Dietary Energy Requirement Estimates for Bangladeshi Rural Population

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Introduction

As in most developing countries undernutrition and malnutrition remain to be serious problems for Bangladesh. Although undernutrition and malnutrition are sometimes used as synonyms, the former is primarily caused by an inadquate intake of food (energy deficit) while the latter results from the deficiency of or from the wrong and disproportionate intake of specific nutrients. Undernutrition resulting from inadequate intake of food (energy deficiency) has been identified to be the major nutritional problem that Bangladesh is confronted with[1,2,3]. Apart from measures for increasing the purchasing power and effective demand for food among the undernourished population groups, maintenance of an adequate food supply at national level is a pre-requisite for addressing the problem of undernutrition. In order to maintain the required level of aggregate food supply it is necessary to make estimates of energy needs at the population level.

Energy requirement estimates at population level are derived from estimates at the level of individuals within specific age, sex and occupati-onal groups. Unfortunately however, the current method of estimating energy requirements, proposed by the FAO/WHO/ UNU Expert Consultation, 1985[5] rendered the process of estimation difficult even for a trained nutritionist. The current method involves detailed calculation of various components of energy expenditure, such as basal metabolic rate (BMR) from body weights for given age and sex; and energy cost of various economically necessary and socially desirable activities. But data on body weights by age and sex (especially for adults) and on occupational patterns and the time allocation on various occupational and leisure time activities are either scanty or non-existent in Bangaldesh. In the absence of these information, this paper attempts to make a crude estimate of energy requirments for Bangladeshi rural population, based on a number of assumptions, and using whatever information on these criterion variables are available. These requirement estimates could be continuously refind as more and more information on different criterion variables are available. Nevertheless, estimates presented in this paper might be of some use for planning national food supplies and for evaluting the adequancy of dietary intakes of puoulation gorups in rural Bnalgadesh.

Procedure for estimation of energy requirements

The FAO/ WHO/ UNU Expert Consultation, 1985[5] defines, 'The energy requirement of an individual is the level of energy intake from food that will balance energy expenditure when the individual has a body size and composition and level of physical activity, consistent with longterm good health; and that will allow for the maintenance of economically necessary and socially desirable physical acitivity. In

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children and pregnant or lactating women the energy requirement includes the energy needs associated with the deposition of tissues or the secretion of milk at rates consistent with good health'. Estimates of energy requirements derived from measurements on individuals of same age, sex, body size and activity are grouped together to give the average requirement of that set of people. The basic concept behind the estimation of energy requirements is the energy balance i.e. a balance between energy intake and energy expenditure. The principal components of energy expenditure are (1) Basal Metabolic Rate (BMR), (2) Physical activity and (3) Metabolic response to food ingestion. For infants, children and pregnant and nursing mothers there is a fourth component i.e. the energy requirements for growth. After estimation of different components of energy expenditure, the total requirement is expressed as a multiple of BMR.

Basal metabolic rate (BMR)

The energy needs of the body under absolute rest and fasting conditions is the basal metabolic rate (BMR). BMR is, in most cases, the largest component of energy expenditure. Other com-ponents of energy expenditure i.e. physical acitivity, metabolic response to food and where relevant energy cost of growth are taken together to construct a factor, by which the BMR is multiplied to obtain the total energy requirement. Based on well tried and reproducible meas-urements conducted under varying conditions in different countries, regression equiations (Table 1) have been developed for calculation of BMR from the average body weight. It is not unlikely that the acutal BMR's of Bangladeshis may differ from the predicted BMR's calculated from these equations. However, in the absence of any local data, it is only practical to use these equations for calculation. What is more impo-tant, is the availability of data on body weight by age and sex. Recent national level data on height and weight of adults are not available in Bangladesh, in the absence of which unpublished data from the 1962-64 national nutrition survey have been used. Assuming that the present day rural Bangladeshi adults are not different in average body weight than those during the 1962-64 period, calculations were made on the basis of observed body weight as well as expected body weight for observed height and are presented in Table 2.

Table 1. *Equations for predicting basal metabolic rate (BMR) from body weight (W)*

Age. (years)	KCal/day	MJ/day
Male		
0-3	60.9W-54	0.255W-0.226
3-10	22.7W+495	0.0940W+2.07
10-18	17.5W+651	0.0732W+2.72
18-30	15.3W+679	0.0640W+2.84
30-60	11.6W+879	0.0485W+3.67
> 60	13.5W+487	0.0565W+2.04
Female		
0-3	61.0W-51	0.255W-0.214
3-10	22.5W+499	0.0941W+2.09
10-18	12.2W+746	0.0510W+3.12
18-30	14.7W+496	0.0615W+2.08
30-60	8.7W+829	0.0364W+3.47
> 60	10.5W+596	0.0439W+2.49

Source : WHO Technical Report Series 724 (1985)

Table 2 . *Height and weight (as assessed in 1962-64) of Bangladeshi rural population aged 10 yrs. and above compared with expected or desirable body weights for height and predicted BMR's.*

Age/Sex group	No. of persons measured	Observed Mean Ht. (cm)	Observed Mean Wt. (kg)	Median or average expected Wt/ht (kg)	Predicted BMR's (KCal/d)	
					BMR 1	BMR 2
10 yr+ M	325	129.0	23.2	26.3	1057	1111
F	213	129.3	23.6	26.6	1034	1072
11yr + M	138	133.9	25.2	28.9	1092	1157
F	105	134.5	26.3	29.8	1067	1110
12 yr+ M	315	137.7	27.5	31.0	1132	1194
F	149	137.4	28.2	31.7	1090	1133
13 yr + M	83	145.0	31.2	35.8	1197	1278
F	65	142.3	31.7	35.6	1133	1180
14 yr + M	143	144.8	34.8	38.5	1260	1325
F	52	145.4	35.2	39.0	1175	1222
15 yr + M	139	155.8	39.2	44.2	1337	1425
F	56	146.4	37.8	42.3	1207	1262
16 yr + M	110	158.0	41.3	47.8	1374	1488
F	57	146.9	39.0	43.1	1222	1272
17 yr + M	55	160.4	44.3	51.8	1426	1558
F	31	147.4	38.5	43.8	1216	1280
18-30 yr + M	1198	161.8	46.8	58.6	1395	1576
F	285	148.0	39.1	46.5	1071	1180
30-60 yr+ M	1811	161.8	46.8	58.6	1422	1559
F	1022	148.5	38.5	46.8	1164	1234
60 yr + M	358	161.0	45.1	58.1	1096	1271
F	181	146.1	35.1	46.2	965	1081

Note : BMRI and BMR2 respectively have been calculated from equations in Table 1 on the basis of observed body weight and expected body weight for observed height. Ht/Wt data (unpublished) are from 1962-64 National Nutrition Survey.

Energy cost of physical activities

The energy cost of various activities vary enormously. The energy needs for physical activities depend on the type of activity, time spent on it and the size of the individual performing the work. In order to calculate the energy cost of activities a detailed description of different kinds of occupational activities and time spent on each, is required. But detailed description on activity patterns of various occupational groups are not available. However, some information on the distribution of Bangladeshis by broad occupational categories according to ILO classification[6] is available from the 1984-85 Labour Force survy[7]. In the absence of more detailed information the BBS classification of occupational categories have been used and the BMR factors suggested

by an FAO working group[8] have been applied for calculation of energy requirement figures. The average BMR factors suggested for various occupational categories incorporate seasonal adjustments for moderate to heavy activity for subsistence farmers.

Calculation of energy requirements

Adults (18 yrs. +)

Average per capita energy requirements for adults have been calculated by multiplying the predicted BMR's by the average BMR factors that correspond to different occupational groups (Table-3).

Some 13.26% and 2.64% of adult males in the age groups 18-30 yrs. and 30-60 yrs. respectively whose occupations have not been adequately defined were assumed to be moderately active and the BMR factors appropriate for moderate activity in subsistence farming communities in LDC's have been used for calculation of energy requirements.

Over 90% of females in these two age groups has not been categorised into any occupational group. It has been assumed that they are rural housewives and the appropriate BMR factors have been applied. Both males and females of 60 years and above have been taken to be moderately active and BMR factors appropriate for this group have been used.

Adolescents (10-18 yrs.)

The method of estimating energy requirements of adolescents is basically the same as for adults. Adolescent BMR's calculated on the basis of observed and expected weight for height have been multiplied by BMR factors that take into account desirable levels of energy expenditure plus the requirements for growth. Observed intakes of the age group are considerably lower than the requirements estimated in this way. The FAO/WHO/UNU Expert Consultation[5] observed that for developing countries fulfilment of the requirements as proposed would provide a margin of safety. Table 4 shows the per capita energy requirements of adolescents.

Children (1-10 yrs.)

For children between 1 and 10 years although data for BMR are available and the energy cost of tissue growth could be estimated, the FAO/WHO/UNU Expert Consultation, 1985[5] could not provide estimates for the energy cost of activity. Instead the energy requirements of this age group are based on observed intakes of well nourished children in developed and in more affluent groups in developing countries. These values are derived from a critical review of available literature and includes 5% extra allowance for desirable physical activity. Table 5 presents the per capital energy requirements of children between 1 and 10 years of age. These values will obvisously, overestimate the energy needs of underweight children in most developing countries but will provide an allowance for catch up growth.

Infants (0-1 year)

In estimating the energy requirement of infants from birth to 6 months of age it has been assumed that these infants are exclusively on breast. The energy cost of milk production during this period is partly met by the fat store laid down by the mother during pregnancy. Assuming that the

Table 3. *Predicted BMR's according to observed and expected or desirable body weight for observed height and estimated average per capita energy requirements of Bangladeshi rural adults (18 yrs.+) by occupational categories (KCal/d).*

Occupational Categories	Male					Female				
	Predicted BMR's		Per Capita Energy Reqnts.			Predicted BMR's		Per Capita Energy Reqnts.		
	Observed wt. basis	Expected wt. basis	BMR Factor	Observed wt. basis	Expected wt. basis	Observed wt. basis	Expected wt. basis	BMR Factor	Observed wt. basis	Expected wt. basis
18-30 year										
1. Professional, Technical & Related Workers	1395	1576	1.61	2246	2537	1071	1180	1.58	1692	1864
2. Administrative and Managerial	1395	1576	1.61	2246	2537	1071	1180	1.58	1692	1864
3. Clerical and Related Workers	1395	1576	1.61	2246	2537	1071	1180	1.58	1692	1864
4. Sales Workers	1395	1576	1.78	2483	2805	1071	1180	1.64	1756	1935
5. Service Workers	1395	1576	1.78	2483	2805	1071	1180	1.64	1756	1935
6. Agriculture, Forestry and Fisheries	1395	1576	1.86	2595	2931	1071	1180	1.69	1810	1994
7. Production and Transport	1395	1576	1.86	2595	2931	1071	1180	1.69	1810	1994
8. Not defined	1395	1576	1.78	2483	2805	1071	1180	1.64	1756	1935
30-60 yrs.										
1. Professional, Technical & Related Workers	1422	1559	1.61	2289	2510	1164	1234	1.58	1839	1950
2. Administrative and Managerial	1422	1559	1.61	2289	2510	1164	1234	1.58	1839	1950
3. Clerical and Related Workers	1422	1559	1.61	2289	2510	1164	1234	1.58	1839	1950
4. Sales Workers	1422	1559	1.78	2531	2775	1164	1234	1.64	1909	2024
5. Service Workers	1422	1559	1.78	2531	2775	1164	1234	1.64	1909	2024
6. Agriculture, Forestry and Fisheries	1422	1559	1.86	2645	2900	1164	1234	1.69	1967	2085
7. Production and Transport	1422	1559	1.86	2645	2900	1164	1234	1.69	1967	2085
8. Not defined	1422	1559	1.78	2531	2775	1164	1234	1.64	1909	2024
60 Yrs +	1096	1271	1.55	1699	1970	965	1081	1.56	1505	1686

Table 4. *Estimated per capita energy requirement (KCal) of rural Bangladeshi Adolescents (10-18 years)*

Age	Predicted BMR's according to observed and expected body wt.		BMR Factor	Per capita energy requirements	
	Observed wt. basis	Expected wt. basis		Observed wt. basis	Expected wt. basis
Male					
10+	1057	1111	1.76	1860	1955
11+	1092	1157	1.73	1889	2002
12+	1132	1194	1.69	1913	2018
13+	1197	1278	1.67	1999	2134
14+	1260	1325	1.65	2079	2186
15+	1337	1425	1.62	2166	2309
16+	1374	1488	1.60	2198	2381
17+	1426	1558	1.60	2282	2493
Female					
10+	1034	1072	1.65	1706	1769
11+	1067	1110	1.63	1739	1809
12+	1090	1133	1.60	1744	1813
13+	1133	1180	1.58	1790	1864
14+	1175	1222	1.57	1845	1919
15+	1207	1262	1.54	1859	1943
16+	1222	1272	1.53	1870	1946
17+	1216	1280	1.52	1848	1946

Table 5.*Estimated average daily energy intakes and requirements of children age 1-10 years (KCal/d).*

Age	Boys		Girls	
	Intake	Requirement	Intake	Requirement
1 +	1140	1200	1090	1140
2 +	1340	1410	1250	1310
3 +	1490	1560	1370	1440
4 +	1610	1690	1465	1540
5 +	1720	1810	1550	1630
6 +	1810	1900	1620	1700
7 +	1895	1990	1685	1770
8 +	1970	2070	1740	1830
9 +	2045	2150	1795	1880

average rural Bangladeshi mothers have no maternal reserve to supplement the energy cost of lactation the total cost of breast milk production i. e. 700 KCal/d has been taken as the energy requirement of infants during the first 6 months of life.

For infants between 6 and 12 months the total energy requirement, calculated on the basis of NCHS[9] median weight for age, is 840 KCal/d. Assuming that the 6-12 month olds are still on breast and that breast milk alone cannot meet their needs their total

Table 6. *Estimated daily energy requirements of rural Bangladesi population by age and sex and by broad occupational categories of adults between 18 and 60 years calculated on te basis of observed body weights and expected body weight for observed height from 10 years and above (KCal/d).*

Age	Population '000		Observed body wt. basis		Expected body wt.basis	
	Male	Female	Male	Female	Male	Female
0- 6 mo	764	769	700	700	700	700
6-12 mo	764	769	945	945	945	945
1 yr. +	1527	1495	1200	1140	1200	1140
2 yr. +	1526	1494	1410	1310	1410	1310
3 yr. +	1526	1451	1560	1440	1560	1440
4 yr. +	1525	1451	1690	1540	1690	1540
5 yr. +	1674	1652	1810	1630	1810	1630
6 yr. +	1673	1652	1900	1700	1900	1700
7 yr. +	1673	1605	1990	1770	1990	1770
8 yr. +	1673	1554	2070	1830	2070	1830
9 yr. +	1673	1554	2150	1880	2150	1880
10 yr. +	1460	1291	1860	1706	1955	1769
11 yr. +	1459	1203	1889	1739	2002	1809
12 yr. +	1360	1157	1913	1744	2018	1813
13 yr. +	1314	1069	1999	1790	2134	1864
14 yr. +	1164	1024	2079	1845	2186	1919
15 yr. +	1102	894	2166	1859	2309	1943
16 yr. +	1001	850	2198	1870	2381	1946
17 yr. +	900	765	2282	1848	2493	1946

(Contd)

Table 6. Continued

Age	Population '000		Observed body wt. basis		Expected body wt.basis	
	Male	Female	Male	Female	Male	Female
18-30 yrs.						
Professionals, Managerial, Tecnical & Clerical	306	104	2246	1692	2537	1864
Sales and Service	1181	263	2483	1756	2805	1935
Agriculture, Forestry, Fiseries, Production and Transport	6282	333	2595	1810	2931	1994
Others (not defined)	1187	9155	2483	1756	2805	1935
30-60 yrs.						
Professionals, Managerial, Tecnical & Clerical	748	88	2289	1839	2510	1950
Sales and Service	1514	380	2531	1909	2775	2024
Agriculture, Forestry, Fiseries, Production and Transport	9981	388	2645	1967	2900	2085
Others (not defined)	332	10512	2531	1909	2775	2024
60 yrs. +	2689	2126	1699	1505	1970	1686
Allowance for pregnancy (No. pregnant=33726)				285		285
Total population requirement (Total population=97026 thousands)			1881.IX10^8 KCal (7870.81X10^5 MJ)		2003.2X10^8 KCal (83$1.43X10^{5}MJ)	
Per capita per day requirement			1939 KCal (8.11 MJ)		2065 KCal (8.64 MJ)	
		rounded :	1940			

Note: The distribution of the projected population of 1990 by age, sex and residence has been computed by extrapolation of the distribution pattern of Sample Vital Registration System 1986-87 (BBS 1987). For simplicity infants under 1 year have been divided into two equal halves.

energy requirement would be the energy cost of breast milk production plus the energy value of dietary supplements. The average amount of breast milk produced by the mother, as per available evidence[10,11] is taken to be 600 ml/d having an energy value of 420 KCal. The energy cost of producing this amount of breast milk at 80% efficiency would be 525 KCal. This figure i.e. 525 KCal/d plus the remaining amount from food supplements i.e. 420 KCal/d constitute to be the total energy requirement of the infant aged 6-12 months.

Population level estimates

Population level estimates of energy requirements are weighted averages calculated according to the 1990 projected population distribution. The distribution of

prejected rural pupulation into different age, sex and occupational groups has been computed by extrapolation of the distribution pattern of 1986-87 sample Vital Registration System[12] and the 1984-86 Labour Force Survey[7].

Table 6 shows the population level computations of energy requirement estimates. There are two sets of estimates. The first one is based on observed body weight (from 10 yrs. +) and the second, on expected or desirable body weights for observed height. For infants and children under 10 years there is only one desirable set of estimates based on observed intakes in affluent societies.

In order to account for additional energy needs of pregnant women the number of pregnant mothers has been estimated on the conventional assumption that at any given time there are 10% more pregnant women than the number of infants under 1 year. Additional allowance for lactation has been incorporated in the requirement of infants under 1 year. According to the two alternative methods of estimation the average per capita energy requirements are 1940 KCal (8.11 MJ) KCal 2065 and (8.64 MJ) respectively. The aggregates for the entire rural population are $1881.1X10^8$ KCal ($7870.81 X10^5$ MJ) and $2003.2X10^8$ KCal ($8351.43 XI0^5$ MJ) respectively.

Discussion

Body weight and activity are the two prime determinants of energy requirement. The basic procedure of deriving estimates of energy requirements according to the current method of estimation is to express requirements as multiples of BMR. THe BMR itself is a function of body dimension, especially the body weight. The BMR multiple, what is called the BMR factor is an average multiple that incorporates the energy cost of occupational and leisure time non-occupational activities; the energy cost of digestion and absorption of food; and the energy cost of growth where appropriate.

Estimates of energy requirements presented in this paper are based on a number of assumptions and extrapolated computations. They should be regarded as crude average estimates applicable to various age, sex and occupational groups. Care must be taken to apply them to individuals. Precise individual requirements can be estimated only when information are available on body dimensions and physiological conditions by age and sex; time spent on various types of occupational and non-occupational descretionary activities; and the energy cost of all such activities. Nevertheless, the estimates presented in this paper may find some use in national food supply planning. Assuming that more than 85% of the food energy in the average rural Bangaldeshi diet is provided by cereals it is for the planners to decide which of the alternative is to be taken into account so as to maintain the required level of foodgrains supply for the rural population. Adequacy in the aggregate food supply is not, however, by itself a guarantee of adequate intake by all sections of the pupulatuon. There will be population groups consuming less than their requirements even in the existence of a surplus in the aggregate supply for which other relevant measures would be necessary.

Summary

According to the recommendations of the 1981 joint FAO/WHO/UNU Expert Consultation on Energy and Protein Requirements and making a number of assumptions with

regard to various determinants of energy expenditure, estimates of energy requirements for rural Bangladeshis of different age, sex and occupational groups have been derived. For deriving population level estimates of energy requirements, the distribution of population by age, sex and occupational categories has been computed by extrapolation of limited available data.

Energy requirement estimates presented in this paper will be of some use in national food supply planning and in evaluating the adequacy of dietary intake of population groups. These estimates are group averages and should not be applied to individuals.

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