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Energy balance among tribal females of reproductive age group in Naugarh block, Chandauli District of U.P.

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ABSTRACT

The percentage of moderate workers was low, constituting 19.65% of the total study subjects. However, more than one -third (37.06 %) of women in the study area were heavy workers. The percentage of women spending <1700 Kcal per day was 15.2%. The mean energy expenditure was found to be 2326.5 Kcal per day. The vast majority of tribal women (84.6%) had energy expenditure more than their energy intake. The mean energy balance of the tribal women in the study area was 683.4 Kcal/day. Majority of study subjects (84.3 %) had negative energy balance and only 15.6% had positive energy balance. Nearly 58.2% women had energy balance as low as less than – 500 Kcal per day. The mean energy balance was highest (200.79 kcal) among sedentary worker, followed by moderate worker (-583.91 kcals) and heavy worker (-1299.80 kcals). The maximum negative energy balance (-1299.80 kcal) was found in heavy worker group, though they were taking 54.96% of estimated mean RDA which was higher than the 51.86 % of estimated mean RDA, taken by sedentary worker. The negative energy balance among moderate worker group was only -583.91 kcal.

Key words : Energy balance, Energy expenditure, Negative energy balance, Physical activity, Nutritional status.

In India, tribals are neglected a lot and discriminated in terms of income distribution and social status. Most of them are desperately poor, backward, generally uneducated and lead a hard and miserable life (Thakur *et al.*, 1991). Apparently, they are the worst victims of food and nutrition imbalance and starvation deaths are reported in these groups (Bagchi, 1994). The body needs energy for maintaining body temperature, metabolic activity, supporting growth and for physical work (ICMR, 1990). Currently, it is recommended that energy requirement must be assessed in terms of energy expenditure rather than in terms of energy intakes. The assessment of energy expenditure is therefore a more logical approach where one can specify the energy requirements in terms of energy out put for productive work and leisure activity (ICMR, 1990). By calculating energy expenditure, we can easily classify population under study according to their life style category *viz.* sedentary, moderate and heavy work (Satynarayana *et al.*, 1987).

From the available literature on the health status of the tribal women in India, it was observed that comprehensive, area specific, health related studies are limited. Most studies are isolated, fragmentary and did not cover the various dimensions of health affecting the tribal women. There is a need for sympathetic comprehensive study of tribal women encompassing urgent issue like energy expenditure pattern, actual energy balance and nutritional status. With this background, this study was conducted on tribal women of reproductive age group to know about energy expenditure pattern, energy balance of tribal females and to find out the effect of various demographic factors on energy expenditure, energy intake and energy balance.

METHODOLOGY

It consisted of a cross-sectional study. Four hundred two females from 342 selected households were included for assessment of energy balance. In the first stage, seven villages were selected by stratified random sampling methods. Stratification was done based on distance from the block head quarters. In the selected villages, families were selected by using P.P.S. (Probability Proportion to Size) sampling technique. Since this study was centered on females of reproductive age group, all the females belonging to the age group of 15-49 years were defined as eligible females.

The primary tool in this study were predesigned and pretested interview schedule. Data were collected in the year of 1999-2000. Relevant data on various aspects on the schedule were obtained by personal interview method by the researcher herself. Activity pattern was determined by 24-hour recall method. Appropriate statistical analysis namely per cent, mean, range, SD and scores chi-square, ANOVA, t-test, z-test etc. were incorporated wherever necessary. For analysis Microsoft excel and SPSS software programmes were mainly used.

Recording of physical activity:

In order to calculate energy expenditure of the study subject, physical activity record on the previous day of

the survey were noted by "24 hour recall' method.

Energy expenditure pattern:

Classification of respondents according to type of activity:

Normally individuals are classified in three broad categories *viz.* sedentary, moderate and heavy according to type of activity. The usual procedure is to have a look on their working pattern and classify them accordingly. This procedure, however simple and practable, involves an element of subjectivity. An alternative objective procedure may be to compute the daily energy expenditure and classify her accordingly in the appropriate category based on the norms of energy requirements. This method has been used by some researchers such as Satyanarayana *et al.* (1987) etc. In the present study also, this approach was used to classify the females in different groups. Sataynarayana *et al.* (1987) has given the classification for sedentary, moderate and heavy workers. These are 1900, 2200, 3000 Kcal / day, respectively. Though not specified explicitly, presumably these values are for average sedentary, moderate and heavy workers. Hence, to decide the cut off points for sedentary, moderate and heavy workers average energy expenditure category will become <2050, =2050 to = 2600, >2600, respectively.

Calculation of energy expenditure:

There are various approaches to measure the energy expenditure. However, the usual procedure is to note the time spent on various activities, multiply them by appropriate multipliers (Physical Activity Ratio), compute the total sum and then make adjustments for various factors so as to arrive at the final figure. The multipliers are normally chosen in terms of BMR units. ICMR (1990) has given energy cost of some common activities and broadly classified occupational and non-occupational activities in terms of BMR units. In present study, the multipliers suggested by Bouchard *et al.* (1983) and used by Satyanarayana *et al.* (1987) have been taken for computation purpose. Utilizing the data on various activities and corresponding multipliers, the rate of energy expenditure in terms of BMR units was found out mathematically

$$\text{Rate of energy expenditure} = \sum t_i m_i / 1440$$

where, t_i is time spent (in minutes) for i^{th} the activity and m_i is the corresponding multiplier.

The total energy expenditure for a female of a given weight can be obtained by multiplying the rate of energy expenditure and the BMR (Kcal/24 hours) for given weight. The ICMR (1990) has given the BMR value for females of different weights. The formula for getting BMR for given weight for females of the a age group 18-30 years is –

BMR = 14.0 x Body weight (in Kg) + 471

While for the females of 30-60 years of age groups the formula is-

BMR =8.3 x Body weight (Kg) + 788

As this study includes tribal female of reproductive age group which ranges from 15-49, for the study subjects belongs to below 18 years of age equation given by (WHO, 1985) were taken; as the ICMR (1990) has not given equation for below 18 year population. Therefore, for below 18 years of age respondent equation was -

BMR = 12.2 x Body weight (Kg) + 746

In this way, total energy expenditure for each study subject of a given weight can be obtained by multiplying the rate of energy expenditure and the BMR (Kcal /24 hours) for given weight.

RESULTS AND DISCUSSION

Energy balance:

Energy balance is the difference between energy intake and energy expenditure. Weight gain or loss is a simple, but accurate way of indicating differences in energy balance (Kumar and Clark, 1998). Therefore, energy balance indicates weight loss or gain of an individual.

Physical activity pattern: (n=402)

The percentage of moderate workers was low, constituting 19.65% of the total study subjects. The usual works of moderately working women in the study area were cooking, cleaning utensils, washing clothes, care of animal, vegetable selection, cow dung cake preparation etc. The physical activity of sedentary worker women (43.28%) included sleeping, sitting, eating, combing, sewing, knitting, 'pattal' or 'dona' making etc. However, more than one -third (37.06 %) of women in the study area were heavy workers and apart from daily household activities they used to perform various heavy works like agricultural work (grass cutting, wheat cutting, grinding and dehusking of rice) fetching water, stone cutting, hunting wild animals and bringing considerable amount of forest

food items and wood.

Energy expenditure of tribal women: (n=402)

Slightly less than half of the study women (42.3%) had energy expenditure 2500 Kcal or more. The percentage of women spending <1700 Kcal per day was 15.2%. Slightly less than nine-tenth (84.8%) women had energy expenditure 1700 Kcal or more per day. This would include majority of heavy workers whose percentage was 37.06%. The mean energy expenditure was found to be 2326.5 Kcal per day. It ranged from 1199.0 to 3821.3 Kcal per day. The mean energy expenditure (2326.5 Kcal) per day in the present study was much higher than the mean energy expenditure of working women of rural Hyderabad (Satyanarayana *et al.*, 1987).

Proportion (ratio) of energy intake to energy expenditure: (n=402)

The energy expenditure of the study subjects were compared with their energy intake and the ratio of energy intake to energy expenditure was calculated. The vast majority of tribal women (84.6%) had energy expenditure more than their energy intake. Only 15.4% women had energy expenditure less than their energy intake. The energy intake was as low as less than 60% of energy expenditure among more than one-third (34.3%) of the study subjects. The results indicate that most women in the study area were heavily worked and their dietary intakes were highly inadequate to combat the energy spended by them.

Energy balance distribution pattern among tribal women:

The mean energy balance of the tribal women in the study area was 683.4 Kcal/day (Table 1). These high degrees of negative energy balance reflect high prevalence of nutritional deficit in the study area. In a study, Kaur *et al*. (1997) also reported similar findings. In the present study, majority of study subjects (84.3 %) had negative energy balance and only 15.7% of the study women had positive energy balance. Nearly (58.2%) women had energy balance as low as less than – 500 Kcal per day (Table 1).

These findings indicate poor nutritional status and under nourishment among majority of tribal women. It is interesting to note that about 37.06% women in the study area were heavy worker. Furthermore, about 85.0% women had energy expenditure 1700 Kcal per day or more and same percentage (84.6%) of women had energy intake to energy expenditure ratio less than 100.0%. In addition, about 84.3 % women negative energy balance. Therefore, it can be said that about 85.0% of tribal women in this study were heavy worker and nutritionally poor with negative energy balance, energy expenditure more than 1700 Kcal and with energy expenditure more than intake (ratio < 100%).

Table 1 : Females according to their energy balance (n=402)

Energy balance (Kcal)	No.	%
< - 500	234	58.2
- 500 to < - 200	75	18.6
- 200 to < 0	30	7.5
0 to < 200	26	6.5
≥ 200	37	9.2
Total	402	100
Mean ± SD: 683.4 ± 769.55		

Energy intake, expenditure and energy balance:

The Table 2 shows differences in mean energy intake and expenditure and thus energy balance between the three working groups.

Observations of Table 2 indicate that mean energy balance was highest (200.79 kcal) among sedentary worker, followed by moderate worker (-583.91 kcals) and heavy worker (-1299.80 kcals). In spite of taking only 51.86 % of their estimated mean RDA (2992.55 kcal), the sedentary worker group remained in comparatively good state of energy balance (positive energy balance of 200.79kcal), as their mean energy expenditure was less *i.e.* Only 1752.91kcal. The maximum negative energy balance (-1299.80 kcal) was found in heavy worker group, though they were taking 54.96% of estimated mean RDA which was higher than the 51.86 % of estimated mean RDA, taken by sedentary worker. The negative energy balance among moderate worker group was only -583.91 kcal. So by analyzing above Table 2 it may be said that the recommendation (ICMR, 1990) of assessing energy intakes of the subject, in terms of energy expenditure

Table 2: Study subjects according to their physical activity, mean energy intake expenditure and balance (n=402)

Type Of Activity	No.	Estimated Mean RDA	Mean Energy Intake	% RDA	Mean Energy Expenditure	Mean Energy Balance
Sedentary	174	2992.55 ± 425.09	1552.11± 549.99	51.86	1752.91± 210.34	200.79 ± 612.45
Moderate	79	3102.27 ± 319.09	1755.06± 548.25	56.57	2338.97 ± 172.94	- 583.91± 519.45
Heavy	149	3074.83 ± 308.09	1689.79± 522.48	54.96	2989.59 ± 288.33	- 1299.80 ± 601.88

rather than energy intake is more logical, where one can specify the energy requirements in terms of energy output for productive work and leisure activity.

Influence of demographic and socio-economic factors on energy intake, expenditure of the study subjects:

Several factors *viz*. type of family, size of family, age of females, educational status, occupation and per capita income strongly influence the energy intake, energy expenditure, energy balance and thus nutritional status of study subjects.

It is obvious from the Table 3 that mean daily energy intake was much less than the corresponding mean daily energy expenditure in all the categories and sub categories and the difference is statistically highly significant in all the sub categories, as tested by 't' test. Type of family, size and per capita monthly income of the family, age, educational status and occupation of the study subjects had not made remarkable difference on the energy expenditure. This is because the tribal women in the study area were hard working and their energy expenditure were very high, however their energy intake was not high, due to inadequate quantity and poor quality of their diet.

From nuclear to joint and to extended family the mean daily energy expenditure was increasing and mean daily energy intake was decreasing. However, the differences were statistically not significant as $p>0.05$ both for the expenditure and intake, respectively. This signifies that the mean daily energy intake and mean daily energy expenditure of the study subjects hardly affected by their type of family.

The difference in mean daily energy expenditure

Table 3 : Influence of various demographic and socio-economic factors on daily total energy intake and daily total energy expenditure of the study subjects (n=402)

Demographic factors	n	Energy exp.		Energy intake		t-value	d.f.	p-value
		Mean	SD	Mean	SD			
Type of family								
Nuclear	172	2290.3	529.4	1679.7	651.7	9.5	342	P < 0.01
Joint	187	2319.9	638.2	1630.7	481.1	11.8	372	P < 0.0001
Extended	43	2499.9	687.7	1549.9	249.7	8.5	84	p^*<0.0001
ANOVA: F=2.12 d.f.=2,399 p>0.05				ANOVA: F=1.1 d.f=2,399 p>0.05				
Size of family								
<5	137	2239.1	545.9	1525.3	636.3	10.1	272	p^*<0.0001
5-7	152	2460.0	625.9	1721.0	532.9	11.1	302	p^*<0.0001
>7	113	2252.7	605.1	1680.9	419.7	8.3	224	p^*<0.0001
ANOVA: F=6.2 d.f.=2,399 p<0.01				ANOVA: F=5.1 d.f=2,399 p<0.01				
Age of family (in years)								
15-24	189	2209.6	542.0	1556.8	443.7	12.8	376	p^*<0.0001
25-34	112	2312.4	554.9	1831.6	701.7	5.7	222	p^*<0.0001
≥35	101	2560.6	689.4	1595.3	465.3	11.7	200	P<0.001
ANOVA: F=11.8 d.f.=2,399 p^*<0.0001				ANOVA: F=9.9 d.f=2,399 p^*<0.0001				
Educational status of study subjects								
Illiterate	278	2332.6	552.5	1608.9	471.3	16.6	554	p^*<0.0001
Just literate	100	2317.6	749.2	1712.9	702.3	5.9	198	p^*<0.0001
Primary +high school	24	2292.0	460.3	1747.2	571.2	3.6	46	p<0.001
ANOVA: F=0.1 d.f.=2,399 p >0.05				ANOVA: F=1.8 d.f=2,399 p >0.05				
Occupation of study subjects								
Domestic only	14	1972.0	506.1	1293.5	410.3	3.9	26	p<0.001
Domestic+agriculture	377	2342.7	606.1	1656.5	550.6	16.3	752	p^*<0.0001
Domestic+ labour+patal	11	2222.4	402.1	1627.6	311.1	3.9	20	p<0.001
ANOVA: F=2.8 d.f.=2,399 p>0.05				ANOVA: F=3.0 d.f=2,399 p<0.05				
Per capita income								
≤100	38	2381.8	625.0	2083.2	491.2	2.3	72	p<0.05
100.1-200	112	2228.9	525.9	1601.5	488.5	9.3	222	p^*<0.0001
200.1-300	146	2292.2	637.4	1548.3	381.6	12.1	290	p^*<0.0001
>300	106	2456.8	600.4	1659.6	713.9	8.5	198	p^*<0.0001
ANOVA: F=2.9 d.f.=3,398 p<0.05				ANOVA: F=10.7 d.f=3,398 p^*<0.0001				

between families with 5 or less family members and families with more than 7 family members was not large. The energy intake decreased with increased family size for the families with 5 or less members (1525.3 Kcal) and for families with more than 7 members in the family (1680.9 Kcal). However, with exception, the highest mean energy intake was found in the families with 5-7 members. This may be because in this category the mean energy expenditure was also highest (2460.1 Kcal). So, females were taking more food in order to fulfill their need. All these differences were statistically significant. This signifies that energy expenditure of subject have impact on their intake, the family size is secondary in comparison to expenditure.

The average energy expenditure raised continuously from lower (15-24 years) to higher (≥35 years) age groups of tribal women, which were statistically significant. The energy intake was highest (1831.6 Kcal) among 25-34 years age group, which was followed by energy intake by ≥35 years (1595.3 Kcal and 15-24 years, 1556.8 kcal) age groups. This indicates that energy intake and expenditure of study women varied largely with respect to their age.

The mean daily energy expenditure was highest (2332.5 Kcal) among illiterate women and lowest (2292.0 Kcal) among women with primary or higher education (Table 3). Just opposite findings have been noted for daily mean energy intake also. However, these differences between various educational groups were not statistically significant. This implies that daily energy intake and expenditure of the study women in the study area were not affected by their educational status. This may be because the vast majority of study women were either illiterate or just literate.

Women performing domestic and agricultural works were consuming maximum energy per day (1656.5 Kcal) while minimum energy (1293.5) Kcal consumption was found among women doing domestic works only. These differences were statistically significant. This explains that tribal women working household chores and other works like agriculture, labour etc. consumed more energy to meet their extra demand of energy due to extra work, However, those tribal women who stayed at home and performed domestic activities only ate less. The differences between mean energy expenditure among various occupational groups were not significant.

The average daily intake by the women with per capita income 100 rupees or less was 2083.2 K cal per day, whereas, those with per capita income more than 300 rupees consume 1659.6 K cal per day. This may be because cash money was not the only factor to decide the dietary intake of the tribal women. Apart from cash, several other factors *viz.* number of livestocks present, amount of forest products collected by them strongly influenced their dietary intake. The women with per capita income 300 rupees or more had maximum energy expenditure 2456.8 Kcal. All these mean differences between various per capita income groups are statistically significant (Table 3).

On the basis of this Table 3 various demographic and socio-economic factors influencing daily average energy intake and expenditure of the tribal women have been discussed.

Effect of various demographic factors on daily energy balance of the study subjects:

Table 4 below shows the influence of the demographic and socio-economic factors on daily energy balance on the study subject.

The percentage of study women with positive energy balance (zero or more Kcals) decreased gradually from nuclear to joint and to extended family and the corresponding values were 19.8%, 12.8% and 9.3%, respectively. Opposite to this, the percentage of study women with energy balance less than -500 Kcal increased from nuclear (55.8%) to joint (59.4%) and to extended (62.8%) families. This indicates that higher percentage of extended families had more negative energy balance and *vice versa*. However, this was not statistically significant ($p>0.05$). The percentages of study women with less than -500 Kcal energy balance increased gradually from 52.4% in 15-24 years age group to 67.3% in 35 or more years' age group. This was statistically significant. This indicates that as the age of the tribal women increased, their nutritional status deteriorated owing to burden imposed by pregnancy, childbirth, care of children, other household responsibilities etc. The percentage of study women with energy balance 200 Kcal or more was highest among women with primary education (15.8%) and lowest among illiterate women (8.3%), indicating educational status had positive role on energy balance of tribal women, but these differences in the percentage were not statistically significant.

More than half (58.4%) of women performing domestic and agriculture work had energy balance less than – 500 Kcal and only about one tenth (9.8%) of these women had energy balance 200 Kcal or more. The result is statistically significant. As the vast majority of study women (93.8%) were involved in domestic work plus agriculture (Table 3), the energy consumption of these hard working women were much less than their expenditure.

More than one-third (34.2%) of the study subjects with per capita monthly income rupees 100 or less have

Table 4 : Effect of various demographic factors on daily energy balance of the study subjects (n=402)

Demographic factors	n	Energy balance (k.cal per day)										Mean	SD
		<-500		-500 to -200		-200 to 0		0 to 200		≥200			
		No	%	No	%	No	%	No	%	No	%		
Type of family													
Nuclear	172	96	55.8	25	14.5	17	9.9	10	5.8	24	14.0	-950.0	799.0
Joint	187	11	59.4	42	22.5	10	5.3	12	6.4	12	6.4	-610.6	846.4
Extended	43	27	62.8	8	18.6	4	9.3	3	7.0	1	2.3	-689.1	672.7
X^{2*} =4.7 d.f=2	p > 0.05												
Age of females (yrs)													
15-24	189	99	52.4	54	28.6	15	7.9	10	5.3	11	5.8	-652.8	580.5
25-34	112	67	59.8	9	8.0	8	7.1	9	8.0	19	17.0	-480.8	923.8
≥35	101	68	67.3	12	11.9	8	7.1	6	5.9	7	6.9	-965.3	816.0
X^{2*} =11.1 d.f=2	p<0.01												
Educational status													
Illiterate	278	159	57.2	57	20.5	25	9.0	14	5.0	23	8.3	-723.7	705.9
Just literate	100	59	59.0	14	14.0	5	5.0	11	11.0	11	11.0	-736.0	730.6
Primary	19	15	78.9	0	0	1	5.3	0	0	3	15.8	-605.3	531.9
high school+inter	5	1	20.0	4	80.0	0	0	0	0	0	0	-314.9	117.2
X^{2*} =0.25 d.f=2	p>0.05												
Occupation													
Domestic+ agriculture	377	220	58.4	67	17.8	31	8.2	22	5.8	37	9.8	-686.2	783.9
Domestic + labour	6	3	50.0	0	0	0	0	3	50.0	0	0	-330.3	519.0
Domestic+ patalwork	5	2	40.0	3	60.0	0	0	0	0	0	0	-912.4	645.9
Domestic only	14	9	64.3	5	35.7	0	0	0	0	0	0	-678.5	427.3
X^{2*} =8.98 d.f=3	p<0.05												
Per capita income (Rs per month)													
≤100	38	13	34.2	9	23.7	2	5.3	7	18.4	7	18.4	-298.6	729.7
100.1-200	112	61	54.5	16	14.3	18	16.1	6	5.4	11	9.8	-627.5	619.9
200.1-300	146	82	56.2	38	26.0	8	5.5	8	5.5	10	8.5	-743.8	727.5
>300	106	78	73.6	12	11.3	3	2.8	4	3.7	9	9.2	-797.2	928.3
X^{2*} =15.2 d.f=3	p<0.01												

X^{2*} = calculated between two groups (negative and positive groups) of energy balance

energy balance less than – 500 Kcal. However, the figure was 73.6% among women with per capita income more than 300 rupees (Table 3). The result is statistically significant, the reason for this may be the same as discussed earlier that apart from cash, several other factors largely influenced the diet of these tribal women.

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