural areas. Energy inadequacy is more widespread and severe among poor preschool children. A careful analysis of diets of those belonging to the low income groups, especially young children in India reveal that although their diets contain adequate cereals, they are very low in fat and fat rich foods like milk (Table 9). Dietary analysis[24] has shown that for meeting the energy needs as recommended by those who are consuming low energy intake should have at least part of energy derived from fats, the visible fat should be at least 15% in the case of children and 10% in case of adults[21].

The current average intake of fat by this population is about 10g/d contributing to less than 5% from fat. In order to provide 10-15% energy from fat daily consumption of edible oil per caput should be in the range of 20-25 g/day (Table 10).

True energy content of cereal-based Indian diets:

There is an overestimation of energy content of diets based largely on cereals with carbohydrate (CHO) as the main source of energy since CHO content is not directly determined but obtained by difference, as 100 – (moisture + protein + crude fat extract + crude fibre). This computation does not take the total dietary fibre (15.7 g) into account in cereals, the total dietary fibre is nearly 10 folds higher than crude fibre (1.6 g). If the total dietary fibre is used to compute the CHO content of cereals and pulses, their resulting energy content would be about 16% lower than the energy content reported in 'Nutritive Value of Indian Foods'. If these lower energy values were used for cereals and pulses, the total daily dietary energy intake in different age groups would be reduced by about 14% (Table 11).

ICMR has constituted an Expert Group for revision of Nutrient Requirements of Indians. This Committee has yet to meet. When it meets, it should consider the recommendations of the recent 2001 FAO/WHO/UNU Expert Consultation on Energy Requirement while revising energy requirements of Indians.

Table 11: Reported and True Energy Content of Food Grains

Food	Reported energy content KCal/100g	Fat Total g/100 g	Protein g/100 g	True[2] carbohydrate g/100 g	True[2] energy content KCal/100 g
Cereals					
Rice	345	1.45	6.8	67.5 (78.2)	310 (10.1)
Wheat	346	2.09	11.8	54.5 (71.2)	284 (17.9)
Sorghum	349	3.10	10.4	58.4 (72.6)	304 (12.8)
Ragi	328	2.90	7.3	51.4 (72.0)	261 (20.4)
Bajra	361	4.73	11.6	49.4 (47.5)	287 (20.5)
Pulses					
Red gram	335	1.76	22.3	43.8 (57.6)	280 (16.4)
Black gram	347	1.36	24.0	46.4 (59.6)	294 (15.3)
Green gram	348	1.36	24.5	44.6 (59.9)	287 (12.5)
Bengal gram	372	5.52	20.8	47.4 (59.8)	322 (13.4)
Average of all food grains	348	2.7	15.5	51.5 (66.5)	292 (16.0)

1. Nutritive Value of Indian Foods, Hyderabad
2. Figures in parentheses are the values given in the Nutritive value of Indian foods
3. Figures in parentheses are the extent of overestimation (per cent).

References

1. Nutrition Advisory Committee, IRFA, New Delhi, Report of the 12th Meeting, 1944.
2. Technical Commission of the Health Committee of League of Nations. Report on the physiological basis of nutrition, Geneva, 1936.
3. Food and Nutrition Board of the Nutrition Research Council. Recommended Dietary Allowances, NRC Reprint & Circular Ser. No.129, 1944.
4. Patwardhan, V.N.: Dietary Allowances for Indians. ICMR Sp. Rep. Ser. No.60 1960.
5. Food & Agricultural Organization of the United Nations. Report of the Committee on Calorie Requirements, Washington. 1950
6. Ibid. Report of the Second Committee on Calorie Requirement, Rome, 1957.
7. Banerjee, S.: Studies on Energy Metabolism, ICMR Sp. Rep. Ser. No.43, 1962.
8. Garry, R.C., Passmore, R., Warnock, G.M. and Durnin, J.V.G.A.: Studies on expenditure of energy and consumption of food by miners and clerks, Fife, Scotland, MRC Sp. Rep. Ser. No.289, London, 1952.
9. Ramanamurthy, P.S.V. and Dakshayani: Energy intake and expenditure in stonecutters. Ind. J. Med. Res. 50, 779,1962.
10. Ramanamurthy, P.S.V. and Belavady, B.: Energy expenditure and requirement in agriculture labourers. Ind. J. Med. Res. 54, 977, 1966.
11. Banerjee, S., Acharya, K.N., Chattopadhyaya, D., Sen, R.N.: Studies on energy metabolism of labourers in a spinning mill. Indian J. Med. Res. 47: 657-662, 1959.
12. Astrand, I.: Degree of strain during building work as related to individual aerobic capacity. Ergonomics. 10, 293, 1967.
13. Rao, M.N., Sen Gupta, A., Saha, R.N. and Sita Devi, A.: Physiological norms of Indians, pulmonary capacity in health. Indian Council of Medical Research Special Report Series No.36, 1961.
14. Nutrient Requirements and Recommended Dietary Allowances for Indians, Report of an Expert Group, ICMR, 1990.
15. World Health Organization. Energy and protein requirements. Report of a Joint FAO/WHO/UNU Expert Consultations. Tech. Rep. Ser. No.724, 1985.
16. Shetty, P.S., Soares, M.J. and Sheela, M.L.: Basal Metabolic Rate of South Indians, FAO Report,1986.
17. Narasinga Rao, B.S., Susheela, T.P., Nadamuni Naidu, A. and Krishnakumari Menon: Energy intake of well-to-do preschool children in India. Ind. J. Med. Res. 77, 62, 1983.
18. Durnin, J.A.V.G.: Food consumption and energy balance during pregnancy and lactation in New Guinea. In: Maternal nutrition during pregnancy and lactation. Ed. H. Aebi and R.G. Whitehead, Hans Haber, Publisher, p.86-95, 1981.
19. Rani Madhavapeddi and B.S.Narasinga Rao: Energy intake and expenditure in undernourished Indian women. Eur. J. Clin. Nutr. 46, 349-354, 1992.
20. Prentice, A.M. (Ed.) The doubly labelled water method for measuring energy expenditure. Technical Communication for use in humans. A Consensus Report by IDECG Working Group. International Dietary Energy Consultative Group and International Atomic Energy Agency, Vienna, 1990.
21. Kurpad, A.V., Borgonha, S., Shetty, P.S.: Measurement of total energy expenditure by the doubly labelled water technique in free-living Indians in Bangalore City. Indian J. Med. Res. 105: 212-219, 1997.
22. Borgonha, S., Shetty, P.S., and Kurpad, A.V.: Total energy expenditure and physical activity level in chronically energy deficient Indian males measured by the doubly labelled water technique. Indian J. Med. Res. 111: 138-146, 2000.
23. Sathyanarayana, K., Hanumantha Rao, D., Vasudeva Rao, D. and Swaminathan, M.C. Nutrition and working efficiency in coal-miners. Indian J. Med. Res. 60: 1800-1806, 1972.
24. Narasinga Rao, B.S.: Role of dietary fat in meeting energy needs on predominantly cereal-based diets. NFI Bulletin. 23: No.2, p.6, 2002.