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## Nutrient Intake and Energy Balance of Adult Women

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**ABSTRACT** Given the fact that diet and environment have a marked effect on the health of the population, sedentary lifestyle coupled with malnutrition can be an important risk factor for the development of chronic diseases. The present study assessed the nutritional status of 40 normal adult women in the age group of 20-60 years residing at different locales of Mysore city of Karnataka State. The dietary status was determined by the food and nutrient intake using diet history, the energy expenditure was computed by a Factorial method using activity level and time records of two consecutive days. The result indicated that the energy and protein intake increased with age but was below the recommended dietary intake. The micronutrient consumption was found to be inadequate with respect to Iron, Niacin and retinol. A positive energy balance in all age groups was observed as there was a tendency towards reduced physical activity. The data suggested that the overweight observed in the subjects above the age group of 40 years could be related to the sedentary lifestyle and possible excess energy intake over a long period of their life. It is suggested that studies such as these are required to elucidate strategies for maintaining optimum nutrition and health including weight management, and also to reduce the risk for the development of chronic diseases.

### INTRODUCTION

India has been going through a period of fast urbanization, industrialization and westernization for several decades (Singh and Agrawal, 2007). The Indian population is also passing through a transition phase where subsistence conditions are being replaced by plentiful food but reduced physical work and therefore, an understanding of the changing nutritional scene is critical (Rao, 2001). Although India has made considerable progress in the economic sphere, it is one of the few countries where men significantly outnumber women (Capoor and Chetna, 2000).

Women play a central role in child care and food processing even when their economic roles require extensive time and physical energy (McGuire and Popkin, 1988). Poor health has repercussions not only for women but also their families (Velkoff and Arjun, 1998). Thus, women work twice as much as men equally at home as well as the work place (Capoor and Chetna, 2000). However it is been argued that while the women's additional work is helpful to increase the household income, it may not always lead to an improved diet due to change in priorities (Wande and Ottesen, 1992). Hence the present study was undertaken to determine the nutrition and health of adult women.

### MATERIALS AND METHODS

The present study included forty women between the age group of 20-60 years with no underlying disorders or morbidities selected randomly from the urban population of Mysore city, Karnataka state, India. An attempt was made to enroll an equal number of subjects in each group of i.e. 20-30, 31-40, 41-50 and 51-60 years.

A preformed questionnaire was used to record personal data, anthropometric measurements, dietary intake and activity record of the selected women.

Anthropometric measurements- Height (cm), Weight (kg), Arm circumference (cm), Waist (cm), Hip (cm), Triceps skin fold thickness (mm), measurements using the standard procedure (Encyclopaedia, 1993 and Jelliffe, 1966) were recorded for all the forty subjects.

The food intake of all the women was assessed by interviewing the women with the help of household measures relevant to Indian cuisine models to construct the individual women's 24-hour food intake. Raw amounts for the cooked food items were derived by standardizing the preparatory methods of different menu items. Energy expended in different activities for two consecutive days was computed using the data on time use recalls of the subjects as per the Food and Agriculture Organization /World Health

Organization estimates (WHO, 1985) of energy required per minute for specified class of activities.

The collected information was consolidated in terms of each subject and computed for the whole group using descriptive analysis. Food intake data was converted into raw amounts in terms of food groups and in turn was translated into energy and nutrients by calculations using Food composition tables (Gopalan et al., 1993). The nutrient intake of the women was computed against Recommended Dietary Intake (RDI) for ensuring the appropriateness of intake derived based on Recommended Dietary Allowances (ICMR, 1987) for age, gender, and activity.

The data was tabulated and subjected to appropriate statistical analysis.

## RESULTS

### Background Information

The study group consisted of Women in the age group of 20-60 years randomly selected from different locales of Mysore city. The women belonged to middle-income group. Table 1 gives the background information of the subjects.

Demographic characteristics of the selected subjects indicated that 80% of the families were of nuclear type, with house hold size having less than 4 in a family. Only 2% of the families had a house hold size above 8.

Though it was found that 65% were vegetarian and 35% were categorized under Non vegetarian, the frequency of consuming of flesh foods by the later was found to be once or twice a week.

Socioeconomic characteristics revealed a higher literary level among the subjects with 32% of women having a post graduate degree. 50% of

**Table1: Background information of the selected women.**

<i>Demographic characteristics</i>	<i>No. (%)</i>
<i>Religion</i>	
Hindu	3 (75)
Christian	8 (20)
Muslim	2 ( 5)
<i>Family Type</i>	
Nuclear	32(80)
Joint	8(20)
<i>Household Size</i>	
<4	15(38)
4	14(35)
5 to 8	10(25)
>8	1(2)
<i>Number of Children</i>	
None	8(20)
1	15(38)
2	16(40)
3	1(2)
<i>Type of Diet</i>	
Non-vegetarian	14(35)
vegetarian	26(65)
<i>Frequency of Non-Veg Item in Diet</i>	
Weekly	10(72)
Rarely	2(14)
Daily	2(14)
<i>Education</i>	
Non-Literate	4(10)
Primary Level	11(28)
Graduate	12(30)
Post Graduate	13(32)
<i>Occupation</i>	
Home maker	20(50)
Lecturer	15(38)
clerk	5(12)

the women were gainfully employed and other 50% were involved only in household work.

### Somatic Status

The mean anthropometric measurements classified according to age groups are shown in Table 2. The results showed that there was a constant increase in weight overtime from 21-60

**Table 2: Mean  $\pm$  SD anthropometric measurements and indices of the women.**

<i>Measurements/Indices</i>	<i>Age group (yrs)</i>			
	<i>20-30</i>	<i>31-40</i>	<i>41-50</i>	<i>51-60</i>
Height (cm)	157.9 $\pm$ 6.5	154.2 $\pm$ 4.0	154.4 $\pm$ 3.0	155.8 $\pm$ 3.4
Weight (kg)	57.3 $\pm$ 6.9	56.1 $\pm$ 5.6	59.4 $\pm$ 4.48	60.0 $\pm$ 0.2
Body Mass Index	22.8 $\pm$ 2.4	23.5 $\pm$ 2.2	24.6 $\pm$ 1.8	24.6 $\pm$ 1.4
Mid upper Arm circumference (cm)	27.0 $\pm$ 2.2	26.8 $\pm$ 1.7	25.3 $\pm$ 1.2	24.9 $\pm$ 1.2
Mid upper muscle circumference(cm)	22.2 $\pm$ 1.7	21.4 $\pm$ 1.8	20.9 $\pm$ 0.9	19.0 $\pm$ 0.9
Triceps Skin fold (mm)	15.4 $\pm$ 1.7	16.1 $\pm$ 2.1	16.3 $\pm$ 1.3	18.2 $\pm$ 2.6
Waist (cm)	78.4 $\pm$ 5.0	89.0 $\pm$ 5.0	86.1 $\pm$ 6.5	91.7 $\pm$ 12.0
Hip (cm)	96.2 $\pm$ 5.9	104.2 $\pm$ 4.7	97.3 $\pm$ 5.1	95.2 $\pm$ 7.0
Waist/Hip Ratio	0.82 $\pm$ 0.02	0.85 $\pm$ 0.04	0.88 $\pm$ 0.02	0.96 $\pm$ 0.19

years. The weight ranged from 57-60 kgs. Body mass index, an indicator of energy status showed an increase as the age advanced. Normal body mass index was observed up to 40 years and gradually increased between 41-60 years, thus indicating positive energy balance. The mean waist to hip ratio increased with increasing age, ranging from 0.82- 0.96, indicating abdominal obesity.

The mid upper arm circumference and mid upper arm muscle circumference of the subjects were below normal values compared to that of standards indicating low protein status. The Triceps skin fold thickness values which indicate the Fat status, increased with the increasing age in the subjects.

### Nutrient Intake

The dietary intake of various food items is

presented in Table 3. The results indicated that the intake of cereals, pulses, green leafy vegetables, other vegetables, sugars and fruits were low compared to the desirable dietary pattern of the subjects. The mean intake of Energy and macro nutrients is presented in Table 4. The mean energy intake was lower than the recommended dietary intake of Indian council of medical research in all the age groups, but still the observed overweight could be related to sedentary lifestyle and possible excess energy intake over the period of time. It was also observed that the energy intake decreased with increasing age unlike protein which increased with increasing age but the protein intake was below the recommended dietary Intake. This could be related to the lower protein status observed in all the age groups. The fat intake decreased with increasing age.

The Mean daily intake of micro nutrients of the women is shown in Table 5. The results

**Table 3: Mean  $\pm$  SD food intake of the selected women.**

Food groups(g/ml)	Age group (yrs)								p-value
	20-30		31-40		41-50		51-60		
	Intake	*DDP	Intake	*DDP	Intake	*DDP	Intake	*DDP	
Cereals	174 $\pm$ 42	345	199 $\pm$ 44	338	217 $\pm$ 42	315	246 $\pm$ 57	324	0.0042**
Pulses	21 $\pm$ 9	65	28 $\pm$ 27	60	30 $\pm$ 12	60	46 $\pm$ 31	30	0.0134**
Green leafy vegetable	22 $\pm$ 35	190	46 $\pm$ 74	190	60 $\pm$ 84	190	73 $\pm$ 71	190	0.0000**
Other vegetable	93 $\pm$ 88	215	98 $\pm$ 45	215	104 $\pm$ 107	215	164 $\pm$ 114	215	0.0000**
Roots & tubers	197 $\pm$ 116	60	197 $\pm$ 60	60	153 $\pm$ 104	60	105 $\pm$ 38	60	0.0000**
Milk	393 $\pm$ 98	200	411 $\pm$ 109	200	509 $\pm$ 97	200	598 $\pm$ 128	200	0.0000**
Sugar & jaggery	28 $\pm$ 6	30	25 $\pm$ 10	30	25 $\pm$ 3	30	24 $\pm$ 7	30	0.9498 <sup>NS</sup>
Fats & oils	36 $\pm$ 16	30	34 $\pm$ 10	30	33 $\pm$ 11	25	26 $\pm$ 7	25	0.6237 <sup>NS</sup>
Fruits	50 $\pm$ 50	85	65 $\pm$ 55	85	65 $\pm$ 48	85	93 $\pm$ 72	85	0.0027**
Fleshy foods	15 $\pm$ 27	30	0	30	26 $\pm$ 47	30	60 $\pm$ 10.8	30	0.0000**

\* DDP- Desirable dietary pattern computed based on RDA of ICMR for Reference Adult Women (Sedentary worker) with desirable body weight for age.

\*\* Significant, NS - Not Significant.

**Table 4: Mean  $\pm$ SD intake of energy and macro nutrients of the selected women.**

Dietary Constituents	Age group (yrs)								p-Value
	20-30		31-40		41-50		51-60		
	Intake	*RDI	Intake	*RDI	Intake	*RDI	Intake	*RDI	
Energy (kcal)	1840	2140	1850	2040	1795	2010	1675	1930	0.0127***
	$\pm$ 405	$\pm$ 175	$\pm$ 270	$\pm$ 105	$\pm$ 125	$\pm$ 90	$\pm$ 220	$\pm$ 75	
Protein (g)	44.0	53.4	44.8	50.9	47.7	50.2	47.6	48.3	0.9645 <sup>NS</sup>
	$\pm$ 7.0	$\pm$ 4.4	$\pm$ 11.2	$\pm$ 2.66	$\pm$ 4.6	$\pm$ 2.2	$\pm$ 11.4	$\pm$ 1.8	
Total fat(g)	65.2	**	55.9	**	53.8	**	52.2	**	0.4409 <sup>NS</sup>
	$\pm$ 22.2		$\pm$ 12.5		$\pm$ 13.4		$\pm$ 4.8		
Carbohydrate (g)	245.3	**	251.8	**	281.0	**	292.6	**	0.1198 <sup>NS</sup>
	$\pm$ 35.4		$\pm$ 51.7		$\pm$ 30.0		$\pm$ 31.2		

\*RDI: Recommended dietary intake – Values are mean of RDI computed using ICMR recommendations for each of the Women based on Desirable body weight (DBW)

\*\* No recommended Dietary Intake.

\*\*\* Significant, NS - Not Significant

**Table 5: Mean  $\pm$ SD daily intake of micro nutrients of the selected women.**

Micro Nutrients	Age group (yrs)								p-Value
	20-30		31-40		41-50		51-60		
	Intake	*RDI	Intake	*RDI	Intake	*RDI	Intake	*RDI	
Calcium (mg)	755 $\pm$ 155	400	840 $\pm$ 205	400	935 $\pm$ 245	400	1095 $\pm$ 315	400	0.0000**
Iron (mg)	14 $\pm$ 2	30	14 $\pm$ 4	30	14 $\pm$ 3	30	13 $\pm$ 2	30	0.9966 <sup>NS</sup>
Retinol (mg)	257 $\pm$ 80	600	295 $\pm$ 75	600	303 $\pm$ 90	600	327 $\pm$ 75	600	0.0000**
Thiamine (mg)	1.3 $\pm$ 0.2	1.1 $\pm$ 0.8	1.3 $\pm$ 0.3	1.0 $\pm$ 0.1	1.4 $\pm$ 0.2	1.0 $\pm$ 0.1	1.5 $\pm$ 0.2	0.9 $\pm$ 0.3	0.9992 <sup>NS</sup>
Riboflavin (mg)	1.4 $\pm$ 0.2	1.2 $\pm$ 0.09	1.4 $\pm$ 0.3	1.1 $\pm$ 0.1	1.6 $\pm$ 0.2	1.1 $\pm$ 0.1	1.7 $\pm$ 0.4	1.1 $\pm$ 0.4	0.9975 <sup>NS</sup>
Niacin (mg)	7.3 $\pm$ 1.4	14.1 $\pm$ 1.1	7.5 $\pm$ 1.3	13.5 $\pm$ 0.7	8.0 $\pm$ 1.2	13.3 $\pm$ 0.6	9.0 $\pm$ 1.5	12.8 $\pm$ 0.5	0.9746 <sup>NS</sup>
Ascorbic Acid (mg)	75 $\pm$ 40	40	105 $\pm$ 75	40	110 $\pm$ 60	40	120 $\pm$ 70	40	0.0118**

\*RDI: Recommended dietary intake – Values are mean of RDI computed using ICMR recommendations for each Women based on Desirable body weight (DBW) for age.

\*\* Significant, NS - Not Significant

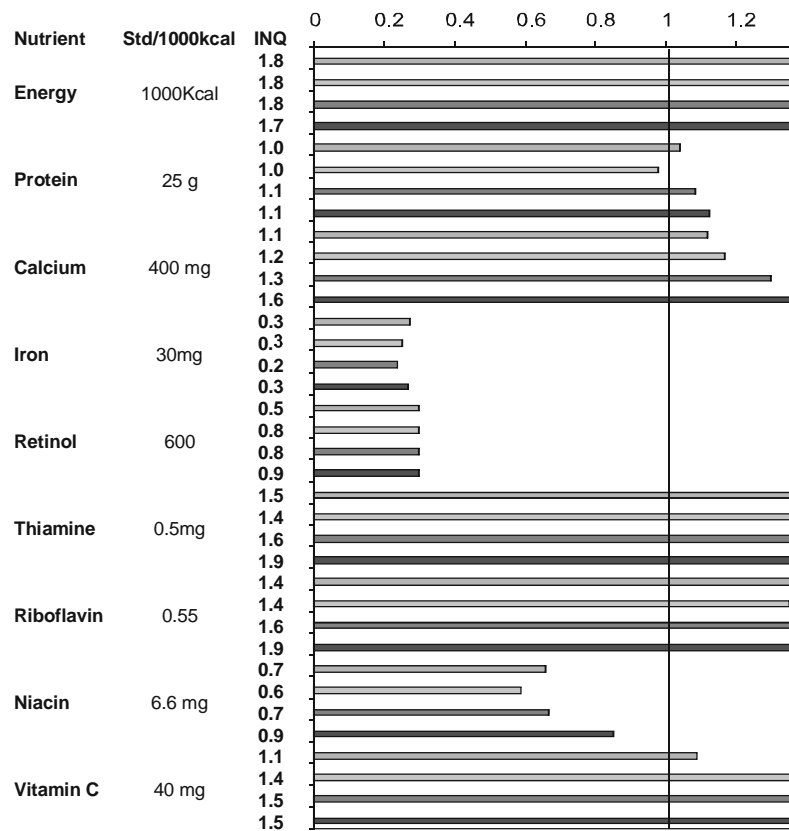


Fig. 1. Nutrient profile of women based on standard allowances per 100 Kcal-Inq

indicated that the intake of Calcium, Thiamin, Riboflavin and Ascorbic Acid were more than the recommended dietary intake in all the age groups. Where as, Iron, Niacin and Retinol intake was below recommended dietary intake.

The percent adequacy of nutrients consumed by women is shown in Table 6. The Indian council of medical research standards (1987) with cut off points of below 50, >51-70, >71-90 and >90 percent of the recommended levels were used to compare the women's intake. It was observed that the intake of Iron was <50 in almost 80% of women in the age group of 20-30 years. This trend was observed even in the other age groups also. Other nutrients in which women most frequently failed to meet below 50% were Niacin and Retinol.

The Nutrient quality index (INQ) of the diets consumed by women is represented in Figure 1. Nutrients as proportions of energy were more than adequate with respect to calcium, thiamine, riboflavin and Vitamin C, but fell short in all other nutrients.

**Energy Intake and Expenditure**

The energy intake of the subjects was found to be less than the recommended dietary intake as can be seen in Table 7. It was observed that the energy intake decreased with increasing age. The energy expenditure of the women was found to be lesser than the intake and hence positive energy balance was observed in all the age groups. The excess energy ranged from 22 - 54 kcal.

**DISCUSSION**

The results of the present study are indicative of the fact that there was a gradual increase in weight over the age range of 21-60 years. The BMI showed an increase starting from 41 years, indicating positive energy balance. The WHR also increased with age indicating abdominal obesity.

Anthropometric values are closely related to nutrition, genetic makeup, environmental characteristics, social and cultural conditions, lifestyle, functional status and health (Garcial et al., 2007).

Overweight/obesity has been related to morbidity and mortality risk among women. The prevalence of being overweight increases from the age of 20 to 60 years (Sammel et al., 2003), which is also observed in the present study.

**Table 6: Percentage adequacy of nutrients by women.**

Constituents	Age group (yrs)												
	20-30			31-40			41-50			51-60			
	<50	51-70	71-90	<50	51-70	71-90	<50	51-70	71-90	<50	51-70	71-90	
Energy	-	4(40)	1(10)	-	1(10)	4(40)	-	1(10)	5(50)	4(40)	-	2(20)	4(40)
Protein	-	2(20)	5(50)	1(10)	2(20)	2(20)	-	-	3(30)	7(70)	-	3(30)	1(10)
Fat	-	-	1(10)	-	1(10)	1(10)	-	-	2(20)	8(80)	-	-	-
Calcium	-	-	-	-	-	-	-	1(10)	-	9(90)	-	-	10(100)
Iron	8(80)	2(20)	-	6(60)	3(30)	1(10)	9(90)	1(10)	1(10)	-	8(80)	1(10)	-
Retinol	7(70)	3(30)	-	6(60)	4(40)	-	6(60)	2(20)	1(10)	1(10)	3(30)	6(60)	1(10)
Thiamine	-	-	1(10)	-	-	1(10)	-	1(10)	-	9(90)	-	-	10(100)
Riboflavin	-	1(10)	9(90)	-	-	10(100)	-	1(10)	-	9(90)	-	-	10(100)
Niacin	7(70)	2(20)	1(10)	4(40)	5(50)	1(10)	1(10)	7(70)	2(20)	-	5(50)	3(30)	2(20)
Ascorbic Acid	-	1(10)	1(10)	-	1(10)	-	9(90)	1(10)	1(10)	8(80)	-	3(30)	7(70)

-NIL

Figures in parenthesis indicate the percentage

**Table 7: Mean  $\pm$  SD estimates of energy expenditure of women vis-à-vis energy intake.**

Age group (yrs)	Recommended dietary allowance (Kcal/day)	Resting metabolic energy (Kcal/day)	Energy intake (Kcal/day)	Energy expenditure (Kcal/day)	Deficit/excess (-) (+)
20-30	2138 $\pm$ 177	1269 $\pm$ 103	1840 $\pm$ 405	1818 $\pm$ 105	+22
31-40	2038 $\pm$ 106	1253 $\pm$ 55	1850 $\pm$ 270	1836 $\pm$ 115	+14
41-50	2009 $\pm$ 92	1278 $\pm$ 46	1795 $\pm$ 125	1741 $\pm$ 120	+54
51-60	1932 $\pm$ 75	1286 $\pm$ 50	1675 $\pm$ 220	1626 $\pm$ 90	+49

Moreover, all the subjects were showing increased abdominal girth indicating a tendency towards central obesity.

Regional fat distribution, particularly a high proportion of upper body fat or abdominal fat is recognized to be an important component in the insulin resistance of obesity and type 2 diabetes (Goodpaster et al., 2000).

Abdominal obesity is particularly important, as excess intra-abdominal adiposity increases cardio metabolic risk directly, via altered secretion of adipokines and indirectly via promotion of insulin resistance and the metabolic syndrome (Haffner, 2006).

It was also observed that the mid upper arm circumference and mid upper arm muscle circumference of the subjects in the present study were below the normal as compared to the standards, thus indicating that the women tend to develop low protein status from a young age and the trend continuing even in the later years of life.

It is reported that rates of loss of lean body mass and reserve capacity or organ function changes are linear from age 20 onwards with an increase in the fat mass (Robert and McGandy, 1982). The Triceps skin fold thickness values of the subjects increased with advancing age indicating an increase in the fat mass.

Nutrition appears as one of the major determinants to predict successful aging. With increase in age, there appears to be a decline in lean body mass, especially muscle mass, which predicts strength and mobility, influences insulin sensitivity and acts as a major determinant of basal metabolic rate (Nicolas et al., 2001).

The food intake data of the subjects revealed that the intake of all the food groups except roots and tubers, milk and milk products, and fats and oils were more compared to desirable dietary pattern.

Innate factors of lacto vegetarian diets, viz, high level of fiber, minerals and reduced fat content are considered beneficial. The recent trend in India has however been a reverse in

dietary habits. Due to increased consumption of fat and reduced intake of complex carbohydrates and fiber, the risk for non-communicable diseases increases. Increasing intake of fruits, vegetables and cereals in the diet is currently advocated as a measure to control non-communicable diseases (Chiplonkar, 2004).

Hence, the somatic status of the subjects in the present study- Low protein and high fat reserves could be related to their dietary intake. It has been shown that dietary inadequacies can lead to energy deficits and micro nutrient deficiencies resulting in physiological stress which in turn may result in the higher deposition of fat around the abdomen through cortisol mechanism (Anon, 1994).

The data on daily intake of micronutrients of the subjects revealed that except for calcium, thiamin, riboflavin and ascorbic acid, all the other nutrients were low compared to recommended dietary intake.

The micronutrient deficiency has been shown as an important risk factor for the development of chronic diseases (WHO, 2002).

The Subjects in the present study followed a sedentary lifestyle and the energy expenditure pattern showed positive energy balance. Women with no regular physical activity tend to have increased body mass (Jain and Singh, 2003). The results of the study are indicative of the fact that these subjects are likely to be at risk for developing chronic diseases- diabetes, cardiac diseases, arthritis and other related disorders.

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