Results and Discussion
4. RESULTS AND DISCUSSION

The present study was conducted with the major objective of focusing on the nutritional profiles of CED, obese and normal women classified on the basis of Body Mass Index. The results and discussion were presented in seven sections. The first section deals with the prevalence of different nutritional states among the study population i.e. the rural women in the age group of 18 – 50 yrs. The remaining six sections deal with the nutritional status of women based on chosen nutritional status parameters in the following order – anthropometry, body composition, dietary intakes, energy expenditure as assessed from physical activity pattern with a focus on BMR, biochemical and clinical examination. The final seventh section deals with the contribution and correlation of the select nutritional status parameters to BMI.

4.1 Prevalence of different nutritional states among the rural women

The 600 non-pregnant and non-lactating women in the age group of 18-50 yrs were distributed according to their BMI to focus on the prevalence of different nutritional states.

The percent prevalence of different grades of CED and obesity and the normal group is presented in table 13 and represented diagrammatically in fig 4. Among the 600 subjects, while 50.3 percent of the women belonged to normal group, 34.8 and 14.83 percent of women belonged to CED and obesity groups respectively.

The distribution of subjects as per income reveal that a high percent of LSL women were in grade I CED (14.52) when compared with MSL women (12.76). There was very little difference for the other grades of CED between the LSL and MSL groups; the percent of women in low weight normal group was 15.81 and 14.48 respectively and an equal percent from both groups were in normal group was (35.16
and 35.17 respectively). With regard to obesity a slightly higher percent (7.24) of women of MSL were in Gr-II obesity when compared with that of LSL (6.45). Whereas in Gr-I the percentage was more in LSL (8.06) when compared with MSL (7.93).

The data as related to age reveal that, in the LSL group of women: the percent in the three grades of CED was greater in the 18-30 yrs age group than 30-50 yrs age group. With regard to MSL age groups such a definite trend was not observed. It was observed that in this group the percent in Gr-II CED was similar for both age groups while those in Gr-III CED was higher in the 18-30 yrs age when compared with 30-50 yrs. With regard to Gr-I CED the percentage was higher in the 30-50 yrs when compared with the 18-30 yrs.

With regard to normal nutritional state the trend observed was similar for the 18-30 and 30-50 yrs age group of LSL and MSL groups. It was evident that the percentage of 'low weight normal' was higher in 18-30 yrs group when compared 30-50 yrs group. With regard to 'normal' group, the percentages of women were greater in the 30-50 yrs when compared with the 18-30 yrs group. However, there were slight differences in the percentage of low weight normal and normal group for the 18-30 and 30-50 yrs age of MSL and LSL categories.

In both LSL and MSL group the 18-30 age group registered a high percentage of overweight and obese subjects when compared with the 30-50 yrs age group. In both the age groups with the exception of MSL 30-50 yrs, the percent of overweight Gr-I were greater than the obese Gr-II women.
Table 13: Distribution of the percent prevalence of different nutritional states among rural women as per standard of living and age.

<table>
<thead>
<tr>
<th>Nutritional State</th>
<th>BMI Cut-off Values</th>
<th>Nutritional Grade (Gr)</th>
<th>18-30 yrs % (No)</th>
<th>30-50 yrs % (No)</th>
<th>Total % (No)</th>
<th>18-30 yrs % (No)</th>
<th>30-50 yrs % (No)</th>
<th>Total % (No)</th>
<th>Grand Total % (No)</th>
<th>% Prevalence (No)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CED</td>
<td>&lt;16</td>
<td>Gr-III-Severe</td>
<td>12.86(18)</td>
<td>9.41(16)</td>
<td>10.96(34)</td>
<td>11.68(16)</td>
<td>12.42(19)</td>
<td>12.07(35)</td>
<td>11.5(69)</td>
<td>34.8 (209)</td>
</tr>
<tr>
<td></td>
<td>16-17</td>
<td>Gr-II-Moderate</td>
<td>9.28(12)</td>
<td>8.82(15)</td>
<td>9.02(28)</td>
<td>10.22(14)</td>
<td>10.46(16)</td>
<td>10.34(30)</td>
<td>9.67(58)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>17-18.5</td>
<td>Gr-I-Mild</td>
<td>15.71(22)</td>
<td>13.53(23)</td>
<td>14.52(45)</td>
<td>15.33(21)</td>
<td>10.46(16)</td>
<td>12.76(37)</td>
<td>13.67(82)</td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>18.5-20.0</td>
<td>Low weight Normal</td>
<td>17.14(24)</td>
<td>14.71(25)</td>
<td>15.81(49)</td>
<td>15.33(21)</td>
<td>13.73(21)</td>
<td>14.48(42)</td>
<td>15.17(91)</td>
<td>50.3 (302)</td>
</tr>
<tr>
<td></td>
<td>20.0-25.0</td>
<td>Normal</td>
<td>29.28(41)</td>
<td>40.0(68)</td>
<td>35.16(109)</td>
<td>31.39(43)</td>
<td>38.56(59)</td>
<td>35.17(102)</td>
<td>35.17(211)</td>
<td></td>
</tr>
<tr>
<td>Obese</td>
<td>25.0-30.0</td>
<td>Gr-I-Overweight</td>
<td>8.57(12)</td>
<td>7.65(13)</td>
<td>8.06(25)</td>
<td>8.76(12)</td>
<td>7.19(11)</td>
<td>7.93(23)</td>
<td>8.04(48)</td>
<td>14.83 (89)</td>
</tr>
<tr>
<td></td>
<td>&gt;30.0</td>
<td>Gr-II-Obese</td>
<td>7.14(10)</td>
<td>6.88(10)</td>
<td>6.45(20)</td>
<td>7.29(10)</td>
<td>7.19(11)</td>
<td>7.24(21)</td>
<td>6.83(41)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>140</td>
<td>170</td>
<td>310</td>
<td>157</td>
<td>153</td>
<td>290</td>
<td>600</td>
<td>600</td>
</tr>
</tbody>
</table>
DISCUSSION:

Periodic surveys carried out by NNMB of the National Institute of Nutrition, Hyderabad and the recent National Family Health Survey (NFHS, 2000) initiated by the Ministry of Health and Family Welfare, Government of India focus on the trends pertaining to CED and obesity among rural women.

The findings for India based on two separate series of National Nutrition Monitoring Bureau surveys conducted between 1974-1979 and 1988-1990 showed that India had a high proportion of adult males and females with BMI < 18.5, even in 1989-1990. It was observed through NNMB survey conducted in 1991 that 3.6 percent of the rural population had a BMI exceeding 25. NNMB reported that the prevalence of CED among the rural women was 47.1 percent, 6.6 percent were obese and 46.3 percent were normal (NNMB Report, 1996). This reveals the increasing trend in the prevalence of obesity even among the rural groups.
In the present study the percent of rural women having BMI < 16 and belonging to GHII CED was 11.5 which is in close agreement with that of NNMB data (1988-1990) of 10.2 percent.

NFHS - 2 surveys (2000) revealed that the prevalence of CED was 40.6 percent and that of obesity was 5.9 percent among rural women. These figures pertaining to CED were greater than those observed for the urban counterparts. When compared with data of the present investigation the percentages were lower for the rural women. The differences may be attributed to the nature of the sample.

The distribution of Indian adults based on BMI was different from those of Brazilian and Chinese population and also when compared with national survey data collected from African, European, North American and Latin American countries. This unique distribution raises the issue of whether the population is constitutionally different from that of other nations (FAO, 1994). NNMB collects data from 10 states and the agreement of this data with that of the present data, which is from a micro level investigation, reveal that the nutritional issues of Indian adults call for an indepth investigation.

Focusing on the recent trends as observed from the NFHS and NNMB surveys Sachdev (1997) in his analysis on nutritional status of women in India, commented that despite of a distinct shift of the distribution to the right even now CED is prevalent in 37 – 47 percent of the women with the severe form being documented in 10 percent. Further, obesity is beginning to emerge (7 to 12 percent) as another end of the spectrum of malnutrition.

Several other researchers globally have focused that the problem of obesity is on the increase. Further, a few of them reveal that obesity is on the increase not only among the elite group but also among middle and low socio-economic groups (Stene et al., 2001; Misra, 2001; Hakeem, 2001; Filozof et al., 2001).
The observations of the present study reiterate the findings of the above surveys and research works. However, the relatively higher percentage of over-weight / obesity (14.83 per cent) observed in the present context may be because of the fact that women aged > 50 yrs were excluded for the assessment of BMI. Even if the total women population is considered the prevalence of both CED and obesity still remain strikingly high in the present rural community.

In the present study slight differences were observed between the LSL and MSL groups and the 18-30 and 30-50 year age groups for the prevalence of different states and grades of malnutrition. BMI closely correlates with body weight. And it is a well-established fact that slight increments in weight are associated with age. The increments may be possible with the normal groups in the present context.

Several studies have proved the effect of income on the nutritional status. The differences in nutritional status related to income may be immediately and clearly evident probably as related to other nutritional status parameters rather than in the body composition which is a consequence of long term nutrition input.

4.2 Anthropometric profile of CED, obese and normal adult women subjects:

In the present context weight (wt), height (ht), skin fold thickness (SFT), mid upper arm circumference (MUAC), hip and waist circumferences were the nutritional anthropometric measurements done for the rural women belonging to the three nutritional states viz., chronic energy deficient (CED), obese and normal.

RESULTS:

The profile of anthropometry of the subjects is presented in table 14. The data reveal that with the exception of height all other anthropometric measurements recorded by CED were lower than the values recorded by normal and obese groups of women. Similarly with the exception of height all other measurements recorded by the obese were greater than those of the normal group women. The ANOVA revealed that the variation between the groups is significant.
4.2.1 Weight status of subjects:

The CED group recorded a mean weight of 36.23 kg. The mean weight registered by the obese was 71.46 kg. The mean weight of normal group was 50.01 kg. The weight recorded by the obese is twice that of the CED group. The mean difference between CED and normal was about 14 kg; between obese and normal was about 21 kg, and between obese and CED was 35 kg. The differences in weight between the groups were found to be significant at 1 percent level (P<0.01).

The data on weight segregated in relation to standard of living and age of the subjects revealed that mean weights recorded by women of MSL were higher when compared with those of the LSL. With regard to age the mean weights of 30-50 yrs women registered were higher than those of the 18-20 yrs age group. However, the differences observed were not significant.

The trends pertaining to the distribution of weight in relation to BMI of the subjects is depicted in (fig. 5). It was observed that the weights ranged from 30-49 kg for the CED, 56-96 for the obese and 39 to 71 for the normal group.

DISCUSSION:

The mean differences in weight are visibly striking as both CED and obese nutritional states chosen belong to the extreme levels. In the present context grade III CED and grade II obese women were chosen for purposes of comparison. The data reveals that the women with a BMI > 18.5, BMI ranging from 18.5 to 25, which is considered to be the ‘Normal’ group, registered a mean weight of 50.0 kg which is the value of weight recommended for reference Indian woman.
Table 14: Anthropometric profiles of CED, obese and normal groups of women subjects

<table>
<thead>
<tr>
<th>Parameter</th>
<th>CED</th>
<th>OBESE</th>
<th>NORMAL</th>
<th>‘F’ value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean ± SD</td>
<td>Range</td>
<td>Mean ± SD</td>
<td>Range</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>36.22±4.15</td>
<td>30-49</td>
<td>71.46±7.76</td>
<td>56-96</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>153.18±7.80</td>
<td>140-178</td>
<td>149.67±5.99</td>
<td>130-163</td>
</tr>
<tr>
<td>BMI (w/h²)</td>
<td>15.34±0.39</td>
<td>13.07-16</td>
<td>31.81±2.71</td>
<td>30-42.6</td>
</tr>
<tr>
<td>Skinfold thickness(mm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biceps</td>
<td>2.36±0.68</td>
<td>1.30-4.00</td>
<td>10.41±1.49</td>
<td>7.30-14.98</td>
</tr>
<tr>
<td>Triceps</td>
<td>5.1±1.18</td>
<td>3.30-7.50</td>
<td>13.57±1.56</td>
<td>9.90-16.58</td>
</tr>
<tr>
<td>Sub scapular</td>
<td>8.19±1.13</td>
<td>6.30-10.10</td>
<td>14.54±1.52</td>
<td>9.97-17.10</td>
</tr>
<tr>
<td>Suprailliac</td>
<td>8.75±1.36</td>
<td>6.90-11.00</td>
<td>16.07±1.43</td>
<td>9.90-18.50</td>
</tr>
<tr>
<td>Sum of skinfold thickness(mm)</td>
<td>24.42±4.12</td>
<td>19.00-31.10</td>
<td>54.54±4.21</td>
<td>42.67-63.37</td>
</tr>
</tbody>
</table>

NS = Not significant
* ‘F’ - Significant at p<0.01 - 1% level
NNMB (1980) reported the mean weight of women aged between 25 and 44 years living in rural areas of ten States. The rural Indian women weighed 42.4 kg. Regional variations were observed, but were not very striking. Weights ranged from a low 39.9 kg in West Bengal, to a maximum of 44.4 kg in Madhya Pradesh. The mean weight for Andhra Pradesh rural women was reported to be 42.7 kg. ICMR (1991) showed the mean weight of rural Indian women as 44.3 kg. That, weight is closely associated with socio-economic status was clearly focused from the data of NNMB collected for men and women belonging to different levels of socio-economic status. The data however, were not segregated for women.

Visvecswara Rao et al., (1986) showed that rural adults had significantly lower weights than the reference values and also stated that males had better weights when compared to the females. The mean weight of urban women of Hyderabad aged 18-40 years was 43.6 kg and these values significantly differed from their respective standards (Sujatha et al., 2000). Ashana et al., (1998) studied females > 15 years age residing in Varanasi in India and showed that the mean weight of obese women was 64.51 kg and that of non-obese women was 49.63 kg. There was a significant difference between these two groups. In the present context when all the groups were combined the mean weight recorded was 52.0 kg. This is greater than those observed for rural women; probably because of the nature of the sample studied.

Not only in the Indian context but also in other developing countries similar trends in body weights of rural women were observed. Immink et al., (1992) in his study on Guatemalan rural adults, observed that males had a weight of 53 kg whereas, females had 47.8 kg and these values significantly differed from their respective standards. In the present study when compared with the standard weight of 50 kg, a deficit of 30 percent was observed for CED; and the normal group registered a mean
(50.02 kg) exactly similar to the standard. Yamauchi et al., (2000) reported that the rural adult villagers of Papua New Guinea Highlanders were lighter than their urban counterparts, with the differences being significant for men (P<0.05) and for women (P<0.005).

Nurdiati et al., (1998) studied the nutritional status of non-pregnant women aged 15-49 years of age residing in Purworejo district of Indonesia, indicated that the overall percent of women below the 5th percentile for weight was 37. Stone et al., (2001) showed that the mean weight of the Westbank village population was 62.7 kg. There was a significant difference when compared with the standards. The extreme status of weight observed in these two situations may be attributed to the lifestyle prevalent as a consequence of either levels of deprivation or levels of affluence.

It is evident from the range of values in each nutritional state that the weights were in a continuum while the BMI chosen was in close range. Weights of CED encroached into the weights of normal group and that of the normal heavily encroached into obese / overweight group and vice-versa. Between the normal and Grade-II, CED Grade-I and Grade-II should occur as per the classification given by James (1988). The two clusters, which have to occur in between, may be very close to either CED or the normal group. In such a situation the other metabolic and biochemical correlates also may be distributed into the adjacent nutritional categories.

Dudeja (2001) attempted to establish appropriate cut-off levels of the BMI for defining overweight considering the percentage body fat in healthy Asian Indians in Northern regions. The mean of weight reported was 56.9 kg. In the present context the women in the healthy BMI range i.e. >18 to 25 recorded a mean body weight of 50.01 kg. But many of the women had recorded weights upto 71 kg.
Fig 5: Distribution of weight of subjects in relation to BMI
In the situation presented body weight while it is closely associated with BMI may show wide distributions, in the same population. And hence, may have to be accompanied by body composition information which will be able to reveal the desirability of the weight status observed.

4.2.2 Height status:

The mean height value registered by the CED group was 153.2 cm. The values registered by obese and normal group were 149.6 and 150.9 cm respectively (table 14).

The data on heights were segregated in relation to standard of living and age of the subjects (table 15). It was observed that the values registered by LSL women in all the three groups were lower than that of MSL group. The differences however, were not statistically significant. Within each nutritional state the differing levels of deprivation or affluence might have influenced the stature to some extent.

The distribution of height in relation to BMI is presented in (fig. 6). The data reveal that unlike the trends observed for weight, the height values of CED not only encroached into both obese and normal height values but also in some instances exceeded them.

The data reveal that women in the CED group were taller than the obese and normal groups. The obese group registered lower values for height when compared with the normal group.

DISCUSSION:

According to NNMB surveys conducted during 1975 and 1994 the mean height recorded by adult women was 149.9 and 151.5 cms respectively. The height increments tended to be higher than past years, probably due to health and nutrition interventions.

ICMR (1991) reported that the mean height of rural Indian women was 154 cm. The NFHS-2 survey (2000) recorded the mean height of the rural women as 151.1 cms.
The values varied only slightly between 150 and 155 cms for different population groups. Thirteen percent of women were under 145 cms in height when compared with the mean height values reported by the above studies the present group of rural women is observed to be in the similar status for height.

The women when classified according to BMI those who are tall but in lower weight range appear to be classified in the CED group. At lower values of height they may have a BMI, which categorizes them as normal. Similarly in the other extreme of obesity / overweight if the statures are improved the women again may shift into the Normal grade. Thus in this classification of BMI those who are tall and those who are short to some extent may not truly belong to the nutritional grades, attributed to them.

With regard to age however no definite trends related to height were observed; which is expected, because height in growth ceases around 18 years of age while muscle mass and fat accretion can occur through life span. Thus adult height may be regarded as a consequence of past nutrition. In the developing countries and in the rural areas no dramatic changes occur in the socio-economic status of the rural households. The deprivations continue over generations. Thus, the better status in height for the rural women in the present study may be understood in the light of genetic potential being realized because of the health and nutrition inputs provided through health and welfare programs.

In the present context as height and weight profiles are being focused for the extreme conditions of malnutrition it may be interpreted that while tall people are at risk of CED, the short statured are at risk of obesity.

4.2.3 Skin fold thickness measurements of the subjects:

In the present context the skinfolds measured were biceps, triceps, subscapular and suprailliac. While biceps and triceps represent peripheral fat the subscapular and suprailliac represent the central fat. The data on sum of skinfolds and the individual skin folds are presented in table 16. The trends observed in relation to the three nutritional states are depicted in fig.7.
Table 15: Mean and standard deviation values for weight (Kg), height (Cm) and BMI as per age and standard of living

<table>
<thead>
<tr>
<th>Age (yrs)</th>
<th>Parameter</th>
<th>CED LSL</th>
<th>CED MSL</th>
<th>CED Total</th>
<th>OBESE LSL</th>
<th>OBESE MSL</th>
<th>OBESE Total</th>
<th>NORMAL LSL</th>
<th>NORMAL MSL</th>
<th>NORMAL Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-30</td>
<td>Weight</td>
<td>34.5±3.2</td>
<td>38.3±4.6</td>
<td>36.4±3.9</td>
<td>70.3±6.2</td>
<td>70.3±4.6</td>
<td>70.3±5.4</td>
<td>48.9±8.1</td>
<td>49.6±5.1</td>
<td>49.3±6.6</td>
</tr>
<tr>
<td></td>
<td>Height</td>
<td>149±6.0</td>
<td>156±9.3</td>
<td>153±7.7</td>
<td>151±6.2</td>
<td>150±3.4</td>
<td>151±4.8</td>
<td>150±6.3</td>
<td>151±5.6</td>
<td>150±5.6</td>
</tr>
<tr>
<td></td>
<td>BMI</td>
<td>15.4±0.6</td>
<td>15.5±0.3</td>
<td>15.4±0.5</td>
<td>30.8±0.9</td>
<td>30.9±0.9</td>
<td>30.9±0.9</td>
<td>21.6±2.2</td>
<td>21.9±1.8</td>
<td>21.7±2.0</td>
</tr>
<tr>
<td>30-50</td>
<td>Weight</td>
<td>36.1±4.1</td>
<td>36.2±4.3</td>
<td>36.1±4.2</td>
<td>71.2±11.6</td>
<td>74.1±7.6</td>
<td>72.6±9.6</td>
<td>49.8±3.1</td>
<td>51.8±8.0</td>
<td>50.8±5.6</td>
</tr>
<tr>
<td></td>
<td>Height</td>
<td>154±7.6</td>
<td>154±7.5</td>
<td>154±7.6</td>
<td>147±7.7</td>
<td>151±5.9</td>
<td>149±6.8</td>
<td>151±4.3</td>
<td>152±6.9</td>
<td>152±5.6</td>
</tr>
<tr>
<td></td>
<td>BMI</td>
<td>15.2±0.6</td>
<td>15.3±0.8</td>
<td>15.2±0.7</td>
<td>32.9±3.7</td>
<td>32.7±3.5</td>
<td>32.8±3.6</td>
<td>21.8±1.5</td>
<td>22.4±1.9</td>
<td>22.1±1.7</td>
</tr>
<tr>
<td>Group Total</td>
<td>Weight</td>
<td>35.3±3.7</td>
<td>37.2±4.5</td>
<td>36.2±4.1</td>
<td>70.7±8.9</td>
<td>72.2±6.1</td>
<td>71.5±7.5</td>
<td>49.4±5.6</td>
<td>50.7±6.6</td>
<td>50±6.1</td>
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<td></td>
<td>Height</td>
<td>152±6.8</td>
<td>155±8.4</td>
<td>153±7.7</td>
<td>149±6.9</td>
<td>151±4.7</td>
<td>150±5.8</td>
<td>151±5.3</td>
<td>151±6.3</td>
<td>151±5.6</td>
</tr>
<tr>
<td></td>
<td>BMI</td>
<td>15.3±0.6</td>
<td>15.4±0.6</td>
<td>15.3±0.6</td>
<td>31.8±2.3</td>
<td>31.8±2.2</td>
<td>31.8±2.3</td>
<td>21.7±1.9</td>
<td>22.1±1.9</td>
<td>21.9±1.9</td>
</tr>
</tbody>
</table>
Fig 6: Distribution of height of rural women subjects in relation to BMI
Fig 7: The mean and sum of skinfold values for the women in three nutritional states
Table 16: Mean and standard deviation values of SFT for CED, obese and normal groups as per age and SL

<table>
<thead>
<tr>
<th>Age (yrs)</th>
<th>Skinfold thickness (mm)</th>
<th>CED</th>
<th>Obese</th>
<th>Normal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LSL</td>
<td>MSL</td>
<td>Total</td>
<td>LSL</td>
</tr>
<tr>
<td>18-30</td>
<td>Biceps</td>
<td>2.88±0.48</td>
<td>2.83±0.63</td>
<td>2.86±0.54</td>
</tr>
<tr>
<td></td>
<td>Triceps</td>
<td>6.32±0.75</td>
<td>3.89±0.71</td>
<td>6.1±0.74</td>
</tr>
<tr>
<td></td>
<td>Sub scapular</td>
<td>9.42±0.45</td>
<td>9.00±0.49</td>
<td>9.21±0.51</td>
</tr>
<tr>
<td></td>
<td>Supra iliac</td>
<td>10.1±0.33</td>
<td>9.99±0.49</td>
<td>10.0±0.41</td>
</tr>
<tr>
<td></td>
<td>SSFT</td>
<td>28.7±1.81</td>
<td>27.7±1.58</td>
<td>28.2±1.73</td>
</tr>
<tr>
<td>30-50</td>
<td>Biceps</td>
<td>1.7±0.32</td>
<td>1.98±0.36</td>
<td>1.86±0.35</td>
</tr>
<tr>
<td></td>
<td>Triceps</td>
<td>4.2±0.58</td>
<td>4.01±0.39</td>
<td>4.11±0.49</td>
</tr>
<tr>
<td></td>
<td>Sub scapular</td>
<td>7.11±0.3</td>
<td>7.2±0.56</td>
<td>7.17±0.44</td>
</tr>
<tr>
<td></td>
<td>Supra iliac</td>
<td>7.34±0.23</td>
<td>7.57±0.39</td>
<td>7.45±0.34</td>
</tr>
<tr>
<td></td>
<td>SSFT</td>
<td>20.4±1.0</td>
<td>20.8±1.21</td>
<td>21.06±1.71</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>2.31±0.7</td>
<td>2.41±0.67</td>
<td>2.36±0.68</td>
</tr>
<tr>
<td></td>
<td>Biceps</td>
<td>5.27±1.3</td>
<td>4.95±1.1</td>
<td>5.11±1.18</td>
</tr>
<tr>
<td></td>
<td>Triceps</td>
<td>8.26±1.2</td>
<td>8.1±1.03</td>
<td>8.19±1.13</td>
</tr>
<tr>
<td></td>
<td>Sub scapular</td>
<td>8.72±1.4</td>
<td>8.78±1.31</td>
<td>8.75±1.36</td>
</tr>
<tr>
<td></td>
<td>SSFT</td>
<td>24.56±4.5</td>
<td>24.3±3.81</td>
<td>24.4±4.11</td>
</tr>
</tbody>
</table>
The data on individual skinfolds revealed that for the skinfolds biceps, triceps, suprailiac and subscapular the lowest mean values (2.36, 5.1, 8.9 and 8.75 mm respectively) were recorded by CED group women. The highest mean values were recorded by the obese (10.4, 13.5, 14.5 and 16.0 mm) and the values of the normal group (9.6, 12.4, 13.8 and 15.1 mm) were in between the values registered by CED and obese groups of women respectively for the four SFTs. The differences between the groups were significant (P<0.01 for all four SFTs). Further, the SFT of CED and obese differed significantly when compared with that of the normal group.

The data was segregated as per age and SL (Table 16). In the case of CED group on all the skinfolds the influence of age was significant (P<0.01) at one percent. Among the obese only for the suprailiac skinfold the influence of age was significant (<0.05) at 5 percent level. In the case of normal however, the effect of age was evident for three skinfolds viz., biceps, triceps and subscapular. The 't' values calculated for different age groups in each of the three nutritional states is presented in Table 17.

Table 17: 't' values of sum of skinfold thickness for CED, obese and normal subjects belonging to different age groups

<table>
<thead>
<tr>
<th>Details of the age groups (yrs)</th>
<th>Calculated 't' value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Biceps</td>
</tr>
<tr>
<td>Obese - 18-30 Vs 30-50</td>
<td>-1.750**</td>
</tr>
<tr>
<td>Normal -18-30 Vs 30-50</td>
<td>2.193**</td>
</tr>
</tbody>
</table>

* 't' - significant at < 0.01 - 1% level
** 't' - significant at < 0.05 - 5% level
NS - Not significant
The effect of standard of living was not evident for the individual skinfolds. A similar trend as observed in the case of individual skinfolds was evident with regard to sum of skinfold thickness.

Sum of skinfolds (SSFT) registered by CED, normal and obese were 24.42, 51.10 and 54.59 mm respectively. The CED group recorded lower value when compared with the normal and obese groups. Obese registered highest value. The variation between the groups was significant (P<0.01).

The influence of age was not evident for the obese group, while the normal and CED groups showed a significant difference (P<0.01) between the two age groups. The mean SSFT of CED and obese differed significantly (P<0.01) when compared with that of the normal group. As age advances a greater proportion of body fat is situated internally than subcutaneously. This may be the reason for the above differences observed between the age groups.

The distribution of SSFT values in relation to BMI are presented in fig. 8. The SSFT were ranging from 19.0 - 31.0 for CED, 42.67 - 63.37 for obese and 39.30 - 59.25 for normal respectively. The deviation from the mean values is very minimal. While SSFTs of CED was lower than and different from that of normal and obese, for the latter two groups the ranges of values recorded were almost similar.

DISCUSSION:

CED is a condition where only very minimal subcutaneous levels are maintained. Further, in the present context the subject's belonged to severe grade of malnutrition i.e. grade III CED. Hence, at lower BMIs the variation might be reduced, when people subsist on very low food intakes.

The obese group chosen belongs to the severe degree of obesity (Grade II) and hence, these women might have reached the maximum scope for fat accretion. A majority of the obese women were found to be relatively short statured when compared with normal and the CED groups.
Fig 8: Distribution of sum of skinfold thickness of rural women subjects in relation to BMI
Thus, the results reveal that at the severe grades of malnutrition the subjects tend to show least variability for the skinfold measurement.

Immink et al., (1992) in a study on resource poor, rural adult females of Guatemala reported the values of 4.9, 9.7, 10.7 and 8.0 mm respectively for biceps, triceps, subscapular and suprailiac skinfolds. The present group of rural women have relatively better value when compared with those of the above study. This may be due to differing levels of nutritional deprivation experienced by the above two groups of women.

Dudeja et al., (2001) showed the four skinfold values for healthy Asian Indians. The values reported for biceps, triceps, subscapular and suprailiac were 14.0, 22.1 23.4 and 24.6 mm respectively. The normal group categorized on the basis of BMI in the present context recorded lower values. The food habits and life styles of these Asian groups may differ when compared to the native rural Indian women groups.

The sum of skinfold values observed for rural females of all groups combined in the present study were 49.97 ± 6.5 mm. Misra et al., (2001) showed that the values for urban slum dwellers were 57.5 mm ± 30 mm which is greater than that observed in the present study. India is a unique country wherein a wide variety of cultures exist with varying levels of affluence and deprivation. Therefore, the variability could be understood in relation to the prevailing conditions.

Durnin et al., (1990) reported the sum of skinfold for rural women belonging to economically deprived sections. The SSFT values ranged from 28 - 32 mm (with a SD of 15-18 mm) in the harvest season and 27 - 31 mm (with a SD of 15 - 17 mm) during the lean periods. The corresponding body fat values in these groups are ranging between 21 to 23 per cent of body weight. The CED group recorded a SSFT value of 44.23 ± 5.6 with a corresponding body fat of 26.65 (refer section 4.3 table 22). The higher SSFT and the corresponding higher fat body observed in the present group of CED women can be attributed to their better economic status and also to the fact that this group of women comprise of purposively chosen CED group.
Kuriyan et al., (1998) reported on the skinfold thickness measurements of South Indian women in the age group of 20-38 years. The values recorded for the triceps, biceps, subscapular and suprailliac were 19.12 ± 3.93, 4.24 ± 2.42, 10.76 ± 4.38 and 11.5 ± 4.96 mm respectively. The values were higher than those observed for the collapsed mean values in the present study. The BMI of the women studied by Kuriyan et al. was 18.85 while in the present study the mean BMI of the group was 23.02. Thus, the fat reserves are bound to show some variation with differing BMI states of the subjects.

In the study by Kuriyan et al., (1998) the corresponding body fat calculated using the Durnin and Womersley (1974) equations reveal that the percent body fat of 20-38 year aged South Indian women was 21.95. In the present study the body fat for the younger age group (18-30 years) is 27.7 while the weight of the South Indian women was 43.96 kg, the present young women group from Andhra Pradesh State; South India recorded a body weight of 49.0 kg. This reveals that women in South India show regional variation in SFT and thus variation in body weight.

Durnin and Womersley (1974) collected data on skinfolds purposefully allowing for wide ranges to study the association between body composition and SFT. The sample consisted of different groups from adolescents (16 years) to the aged (68 years). To have wide range of values people attending obesity clinics were also included. The biceps, triceps, subscapular, suprailliac measured for females ranged from 16 - 68 years 8.7 to 15 mm, 16 to 25 mm, 14 to 24 and 16 to 23 mm. The present study, which includes 18-50 years aged women showed slightly lower ranges for each measurement even when the obese group was included. This may be because of the fact that severity of obesity in the western context may refer to more morbid types of obesity.

4.2.4. Mid upper arm circumference of the subjects:

In the present context the circumferences measured were mid arm (MUAC), waist (WC) and hip (HC). The data on circumferences are given in table 18. The mean mid arm circumference values registered by the CED, obese and normal women were
20.42, 28.45 and 23.72 cm respectively. A significant difference (P<0.01) was evident between the three nutritional states.

Table 18: Mean values of MUAC, WC, HC and WHR of three groups of subjects

<table>
<thead>
<tr>
<th>Parameter (cm)</th>
<th>CED</th>
<th>OBESE</th>
<th>NORMAL</th>
<th>&quot;F&quot; value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MUAC</td>
<td>20.43 ± 1.29</td>
<td>28.45 ± 2.59</td>
<td>23.72 ± 2.92</td>
<td>115.431</td>
</tr>
<tr>
<td>WC</td>
<td>58.70 ± 1.91</td>
<td>83.23 ± 5.67</td>
<td>87.58 ± 11.34</td>
<td>21.0 ± 8.0</td>
</tr>
<tr>
<td>HC</td>
<td>88.85 ± 13.88</td>
<td>105.13 ± 6.92</td>
<td>94.65 ± 12.30</td>
<td>71.0 ± 10.0</td>
</tr>
<tr>
<td>WHR</td>
<td>0.77 ± 0.04</td>
<td>0.65 ± 0.85</td>
<td>0.78 ± 0.91</td>
<td>0.32 ± 0.91</td>
</tr>
</tbody>
</table>

**"F"** - significant at <0.001 - 1% level

**"F"** - significant at <0.05 - 5% level

CED group recorded lower value when compared with normal and obese groups. Obese recorded the highest value. The mean MUAC values of CED and obese differed significantly (P<0.01) when compared with that of the normal group. The mean values of MUAC as per age and SL group is presented in table 19.

The influence of age was evident for both obese and normal groups with the difference in the mean MUAC between the two age groups being significant (P<0.05). The 't' values are presented in table 20. The mean of 30-50 yr age group was lower than the younger age group of 18-3 0yrs.

Table 20: 't' values of anthropometric measurements for CED, obese and normal subjects in the select age groups.

<table>
<thead>
<tr>
<th>Details of the age groups (yrs)</th>
<th>Calculated 't' value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MUAC</td>
</tr>
<tr>
<td>CED 18-30 vs 30-50</td>
<td>1.615 (NS)</td>
</tr>
<tr>
<td>Obese 18-30 vs 30-50</td>
<td>-2.171 **</td>
</tr>
<tr>
<td>Normal 18-30 vs 30-50</td>
<td>2.346 **</td>
</tr>
</tbody>
</table>
Table 19: Mean values of MUAC, WC, HC and WHR values as per age and SL of the subjects

<table>
<thead>
<tr>
<th>Age (yrs)</th>
<th>Parameters (cm)</th>
<th>CED</th>
<th>OBESE</th>
<th>NORMAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LSL</td>
<td>MSL</td>
<td>Total</td>
<td>LSL</td>
</tr>
<tr>
<td>18-30</td>
<td>MUAC</td>
<td>20.5±1.2</td>
<td>21±1.3</td>
<td>20.8±1.25</td>
</tr>
<tr>
<td></td>
<td>WC</td>
<td>58.9±2.9</td>
<td>53.1±8.7</td>
<td>56±5.8</td>
</tr>
<tr>
<td></td>
<td>HC</td>
<td>77.4±4.7</td>
<td>75.9±3.9</td>
<td>76.7±4.3</td>
</tr>
<tr>
<td></td>
<td>WHR</td>
<td>0.76±0.04</td>
<td>0.7±0.1</td>
<td>0.73±0.07</td>
</tr>
<tr>
<td>30-50</td>
<td>MUAC</td>
<td>19.6±1.4</td>
<td>20.6±2.6</td>
<td>20.1±2.5</td>
</tr>
<tr>
<td></td>
<td>WC</td>
<td>57.4±2.0</td>
<td>57.6±4.0</td>
<td>57.5±3.0</td>
</tr>
<tr>
<td></td>
<td>HC</td>
<td>75.1±5.0</td>
<td>76.6±3.6</td>
<td>75.9±4.3</td>
</tr>
<tr>
<td></td>
<td>WHR</td>
<td>0.77±0.1</td>
<td>0.75±0.1</td>
<td>0.76±0.1</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>20.1±1.3</td>
<td>20.8±2.5</td>
<td>20.4±1.9</td>
</tr>
<tr>
<td></td>
<td>WC</td>
<td>58.2±2.5</td>
<td>55.4±6.4</td>
<td>56.8±4.4</td>
</tr>
<tr>
<td></td>
<td>HC</td>
<td>76.3±4.9</td>
<td>76.3±3.8</td>
<td>76.3±4.3</td>
</tr>
<tr>
<td></td>
<td>WHR</td>
<td>0.76±0.07</td>
<td>0.72±0.1</td>
<td>0.74±0.09</td>
</tr>
</tbody>
</table>
As in the case of other anthropometric indices discussed in the preceding section, the variability of the MUAC appears to be very little in Grade III level CED and hence the age related differences are not brought out. Whereas in the case of normal group, the age related trends may be expected to be projected. With regard to Grade II obesity, the MUAC values ranged from 25 to 38 cms.

The distributions of the MUAC values of the subjects in each nutritional state in relation to BMI are depicted in fig 9.

The distribution reveal that there is a wide variation in the MUAC values of CED when compared to obese and the normal groups. It was observed that CED consisted of a high number of women having better stature when compared to normal and obese. The body frame influences the distribution of both lean body mass and fat mass. When compared with CED and normal the range of values observed for obese is limited. This also may be due to relatively short stature observed for the group and hence the pattern of LBM, BF distribution may also have limited scope.

This dispersion observed from a minimum to high values allow for the differences evident as related to age. It is also evident that the MUAC values in the upper limits of CED encroach into the lower limits of normal and obese group and the upper limits of the normal group encroach into the lower limits of the obese group. It is to be noted that though the extreme conditions were intentionally picked the occurrence of MUAC values reveal some amount of continuity even if the link was weak. Between CED and the normal two more grades of CED grade II and grade I should present their characteristic MUAC values. Similarly between the normal and obese groups, Grade - I obesity should exhibit its characteristic MUAC.
Fig 9: Distribution of mid arm circumference values of rural women subjects in relation to BMI
At an extremely low BMI, a better value of MUAC observed among the CED group may be due to the fact that a majority of the women were tall stunted which influenced even their BMI. A significant negative correlation (P<0.05) was obtained between BMI and height. Thus, it is possible that a tall woman with a relatively low body weight but with a better MUAC might be classified under CED group. However, when the mean values only were taken into consideration the distinct differences between groups are unmistakable.

The CED group with a mean BMI of <16 and normal group with a BMI of >18.5 registered MUAC values of 20.75 and 24.2 cm in the present study. In the investigation by James for Indian women the mean BMI was 18.1 ± 2.2 and the MUAC was 21.42 cm. In this study the study samples were drawn from rural farming communities representing the poor income groups. Therefore, if a significant correlation is evident for the CED subjects with limited variability in the MUAC values, a highly positive correlation is expected for the present sample, which includes III grade CED, normal, and II grade obese groups with MUAC values ranging from a minimum to a maximum. The range of values observed for CED in the present study was 17-24, 25 – 38 for obese and 20 – 30 cms for normal.

The value of arm circumference measurements in assessing CED in the third world countries was evaluated by James et al., (1994). The MUAC and BMI were highly correlated in each of the 4 national groups and the 5 groups of Africans studied.

Mason et al., (1963) reported a study conducted among Indian adolescent and young urban adult women. They attempted to establish standards of reference for basal metabolism and other anthropometric measurements. The results of the study revealed a significant correlation between arm circumference and w/h.t². The mean arm circumference recorded by the young adult women was 24.03 cms. Visweswara Rao et al., (1986) correlated the arm circumference values of rural adult women with w/h.t² and found it to be significant (P<0.05).
Indices least correlated with stature and better correlated with measurements, which reflect muscle (and fat) may serve as good indicators for the assessment of undernutrition and overnutrition. The values of MUAC obtained for women in the present study appear to be valuable in judging the nutritional state of the women groups.

4.2.5. Arm measures of the subjects:

The mid upper arm circumference either alone or combined with triceps skinfold thickness for calculating mid upper arm muscle area, provides estimates of varying accuracy of protein reserves of the body and hence protein nutritional status. Mid upper arm muscle area is preferable to circumference, because it adequately reflects the true magnitude of tissue changes.

In the present study arm muscle circumference and arm muscle area were calculated with standard formulae (Frisancho, 1990) using MUAC and triceps skinfold. The values pertaining to arm measures are presented in table 21.

Arm muscle circumference:

The mean AMC values obtained for the CED, obese and normal groups of subjects in the present study was 18.72, 24.19 and 19.80 cms respectively. A significant difference at 1% level (P<0.01) was evident among the three groups of women for AMC. The obese group recorded higher value when compared to normal and CED group.

Table 21: Arm measures of women in three nutritional states

<table>
<thead>
<tr>
<th>Parameter</th>
<th>CED Mean ± SD</th>
<th>Range</th>
<th>Obese Mean ± SD</th>
<th>Range</th>
<th>Normal Mean ± SD</th>
<th>Range</th>
<th>‘F’ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MUAC(cm)</td>
<td>20.43 ± 1.29</td>
<td>17.0 - 24.0</td>
<td>28.45 ± 2.59</td>
<td>25.0 - 38.0</td>
<td>23.72 ± 2.92</td>
<td>20.0 - 30.0</td>
<td>115.43*</td>
</tr>
<tr>
<td>Triceps(mm)</td>
<td>5.11 ± 1.18</td>
<td>3.30 - 7.50</td>
<td>13.57 ± 1.56</td>
<td>9.90 - 16.58</td>
<td>12.50 ± 1.87</td>
<td>7.90 - 16.0</td>
<td>348.383</td>
</tr>
<tr>
<td>MC(cm)</td>
<td>18.72 ± 1.91</td>
<td>14.8 - 22.08</td>
<td>24.19 ± 2.51</td>
<td>19.99 - 32.79</td>
<td>19.99 ± 2.79</td>
<td>15.65 - 25.54</td>
<td>54.52*</td>
</tr>
<tr>
<td>AMA(cm²)</td>
<td>21.66 ± 5.64</td>
<td>32.19 - 10.93</td>
<td>40.54 ± 10.53</td>
<td>25.3 - 79.05</td>
<td>25.3 ± 9.48</td>
<td>45.39 - 12.98</td>
<td>52.52*</td>
</tr>
<tr>
<td>IM(kg)</td>
<td>29.49 ± 3.39</td>
<td>24.49 - 60.01</td>
<td>48.82 ± 5.12</td>
<td>38.56 - 62.36</td>
<td>35.90 ± 4.63</td>
<td>28.07 - 51.01</td>
<td>196.428</td>
</tr>
</tbody>
</table>

* ‘F’ – Significant at p < 0.01 – 1% level
** - Bone corrected
The range of values observed for CED, obese and normal group of women were 14.81-22.05, 19.99-32.79 and 15.65-25.54 cm respectively. The distributions of the AMC values of the subjects in each nutritional state in relation to BMI are depicted in Fig. The middle lower end of AMC values of normal has greater encroachment into the CED group. The obese touched the upper end of CED and middle and upper end values of normal group.

The influence of age was evident for only obese group of women. In this group a significant difference at 5% level (P<0.05) was evident between two age groups. In CED and normal groups the influence of age was not evident. The 't' values for arm measures for three nutritional states is presented in Table 22.

Table 22: 't' values of arm measures for CED, obese and normal subjects in the selected age groups

<table>
<thead>
<tr>
<th>Details of the age group</th>
<th>Calculated 't' value</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AMC</td>
<td>AMA</td>
</tr>
<tr>
<td>CED 18-30 vs 30-50</td>
<td>0.285&lt;sup&gt;NS&lt;/sup&gt;</td>
<td>0.150&lt;sup&gt;NS&lt;/sup&gt;</td>
</tr>
<tr>
<td>Obese 18-30 vs 30-50</td>
<td>2.10**</td>
<td>2.08**</td>
</tr>
<tr>
<td>Normal 18-30 vs 30-50</td>
<td>1.55&lt;sup&gt;NS&lt;/sup&gt;</td>
<td>1.62&lt;sup&gt;NS&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

**'t' - Significant at < 0.05 - 5% level

NS - Not Significant

Arm muscle area:

The mean AMA values registered by CED, obese and normal women were 21.66, 40.54 and 25.35 (cm)<sup>2</sup> respectively. A significant difference at 1% level (P<0.01) was evident between the three groups. Obese group recorded higher value when compared to normal and CED group.
Fig 10: Distribution of arm muscle circumference values of rural women subjects in relation to BMI
The range of values observed for CED, obese and normal group of women were 10.93-32.19, 25.31-79.09 and 12.98-45.39(cm)² respectively. The distribution of the AMA values of the subjects in each nutritional state in relation to BMI is depicted in Fig 11. AMA values showed that the middle and lower end of AMA value of normal have greater encroachment into the CED group. The obese touched the upper extreme of CED and middle and upper end of normal group.

The influence of age was evident for only obese women. Where as in CED and normal it was not evident. The difference between the two age groups in the obese group was significant at 5% level (P<0.05).

A significant correlation was shown between BMI and AMA (r = 0.758) and also between the LBM and AMA (r = 0.753). The relation was significant at 1% level.

DISCUSSION:

The value of arm circumference measurements in assessing CED in third world countries was evaluated by James et al., (1994). The estimates of muscle area circumferences and fat areas in the arm were also measured. The values of AMC and AMA in Indian rural women were 19.4 cm and 23.6(cm)² with BMI 17.7 kg/m². Men registered higher AMC than women. The regression coefficients were less than for total arm circumference (regression of circumferences on BMI). Muscle and fat measurements showed similar increase with BMI.

The values of AMC and AMA of the normal women in the present are similar to those reported by James et al., (1994). Further, as observed by these investigators the measure and fat measures increase with BMI.
Fig 11: Distribution of arm muscle area of rural women subjects in relation to BMI
Gartner et al., (2001) conducted a study among rural Congo African women. The AMA value was 31.0 cm² with BMI 18.5 kg/m². The AMA value was significantly lower in low MUAC when compared to normal MUAC women. Arm muscle mass was lower with BMI < 17.0. In the present study the value of AMA is lower (23.35 cm²) compared to that of African women. However, a similar trend was observed with regard to AMA and BMI.

Thus as proposed by several researchers, AMA might prove to be a more sensitive index of tissue atrophy than low body weight. In the case of CED women there is a loss of both adipose and lean tissue. Measurements of arm may therefore provide additional information on peripheral wasting.

The equation used for calculation of AMA has been shown to overestimate the measure by 20%. However, the strong association existing between the BMI and MUAC and AMA reveal that either independently or in combination they are indicative of chronic muscle wasting situations.

While muscle wasting may be evident with different degrees of CED, at higher levels of BMI, however, as in the case of obese condition distinguishing the composition as fat mass and lean body mass may become difficult. Hence in the case of obese the use of MUAC may be of some value in focusing the increment in fat tissue but AMA is of little use.

4.2.6 Waist and hip circumference and waist hip ratio of the subjects:

The data pertaining to waist, hip circumferences, and their ratio is presented in table 18.
**Waist Circumference:**

The mean waist circumference values registered by CED, obese and normal women were 56.75, 83.22 and 67.67 cm respectively. A significant difference (P<0.01) was evident between the three nutritional state groups.

Obese group recorded higher value when compared to normal and CED group. The mean waist circumference values of obese and CED group differed significantly (P<0.01) when compared with that of normal group women.

The influence of age was evident for obese and normal; there was a significant difference between the two age groups (P<0.05, P<0.01) respectively. In CED group the influence of age was not evident. The influence of standard of living was not evident in the three groups of women. The range of values observed for CED, obese and normal group of women were 23-67, 75-109 and 23-88cms respectively.

**Hip Circumference:**

The mean hip circumference values recorded for the CED, obese and normal women were 76.25, 105.12 and 89.27 cm respectively. A significant difference (P<0.01) was evident among the three nutritional state groups of women.

The CED and normal group values were lower than that of the obese women. The mean hip circumference values of CED and obese group differed significantly (P<0.01) when compared with that of normal women.

The influence of age was not evident in CED women. There was a significant difference between the two age groups (P<0.01) in obese and normal groups of women. The influence of income was not evident in the three groups.

The range of values observed for CED, obese and normal groups were 65-85, 94-125 and 71-106 cms respectively.
**Waist hip ratio (WHR):**

A waist hip ratio is a simple method for describing the distribution of both subcutaneous and intra-abdominal adipose tissue (Larsson et al., 1984; Jones et al., 1986). Willet et al. (1999) recommended a WHR > 0.8 as indicative of abdominal / central obesity. In the present context the mean waist hip ratio values recorded by the CED, obese and normal women were 0.74, 0.79 and 0.75 respectively. A significant difference (P<0.05) was evident between the three groups.

Obese group recorded higher value when compared to normal and CED group. The mean WHR of obese women differed significantly (P<0.05) when compared with that of the normal group. The influence of age and standard of living was not evident for the three groups of women.

The percentage of subjects having a WHR > 0.80 revealed an interesting trend (table 23). It was observed that in the Grade II obese group (BMI of >30) only 12.5 percent of the subjects had a waist hip ratio of >0.80. Whereas in the normal group a highest percent i.e. 35 of women had WHR>0.80, followed by the 27.5 percent of the CED group. When the correlation between WHR and BMI was assessed for individual groups no significant relationship was evident.

**Table 23: Percentage of subjects with high WHR by grades of BMI**

<table>
<thead>
<tr>
<th>Details</th>
<th>Grades of BMI</th>
<th>WHR &gt; 0.80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade II CED</td>
<td>&lt;16.0</td>
<td>27.5</td>
</tr>
<tr>
<td>Normal</td>
<td>18.5-25</td>
<td>35.0</td>
</tr>
<tr>
<td>Grade II obese</td>
<td>&gt;30</td>
<td>12.5</td>
</tr>
</tbody>
</table>

The collapsed BMI for the three groups existing at different levels of nutritional status in the present study was 23.0 and the WHR was 0.76. Further, the WHR differed significantly between the three groups. The distribution show that inspite of the extreme levels of malnutrition viz; CED and obesity the WHR values were in a continuum (fig. 12).
DISCUSSION:

Considering the percent body fat of 26.16 kg and the sum of skinfolds of 43.37 mm for rural women, BMI may be considered as a good predictor of body fat. And its use along with WHR may be useful in projecting abdominal obesity, which is associated with greater hazards.

Misra et al., (2001) focused on the anthropometric and metabolic profiles of slum dwelling women of Northern India. The waist hip ratio recorded for these women was 0.81. The researcher reported a high prevalence of abdominal obesity (16%).

There is growing evidence that obesity of the type in which fat is deposited centrally (abdominal obesity) as contrasted to obesity of the type where fat deposits occurs in the hips and gluteal region, is associated with greater hazards.

However, significant correlation (P<0.05) was shown between BMI and WHR in the present study when all the groups were combined. However, other workers have shown among the Indian urban slum women (Misra et al., 2001) and among the migrant Indian women (Dudeja et al., 2001) that despite high prevalence of obesity / abdominal obesity indicated by WHR and the corresponding BMI was relatively lower. They further focused on the higher percent body fat that occurred with low BMI. Thus, in the above population it appears that BMI may not be significantly correlated with waist hip ratio. Misra et al (2001) reported high prevalence of abdominal obesity, 16 percent of females had WHR higher than 0.80. It is worth noting that the BMI discussed is a mean value and it is possible that WHR ratios may be increasing at the upper limits of BMI for these 16 percent of females.

It was pointed out by Joann et al., (1995) that relation between waist to hip ratio and mortality from all causes from 1986 through 1992 among the US middle aged women group was weaker than between the BMI and mortality among women. In contrast the waist to hip ratio was a strong predictor of death due to coronary heart disease in this cohort.
Deurenberg et al., (1999) showed that at higher levels WHR, BMI and all biochemical cardio-vascular risk factors were higher. Further, they also focused that the elevated risks were prevalent even in the lower levels of WHR and BMI and reiterated the fact that the Asian population have higher body fat at lower WHR and BMI.

In the present study however, the strong correlation suggests that among Indian rural women both WHR and BMI can be used as predictor of body fat; and at higher values of these parameters the risk of chronic diseases may be predicted.

It may be noted that Indian rural women in the present study had registered lower values than that observed for Chinese women in the above mentioned study.

It is also noted that while range of BMI in CED group is narrow there is a high variability in the WHR values. This indicates that even at low levels of BMI some women show higher abdominal/central obesity/visceral fat distribution. The minimum and maximum values observed for WHR for normal at lower limit were almost similar to CED, which again emphasises the fact that even among the normal some individuals have very high WHR.

Urban slum women with a BMI of 20.5 had a mean WHR of 0.81 (Misra et al., 2001). The researchers also reported a high prevalence of abdominal obesity. In the present study a significant correlation is shown between BMI and WHR. However, Indian studies on migrant Indian females with a BMI of 23.3 had a WHR of 0.82 (Dudeja et al., 2001).

Other workers have observed a higher percentage of body fat in Asian Indians at a relatively low BMI. Considering the percent body fat 26.16 kg and the sum of skinfolds (43.37 mm) BMI may be considered as a good predictor of body fat among the rural women.
Fig 12: Distribution of waist hip ratio values of rural women subjects in relation to BMI
4.3. Body composition in relation to the nutritional state of women subjects:

In the present study the prediction equations formulated by Durkin and Womersley (1974) using SFT measurements were utilized to focus on the body density, percent body fat, body fat (kg) and LBM (kg) of the subjects. The values pertaining to body composition are presented in table 24.

Table 24: Body composition of women subjects

<table>
<thead>
<tr>
<th>Parameter</th>
<th>CED</th>
<th>OBESE</th>
<th>NORMAL</th>
<th>F' value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean ± SD</td>
<td>Range</td>
<td>Mean ± SD</td>
<td>Range</td>
</tr>
<tr>
<td>Body density</td>
<td>1.06±0.00</td>
<td>1.03-1.08</td>
<td>1.02±0.06</td>
<td>1.04±0.06</td>
</tr>
<tr>
<td>Body fat (%)</td>
<td>18.59±6.82</td>
<td>17.16-21.88</td>
<td>31.65±1.96</td>
<td>28.07-35.85</td>
</tr>
<tr>
<td>Body fat (kg)</td>
<td>6.74±0.84</td>
<td>5.51-8.39</td>
<td>22.64±3.19</td>
<td>17.44-33.64</td>
</tr>
<tr>
<td>LBM (kg)</td>
<td>29.49±3.39</td>
<td>24.49-40.01</td>
<td>48.82±5.12</td>
<td>38.56-62.36</td>
</tr>
</tbody>
</table>

* 'F' - significant at < 0.01 - 1% level

4.3.1 Body density:

The body density was calculated using the logarithm of SSFT. The mean body density obtained for the CED, obese and normal groups of subjects in the present study were 1.06, 1.03 and 1.04 respectively (table 24). A significant difference (P < 0.01) was evident among the three groups of women for body density.

The values registered by the obese subjects were lower than the CED and normal subjects. The mean body density values of CED and obese groups differed significantly (P < 0.01) when compared to that of the normal women.

The age effect was evident in three groups of women. There is a significant difference between the two age groups in CED and obese women (P < 0.01) and normal women (P < 0.05). Influence of standard of living was not evident in the CED, obese and normal groups of women.
The range of values for body density observed for CED, obese and normal women were 1.05 - 1.06, 1.02 - 1.035 and 1.029 - 1.042 respectively.

DISCUSSION:

A significant negative correlation (P < 0.01) existed between BMI and body density. This relationship is expected as BMI is positively and significantly correlated with each single skinfold thickness and with the sum of the skinfolds. At a high level of BMI a higher amount of body fat exists resulting in a low body density.

In the present study the mean body density value of obese women was lower than the CED and normal women. It once again proved the statement given by Durnin and Womersley (1974), that the greater the proportion of body fat in the body, the smaller is the body density.

The density ranges recorded by Durnin and Womersley (1974) was 1.040, 1.034, 0.025, 1.020, 1.013 respectively for 16-19, 20-29, 30-39, 40-49, 50-68 yrs age groups, the sample consisted of subjects deliberately selected to represent a variety of body types. Hence, in each age group a wide variation was evident in the body density. The lower limits were 1.004, 0.983, 0.985, 0.968 and 0.986 and the upper limits were 1.067, 1.078, 1.077, 1.045 and 1.041 respectively for the above mentioned age groups. The grand mean values of density observed in the present study when all three groups collapsed was around 1.03, which focuses that the body fat among these rural women may be lower irrespective of the nutritional status. However, within the limits the densities as related to the condition of malnutrition show distinct differences.

4.3.2 Body fat of the subjects

Body fat of the rural women subjects in the three nutritional states is focused through calculation of percent body fat and body fat in kg.
Percent body fat:

The mean body fat percentage recorded for the three groups of women in the present context was 18.59, 31.64 and 28.23 respectively. A significant difference (P<0.01) was evident among the CED, obese and normal groups of women.

The mean values of obese group were higher than the CED and normal group of women. The mean fat percent values of CED and obese group differed significantly (P < 0.01) when compared with that of normal women.

The influence of age was evident in CED, obese and normal groups. There was a significant difference between the two age groups in CED (P < 0.01), obese (P<0.05) and in normal women (P < 0.01). The influence of standard of living was not evident in the three groups of women. The range of body fat values observed for CED, obese and normal groups were 19.68 – 30.81, 28.07 – 35.05 and 24.68 – 30.95 per cent respectively. The distribution of percent fat values is depicted in fig 13.

Fat in Kg:

The mean body fat of the CED, obese and normal group of women was 9.68, 22.64 and 14.11 kg respectively. A significant difference (P<0.01) was evident among the three groups of women.

The values of the obese group were higher than the CED and normal women. The mean body fat values of CED and obese groups differed significantly (P < 0.01) when compared with that of normal women.

The influence of age was evident in CED and obese groups but not in normal group. There is a significant difference between two age groups (P < 0.01) in CED and obese groups of women.

The range of values observed for CED, obese and normal groups were 5.51–8.99, 17.44 – 33.64 and 10.93 – 19.99 respectively. Body fat was significantly (P<0.01)
correlated with BMI. The distribution of fat values of the subjects is depicted in Fig. 14. It is evident that while the body fat (kg) range is within 3.5 kg, for obese it is about 16.0 Kg and for normal about 9.0 Kg.

DISCUSSION:

Body fat over 30 per cent in females indicates obesity (Bray, 1985). Durnin and Rahaman (1967) estimated that the percent fat in Britain women was 24.2. Imminink et al., (1992) used BMI and also assessed body density to focus on CED of rural adult population in Guatemala. The fat percent in females was 21.6. James et al., (1994) in his study reported mean value of fat per cent in women to be 27.2. Davidson and Passmore (1970) and Joshi (1992) stated that fat percentage in normal healthy women was 22.3.

Edmundson and Edmundson (1988) stated that the fat percentage was higher in females. In females fat per cent in 25 – 40 yrs age groups was about 21.2 percent. These findings imply that the fat accretion in the females is more than that of men.

Densitometry is a relatively accurate method, which reflects the contribution of fat mass to the body density. The skinfold thickness and body impedance methods have been validated against a reliable estimate of fat mass. BMI also has been used as a simple index that reflects the body's fat content and hence body's energy stores. By comparing BMI with estimation of body fat stores, obtained through reliable methods such as densitometry, it has been shown that the BMI correlates well with body fat (Norgan and Ferroluzzi, 1982). The correlations were found to be high among individuals whose age ranges between 26 and 55 years. There were good correlations between the sum of several skinfolds and BMI (Keys et al., 1972).
Fig 13: Distribution of percent body fat of rural women subjects in relation to BMI
Women in both developing and developed countries have a greater fat mass than men at each level of BMI. The proportion of body fat in individuals from the developing countries (Papua New Guinea, Ethiopia and Somalia) was less than that of the Europeans (Italians and British) particularly for women. Whereas, in the present study even for CED at BMI of < 16 the percent body fat recorded is high 18.59 while Guineans and Somali women recorded a values ranging from 16 – 19 percent. Italian at a BMI of 18 – 20 recorded body fat of 28 percent. Norgan (1990) indicates that fatness or energy stores may vary in different population groups. Body fat differed markedly in the three population groups studied by the researchers for the same BMI.

At normal ranges of BMI the relationship between BMI and percent body fat is approximately linear (though this tends to vary in different groups of individuals). However, at higher levels of BMI a disproportionate increase in body fat was observed.

Durnin et al., (1984) in young healthy UK female soldiers showed that the percent body fat was 28.1, 28.2 and 29.8 at 20-24, 25-29 and 30-34 ages with the BMI of 22.8 and 22.5 and 22.9 respectively.

Indian male have been shown to have low fat and fat free mass while having lower BMI values. This explains why Indians probably well fed still had mean BMI less than 20.0. Shetty (1984) observed that chronic energy deficient 19-38 yrs male's labourer subjects who were slightly short statured had significantly lower body weights and body surface area and lower BMI. They had lower skinfold at four sites measured with an estimated total body fat of 6.1 percent. The BMI was 16.6 for labourers and 20.7 for normal controls.

Based on the four skinfolds viz., biceps, triceps, subscapular, suprailiac Misra et al., (2001) focused the percent body fat of Northern Indian women as 26.7 percent. In the present context though the SSFT was lower for normal women (49.97mm) when
Fig 14: Distribution of body fat of rural women subjects in relation to BMI
compared to that of Northern Indian slum women the body fat calculated was slightly higher (28.0). Durnin and Rahaman (1967) showed that for a skinfold thickness of 50 and 55 and 60 mm the corresponding percent body fat is 26.0, 27.5 and 29.0 respectively. The mean body fat (%) calculated for the subjects of the present study was 27.5 while this is closer to the corresponding value reported by Misra et al., (2001), the differences observed when compared with other works may be attributed to the variable skinfold measurements that may result in a wide range of values which influences the central tendency or mean values.

At very low body weights the body fat is lowered and ranges are closer whereas in the normal and obese the scope for wider ranges is possible.

4.3.3. Lean body mass

Lean body mass of the individuals is obtained by subtracting the fat in kg from that particular individual's body weight. When a person increases or decreases in weight, the net result is observed as increase or decrease, in the two body compartments- (i) fat free mass or lean body mass and (ii) fat mass. The mean lean body mass values registered by the CED, obese and normal women were 29.49, 48.82 and 35.90 kg respectively. A significant difference (P < 0.01) was evident between the three groups.

CED group recorded lower lean body mass value when compared with normal and obese groups. Obese recorded the highest value when compared with normal and CED groups. The mean lean body mass values of CED and obese differed significantly (P < 0.01) when compared with that of the normal group. The influence of age and standard of living was not evident in the three groups of women.

The range of values observed for CED, obese and normal women were 24.49 - 40.01, 38.56 - 62.36 and 28.07 - 51.01 kg respectively. The distribution of LBM values of the subjects against the mean BMI of subjects is plotted in the fig 15.
Fig 15: Distribution of lean body mass of the rural women subjects in relation to BMI
DISCUSSION:

Forbes and Welle (1983) pointed out that obese individuals generally exhibit a modest increase in lean body mass as well as excess body fat in comparison to normal weight peers, and among obese LBM tends to rise with increasing degrees of obesity. The malnourished individuals, on the other hand, have a reduced LBM as well as less body fat as shown by Barac Nieto et al., (1979) and Forbes et al., (1984). In the present study also highest LBM values were recorded by obese and lowest by the CED group. The mean LBM of CED was lesser by about 9 kgs and that of obese was higher by 13 kgs when compared with the mean LBM (about 35 kg) of the normal group.

Observations from a number of body composition experiments lead to the conclusion that significant weight loss in humans is almost always accompanied by loss of LBM as well as fat. Individuals with meager fat stores are forced to burn protein when faced with energy deficits. In the present study the mean energy intakes of the CED group women were lower when compared with the other two groups.

The obese women were shown to have larger LBM than non-obese (Forbes, 1983). Even if energy deficits are present the obese have the advantage of preferentially burning off fat. But it was observed that some loss of LBM also occurs, when low energy diets composed entirely of protein are consumed. Lower energy intakes indicated higher energy deficits. In the present study better intakes were recorded for the obese. However, the high energy expenditure (kcal) of the group has resulted in a negative energy balance for a majority. The higher LBM as well as fat levels indicate that mechanisms for maintenance of their body composition are operating inspite of the negative energy balance experienced by them.

Energy sufficiency also has been shown to result in an increment in LBM as well as fat. It was clearly focused through overfeeding experiments that both LBM and fat were gained at high energy diets containing adequate protein (15 per cent of total calories). Where as, LBM tended to fall as weight was gained on high energy diets low in protein contributing only 2.8 percent of total calories. This was further confirmed by Barac Nieto et al., (1979) through nutritional repletion of undernourished men. When adequate protein was given without a change in energy intake these subjects gained
protein intake may probably protect the LBM of the obese in the present study.

Further, it was also shown that during fasts of many days obese people also loose on an average only 10 g N for each kilogram of weight lost compared to 20 g N/kilogram for thin individuals (Forbes and Drenick, 1979). Therefore, even if the obese are in an energy deficit either due to low energy intake or due to high expenditure reduction in their LBM may not occur easily.

4.4. Food consumption pattern and dietary intakes of the rural women subjects belonging to three nutritional states:

The mean intake of different foods by the rural women belonging to the three nutritional states is presented in table 25. The data reveal that the mean intakes of all foods were lower for the CED when compared with the obese and normal groups. The obese women registered highest intake for almost all foods when compared with normal as well as the CED group. For any one food item the differences between the normal and CED were greater when compared with the difference between obese and normal.

The data when compared with that of the balanced diets revealed that intake of cereals was adequate for all women. In fact the mean intake was higher by 10, 48 and 33 percent for the CED, obese and normal women respectively. However, the intake of all the other foods was found to be lower than that of the balanced diets suggested for these groups. The trends observed in the food consumption pattern of the subjects as compared against the RDA are depicted in fig. 16, 17 and 18.

DISCUSSION:

The percent deficit for pulses was observed to be 61, 25 and 37 for the CED, obese and normal groups. However, the women in the three groups were consuming 30, 60 and 37g of non-vegetarian food, respectively. When this intake is considered the deficit in pulses is made up for normal, and for the obese they exceed the stipulated intake. Where as in the case of CED the deficits existed even afterwards.
Table 25: Mean food intakes of the rural women subjects as compared against RDA

<table>
<thead>
<tr>
<th>Foods (g)</th>
<th>CED</th>
<th>OBESE</th>
<th>NORMAL</th>
<th>TOTAL</th>
<th>RDA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean ± SD</td>
<td>Range</td>
<td>Mean ± SD</td>
<td>Range</td>
<td>Mean ± SD</td>
</tr>
<tr>
<td>Cereals</td>
<td>331±32.5</td>
<td>225-300</td>
<td>446±40.5</td>
<td>300-450</td>
<td>400±31.26</td>
</tr>
<tr>
<td>Pulses</td>
<td>155±3.75</td>
<td>15-30</td>
<td>30.75±6.25</td>
<td>20-45</td>
<td>25.1±5.13</td>
</tr>
<tr>
<td>Leafy vegetables</td>
<td>20.3±3.53</td>
<td>10-25</td>
<td>50.4±8.5</td>
<td>30-60</td>
<td>40.3±7.26</td>
</tr>
<tr>
<td>Other vegetables</td>
<td>25.7±7.15</td>
<td>20-50</td>
<td>71.2±18.75</td>
<td>25-100</td>
<td>50.5±13.2</td>
</tr>
<tr>
<td>Roots &amp; Tubers</td>
<td>15.8±3.3</td>
<td>10-20</td>
<td>35.6±7.5</td>
<td>20-50</td>
<td>27.7±6.25</td>
</tr>
<tr>
<td>Fruits</td>
<td>44.9±17.67</td>
<td>20-70</td>
<td>62.5±17.8</td>
<td>30-100</td>
<td>60.1±18.32</td>
</tr>
<tr>
<td>Milk and milk products</td>
<td>125.2±37.5</td>
<td>50-200</td>
<td>175.0±54.2</td>
<td>100-300</td>
<td>160.5±43.75</td>
</tr>
<tr>
<td>Egg</td>
<td>30.3±7.24</td>
<td>20-50</td>
<td>60.5±6.25</td>
<td>50-75</td>
<td>37.2±6.25</td>
</tr>
<tr>
<td>Sugar &amp; Jaggery</td>
<td>10.2±2.5</td>
<td>5-15</td>
<td>15.7±4.32</td>
<td>10-30</td>
<td>17.5±5.31</td>
</tr>
<tr>
<td>Oil</td>
<td>5.5±1.3</td>
<td>5-10</td>
<td>7.5±3.5</td>
<td>5-15</td>
<td>6.5±0.5</td>
</tr>
</tbody>
</table>
The deficit for intake of protective foods such as green leafy vegetables and milk and milk products was very high for the CED group. Further, the intake of concentrated sources of energy such as sugar, jaggery and fat were also low. The obese had better intake of all these foods inspite of the deficit when compared with CED and normal groups.

It is to be noted that the diet survey was conducted on two week days and one week end day. Though all the subjects were non-vegetarians the information related to intake of flesh foods and eggs revealed that the frequency of consumption was only once or twice in a week. Therefore, if the 3 day intake of non-vegetarian food is taken as the probable intake over one week period, the average intake per day worked out will be lowered and when its pulse equivalent is calculated the obese and normal groups also will be in a deficit for pulses.

When the data are compared with the data on food intake of adult women (>18 years) of Andhra Pradesh state (NNMB, 1996) a similar trend as observed in the present context is evident; while cereal intakes were higher, for all other foods the intakes were lower than the balanced diets. However, while the data obtained by NNMB showed very little variation, in the present context, the ranges of food intakes reveal the probability of higher deviation indicating a greater intra individual variation. This may be due to the fact that sample in NNMB survey comprises only of low income groups.

The main occupation of a majority of the families of subjects was agriculture. While some families were landowners and were involved in farming directly, the others who did not own any land were involved in farming by taking land on the lease and were working as agricultural labourer. In a majority of cases the agricultural labour was a shared activity between the medium standard of living and low standard living (MSL & LSL) families. The cropping pattern had reflected in the dietaries consumed by the women subjects. In general, in rural areas foods grown locally are utilized to the maximum extent and only few foods are bought from outside. The major crops grown in the villages of eastern parts of Chandragiri mandal were paddy, groundnuts, sugarcane, mango etc. Small-scale vegetable farming was also observed. While sugarcane and mango were purely cash crops, groundnuts and paddy were partly cash crops. A substantial quantity of the latter was used to meet the family's foods needs. This pattern was observed for those in MSL.
Fig 16: Mean food intake of CED rural women as compared to RDA
Fig 17: Mean food intake of obese rural women as compared to RDA
Fig 18: Mean food intake of normal rural women as compared to RDA
A majority of those in the LSL (30 %) possessed very small area of farming land and further lack of resources required for farming activity. Hence, most of the families depend on their daily earnings for satisfying their food needs.

The public distribution system (PDS) in vogue was able to supply the staple as well as the concentrated sources of energy such as oil and sugar. While the need for cereal food was satisfied, the needs of oil and sugar were not met fully. This was because of the fact that the cost of both oil and sugar in the open markets was higher than that of PDS. Therefore, the beneficiaries were tempted to sell at a price higher than the subsidized rate of PDS. This encashment of the subsidized foods appears to be regular feature among the LSL families. Further, the PDS supplies were observed to be not regular. In such situations the LSL families may have to face dire nutritional situation.

Three meals a day, was the food consumption pattern observed in the rural area. Rice was the predominant staple consumed and occasionally the minor millet, ragi and wheat was also used in limited quantities.

In the morning between 7:00 to 9:00 a.m. most of the subjects consume ‘saddi’ as breakfast. Saddi is the leftover rice soaked overnight in water or buttermilk. Most of the times the soaked rice was mixed thoroughly with water or butter milk and consumed as a drink. Sometimes, the soaked rice is eaten separately with tomato chutney/tamarind chutney / pickles (mango or lemon) and the remaining butter milk or water was used as a drink.

A majority of women (< 15 percent) both in the MSL and LSL were in the habit of drinking coffee or tea regularly in the morning as well as in the evening. A few were in the habit of preparing breakfast items like idli, dosai, pongal etc., which were consumed with chutney, sambar etc. Most of the times, soaked rice or sangati is mixed thoroughly with water or butter milk adding chillies and onions and used as a drink. Lunch was generally consumed between 12.30 to 1.30 p.m. Usually the staple was
eaten with a dish prepared from dhals. The liquid dhal preparation called as sambar was made with inclusion of a variety of seasonal vegetables such as brinjal, lady’s finger, drumstick, onion and tomatoes etc. The thick dhals may also be made with a variety of greens. Sometimes greens alone were made into a dish (Pullakura).

Thus, the common preparations consumed during lunch were rice, dhal or sambar, rasam and buttermilk. It was also observed that only some women include buttermilk in their diet and it was not a must for all. In a few families only one item either sambar or rasam was included in the lunch. A majority of the labourers were eating sangat made with rice alone or rice and ragi cooked together, and made into balls and consumed with pullakura or sambar as dish. Supper was taken between 7.30 to 8.00 p.m. and the items for the food were more or less the same as that of lunch.

It was observed that groundnut was the oil seed very popular and highly relished by all. It was available in these areas in plenty. It was eaten raw, boiled, roasted and also made into chutney, powder and as a thickener in all dishes and some snack preparations.

Women were in the habit of observing fasts. The period of fasting varies from ½ day to one full day. The frequency of fasting ranges from once a week to twice a month. During these fasts some accept only fruits and some accept small quantity of savories and sweets and some of the women were very strict and do not consume any food throughout the day.

Once or twice in a week, egg or any other non-vegetarian dish was consumed. A variety of fruits are available in the village. The fruits grown were papaya, guava, custard apple and mango. Some other forest produces and wild fruits locally known as nelli, usiri, kallinkaya, neredu, regi, bikki, beera, thoti, pariki, velaga, donda, eethu etc., were observed to be consumed by these rural communities. Some seasonal fruits like bananas, apples, grapes are bought from the nearest urban areas.
4.4.1. The nutrient intake of the subjects:

Nutrient intakes usually are a reflection of food intake, as cooked food is translated into raw ingredients and their nutrient composition is focused as nutrient intakes. However, the variety of foods included contributes significantly to the variation in the nutrient intakes particularly with regard to vitamins and minerals. The food intake usually closely reflects the calorie and protein intake.

The data on nutrient intakes is presented in table 26. The analysis of variance conducted reveals that there is a significant variation in all the nutrient intakes for the women in the three differing nutritional states. For all the nutrients the intake of CED group women was lower than obese and normal groups. The 't' test revealed that difference was significant ($P < 0.01$). With regard the obese and normal groups however, for a majority of nutrients the difference between the groups was not significant. The mean intake of fat by the obese was observed to be lower than that of the normal group. The difference was significant ($P < 0.05$). A similar trend was observed in the case of intakes of Vit C. However, a distinct and significant ($P < 0.01$) difference was evident between the above two groups for calorie intakes; the intake of calories of obese was greater than the normal women group.

The mean nutrient intakes were compared with the RDA (ICMR, 1991). The mean deficits observed with regard to calories were 25 percent for the CED group. All 40 members in the group showed deficits of varying level. Nearly 70 percent of the subjects in this group had percent deficit ranging from 20 to 35.

In the case of obese 57 percent of the subjects had intakes exceeding the RDA for calories. However, the remaining 43 per cent subjects showed deficits of varying degrees. Among the 17 subjects 13 showed deficits in the range of $1 - 10$ percent, while for 4 subjects the deficits ranged from $15 - 25$. 

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Table 26: Mean nutrient intakes of the rural women subjects

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>CED</th>
<th>OBESE</th>
<th>NORMAL</th>
<th>'F' VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean ± SD</td>
<td>Range</td>
<td>Mean ± SD</td>
<td>Range</td>
</tr>
<tr>
<td>Energy (k.cal)</td>
<td>1680.8±141.8</td>
<td>1432.1-2000</td>
<td>2458.8±286.3</td>
<td>2053-3043</td>
</tr>
<tr>
<td>Protein (gm)</td>
<td>44.9±4.7</td>
<td>35.7-56.6</td>
<td>52.6±7.6</td>
<td>35-70.5</td>
</tr>
<tr>
<td>Fat (gm)</td>
<td>29.2±7.9</td>
<td>20.0-53.35</td>
<td>44.9±9.6</td>
<td>25-68.5</td>
</tr>
<tr>
<td>Carbohydrate (gm)</td>
<td>283.1±47.4</td>
<td>216.3-370.4</td>
<td>431.3±67.4</td>
<td>300.5-578.1</td>
</tr>
<tr>
<td>Calcium (mg)</td>
<td>363.9±62.7</td>
<td>300.5-500</td>
<td>576.1±108.3</td>
<td>265.8-720.5</td>
</tr>
<tr>
<td>Iron (mg)</td>
<td>13.3±5.1</td>
<td>7.0-25.8</td>
<td>23.2±4.9</td>
<td>13-35</td>
</tr>
<tr>
<td>Vit A (µg)</td>
<td>1692.3±353.0</td>
<td>549.6-2300</td>
<td>1987.6±6287</td>
<td>600.3-3200</td>
</tr>
<tr>
<td>Vit B (mg)</td>
<td>0.8±0.2</td>
<td>0.2-1.05</td>
<td>1.0±0.2</td>
<td>0.6-1.5</td>
</tr>
<tr>
<td>Vit C (mg)</td>
<td>34.3±7.7</td>
<td>25.0-69.0</td>
<td>34.2±12.8</td>
<td>16-75.5</td>
</tr>
</tbody>
</table>

* 'F' - Significant at <0.01 - 1% level

** 'F' - Significant at <0.05 - 5% level
With regard to normal subjects, 50 percent of the subjects were having caloric intakes above the RDA. The remaining 50 percent showed deficits ranging from 1-20 percent.

The trends evident in the contribution of calories to the total calories by the proximate principles CHO, protein and fat in different nutritional states is presented in Fig. 19. It was clear that irrespective of the nutritional state carbohydrate dominated in satisfying the caloric needs, followed by fat, both visible and invisible making a combined contribution. The contribution from protein was lower than that of fat.

![Graph showing contribution of calories from CHO, Protein and Fat](image)

**Fig. 19: Contribution of calories from CHO, Protein and Fat**

The percent contribution of carbohydrate to calories was 67.3, 70.16 and 81.5 for CED, obese and normal groups respectively. The recommended intake of cereals is around 300 g/day. The women were observed to be using high amount of cereals. In addition, even if the pulse intakes were low, it would make additional contribution to the total carbohydrate intake. Thus in this context the contribution to the total calories is dominated by carbohydrate calories. As per the balanced diets 75 percent of the total calories should come from carbohydrates. This indicates an imbalance in the food intake, which may significantly affect other nutrient intake profile.
The mean protein intake was found to be satisfactory for the obese and normal groups. When compared with the RDA, CED group showed 10 percent deficit for protein. It is clear from the discussion in the preceding section that these women consumed cereal food in large quantities. This implies that the major contribution to the protein intake is from cereal foods alone as the intakes of other food items that contribute to protein such as pulse, milk and milk products registered inadequate intakes.

While evaluating the adequacy of diets it is useful to consider together the energy and protein requirements. The protein requirement can be expressed as the ratio of protein calories to total dietary calories (PE %). A comparison of this PE % value with PE % of the diet under examination will indicate whether the diets can fulfill protein needs if the energy requirement is met. In the present context for the CED group the energy needs in relation to age and sex were not met. The mean PE % for this group was 10.7, while recommended is 9.1. As the calorie need is not met the protein may be utilized for supply of calories in dire nutritional situations. It is also to be noted that the body weights are too low for this group and the energy intake/kg body weight for CED, group was 46.89 Kcal. Thus, if there were no demands of energy for physical activity with the lower BMR for the CED group the calories would be sufficient to maintain the existing state. In this state the protein intake also may be judged to be adequate. But, in view of the mere fact that CED is an undesirable state and also the fact that moderate level of activity, occurs as a chronic pattern with these groups, both calorie and protein may be stated to be inadequate. Further, the probability of substitution of protein to meet calorie need may be increased.

The PE percent of obese on the other hand was 8.7. It was also observed that the energy intake (Kcal)/kg body weight was 35. Though the energy intake registered
was higher than CED and normal groups, because of high body weight, the proportion of calories/kg wt is reduced. This again is a deviant state from normalcy. Thus the PE percent also was below the standard of 9.1 and hence not an ideal situation.

The PE percent of the normal was 10.0 indicating adequacy of protein. It was also observed that the normal group had adequate calorie intakes and had acceptable body weights, per kg body weight the calorie intake (Kcal) was 43 for this group.

Thus it may be inferred that the PE percent is adequate for the normal group while it appears to reveal some imbalance in the case of CED and obese due to obviously low or excess intake of calories, and, considering the low and excess body weights of above two groups, respectively. A major portion of protein was supplied from plant sources. The women being non-vegetarians 7-10 g protein was observed to be supplied from the animal foods. Though protein intake is lower, groundnut was consumed in appreciable quantities. Even if the quantity of protein was limited, there is scope for mutual supplementation of amino acids and hence the supply of essential amino acids may enhance the utilization of protein, provided when the calorie needs are met.

With regard to fat while the recommended intake was 20 g per day all groups including CED registered higher intakes than the RDA. The intakes of fat by obese and normal were 40 percent higher than that observed for the CED group. The visible fat intake was only 6–7 g/day. A daily Indian diet which provides 2400 calories will contain about 40 g of fat a day out of which 25 g will be invisible fat and 15 g visible fat (ICMR, 1995). Therefore, in the present context also it may be inferred that though the visible fat is minimum the rest is being contributed by invisible fat. Further, the dietaries of the women showed liberal consumption of groundnut, which can make a substantial contribution of fat to the diets.
With regard to iron while the recommended intake was 30 mg per day in all groups the mean iron intake was found to be lower when compared with that of RDA. The deficits observed were 53 percent for the CED group. In the case of obese and normal deficit of 20 percent was evident.

In the present context the mean calcium intake was found to be satisfactory for the obese and normal groups. The intakes were 30 percent more than the RDA. The CED group showed 10 percent deficit when compared with that of RDA.

The mean vitamin A intakes of all the three groups were lower than the RDA. The deficit was observed to be high for CED group (30 percent) and for obese and normal groups the deficits were 18 and 11 percent, respectively.

The mean Vitamin B1 intake was satisfactory for normal women. The deficit observed for CED group was 30 percent and for obese group was 5 percent respectively when compared with that of RDA.

The mean Vit C intake of CED and obese women was similar (34 mg) and had deficit of 15 percent when compared with that of RDA. The intakes were satisfactory for the normal women (40 mg).

The mean intake of calories by adult rural women in Andhra Pradesh state (> 18 yrs) is 1701 and 1789 Kcal/day (NNMB, 1975-80). There was a wide range in the intakes of rural women (1400 to 3000) Kcal/day.

DISCUSSION:

NNMBs (1980) data shows that the average intake of energy is much lower than the RDA, in both sexes. Further, they suggest that the energy intakes of adults after adjusting for lower body weights appear to be just adequate. The higher intake of the non-agricultural workers was attributed to their regular monthly income and nutritional awareness than the agricultural workers. The NNMB’s dietary intake surveys (1989)
document lower food consumption in households without land, compared with households with land; among labourers when compared with cultivators; and among schedule castes and tribes, compared with non-schedule groups.

The NNMB data is collected from household survey and does not take into account either the actual body size or the physical activity level of the individual within a household, both of which influence the energy needs. This method involves collection of household food intake data a time consuming process, which can be inaccurate. The use of household energy intakes and crude averages must be therefore, considered only as a general approximation of the nutritional situation within a community (Shetty and James, 1994). The actual intakes of women subjects' in the present context were higher for a majority of households than those observed by the NNMB surveys. In the present study utmost care was taken in recording and translating the food intakes into nutrient intakes. Further, India has experienced a dramatic increase in the food production particularly that of the cereal grains. The public distribution system (PDS) supplies cereal grains at subsidized rates. This and the measures taken by the government in ensuring equal wages for women might have shown some visible changes in the food intakes in the recent years. The higher intakes observed for the present group may be a consequence of these improvements.

Protein intakes based on NNMB (1980) survey data showed that the mean protein intake was 48.79 g/day in females of Andhra Pradesh. The protein intake by women was below 75 percent of RDA in all states, several investigators (Phansalkar et al., 1959, Apte and Venkatachalam, 1962 and Narasinga Rao, 1989) have stated that in India the diet of a large majority of the population consists predominantly of cereals and lacks protein rich and protective foods.
The iron content of several commonly consumed foods as reported in earlier food composition tables has been shown rather high. Re-evaluation has yielded much lower figure for so called iron rich foods, like green leafy vegetables.

Recent studies have also shown that iron contents based on analysis of food as purchased are higher due to contaminant iron. Washing the foods free of contamination lowers the iron content by about 20-30 percent. The true iron intakes in India are about 20-30 percent lower than those assessed earlier (ICMR, 1995). The preparation procedures followed like mincing the green leafy vegetables and then cleaning is still most prevalent inspite of continuous community education efforts. Some greens like drumstick and Agath were boiled and the cooked water is drained off. Such procedures may lead to substantial loss of the nutrient. Thus, most probably the intakes focused may be still lower in view of the facts stated above. Further, the three day dietary intake recorded the frequency of intake of green leafy vegetables at least once and also has the advantage of the iron contribution from the consumption of animal sources of food from a week end day. However, the intakes spread out for 7 days may still be lowered.

The percent iron content of greens, which were the main source, varies from 0.3 to 38.5 mg. Therefore, the type of greens added is significant in meeting the iron content. It was observed that the green leafy vegetables ‘Sirikeerai’ was grown as a cash crop and consumed by a majority. But, at other times when this vegetable is not available the dietaries may show different levels of iron intakes in these subjects.

Milk is a rich source of calcium. Calcium intake is fairly high being in the range of 1 g or more a day in communities that consume plenty of milk as in the west. However, in developing countries where milk intake is low, most dietary calcium comes from cereals. Since these are only a moderate source, the daily intake of calcium in such communities is in the low range of 300 – 500 mg a day. Other rich sources of calcium among plant foods are the millet, ragi and green leafy vegetables (ICMR, 1995).
In the present study though quantitative judgment is used, in the case of milk intake, it is a well known fact that milk is diluted at various levels; at the time of milching, at the time of transferring from one vessel to another (rinsing), while preparing curd, while preparing buttermilk, while preparing coffee etc. Therefore, the intake may be influenced by these dilutions, which could not be objectively assessed. However, the milk consumption has increased particularly because of the ‘operation flood’ or ‘white revolution’ programmes aiming at the increase in milk production. In the rural areas the farmers, and women groups were supplied with milching cows or loans are given to purchase milching cows at subsidized rates. Sale of milk has become one of the additional occupations for a majority. Therefore, only some amount of the milk was observed to be utilized for household consumption. Thus, deficiency of calcium is observed only among CED group for which all the foods consumed were found to be inadequate when compared with the standards.

β-Carotene forms a major source of dietary Vitamin ‘A’ in many developing countries including India. The major plant sources of β-Carotene are green leafy vegetables. The absorption of carotene from greens was found to be much higher than carrots and papaya, ranging from 50 – 99 percent. Among factors, which can influence the absorption and utilization of β-carotene, levels of dietary protein and fat are believed to be important. At recommended levels of dietary protein and fat, absorption of β-carotene has been shown to be satisfactory in Indian subjects.

In the present context the intake of both protein and fat were lower than the recommended levels for the CED group. This situation may aggravate the already existing deficiency. A moderate level of deficiency was observed for the obese and normal groups. It is to be noted that though green leafy vegetables were the main source of the Vitamin A precursor, the β-carotene, their composition for the same
shows a wide range. The $\beta$-carotene content of greens popular in these areas ranged from 14,000 to 120 $\mu$g. This implies that the type of green leafy vegetables included in the diet is crucial to meeting the need for Vitamin A.

The diet survey was undertaken during the months of June and July when the monsoon should begin. But in the recent years there are some changes observed in the seasons and many times summer is extending upto June and July with one or two episodes of rain. With the result fruits like mango and papaya are available in plenty and the consumption of the same is high. The same adequate intake levels may not be uniformly maintained all through the year.

In habitual Indian diets cereals form the major source of thiamine. In the rice eating population, this is the single most important dietary article, which provides thiamine. Since the vitamin is both water-soluble and heat labile in alkaline solution, considerable amounts are lost during cooking. Retention of thiamine has been found to vary between 30 and 80 percent of the original amount in several Indian preparations. From rice, loss of thiamine is much higher during washing than cooking (ICMR, 1995). If calculated on this basis all groups including the normal group too may be expected to be experiencing some degree of thiamine deficiency and the already existing deficiency of obese may be increased and in the case of CED the condition may be aggravated further reaching severe degree of deficiency.

Vitamin C is present in high concentrations in leafy vegetables and citrus fruits. Many other commonly consumed fruits such as tomatoes and bananas and vegetables such as potatoes, contain useful amounts. The vitamin is readily destroyed by oxidation during storage and cooking at high temperatures. As practiced in Indian households, cooking losses from vegetables have been found to vary widely ranging from negligible quantities to as high as 80 percent that originally contained. Vitamin C in Indian diets is contributed to a very large extent from cooked vegetables and only a small proportion is derived from raw vegetables and fruits.
In the present context the procedures observed to be followed during preparation and cooking of the vegetable certainly would lead to some losses of this nutrient. However, the intake of several seasonal wild fruits and berries which could not be quantified may be significantly contributing to the need for the vitamin.

Thimmayamma et al., (1982) examined the food consumption pattern and nutritional adequacies of population groups in and around Hyderabad as related to age, sex and socio-economic status. Among adults sex differences were observed mostly in the intake of cereals. A decreasing trend in the intake of energy and proteins with a decrease in socio-economic status was observed in all age groups. Adults in the upper middle and middle-income group had better energy and protein adequacies than those of low income and rural groups. There were no differences in the adequacies between upper middle income and middle-income groups. Among adult females the percent adequacy for calories was 69, 59, 47 and 63 of recommended allowances in the four socio-economic groups respectively. In a majority of the studies the intakes were shown to be influenced by the socio-economic status. In the present study however, an assessment of the standard of living, which is presently being used in the National sample and Family Health Surveys, was utilized and the women were grouped as low standard of living (LSL) and medium standard of living (MSL). It was observed that while LSL women spent major portion of their income to meet food needs, those in the MSL group were spending similar amount for food and remaining was expended towards maintenance of their status. In the present study the intakes were influenced by the age in each nutritional state. Thus, age emerges as an important factor in meeting the nutrient intakes.

According to Walter and Wakefield (1971) and Bhatia et al., (1981) calorie intake of low-income urban women in India ranged from 1200 to 1600 kcal/day.
Gupta Sushmita et al., (1987) studied the intake of different food items and energy by three groups of Indian adult women with different socio-economic status in relation to their body weight. Three groups were manual workers (MW), working women (WW) and housewives (HW) with respective per capita income of Rs. 182, 863 and 1643 per month. Compared to RDA adjusted to desirable body weight, the deficit in energy intake of MW (33.8%) could be related to their lower body weight by (21.5%) and a similar excess in the case WW (5.7%) and HW (17.4%) to their overweight (1.9%) and 7.6% respectively.

Durnin et al., (1990) showed that the intakes of Indian rural women in the middle income group was 1760 Kcal which was lower than that of the intake of working women (1890 Kcal). The researchers also focused that there was significant reduction in the energy intakes of the working women during the lean season compared to post-harvest.

Misra et al., (2000) focused on adverse profile of dietary nutrients, anthropometry and lipids in urban slum dwellers of Northern India. The mean nutrient intake of women were 1395 ± 379 Kcal of energy, 204 ± 54.3 gm of CHO, 41 ± 12.5 g of protein and 45.8 gm of fat respectively.

The most important finding of Prentice et al., (1986) was that the obese subjects must have been consuming an average of 531 kcal/day more than the lean controls in order to sustain their obesity but that this would have been underestimated by almost 837 kcal/day on the basis of dietary information alone. This emphasizes that mild hyperphagia may quite easily exist, and remain undetected, in pre-obese subjects and removes the need to invoke the energy sparing mechanisms to explain at least some forms of obesity. Metabolic or behavioural defects in appetite control mechanisms now seem a more likely explanation.
Anita et al. (1993) focused on demographic profile and food behaviour in selected obese adults. The subjects included, out-patients and in-patients enrolled in the department of endocrinology and cardiology of the hospital in Bangalore. The mean nutrient intakes of female subjects were 2507 ± 166 Kcal of energy, 75 ± 6.3g of protein, 85.6 ± 12.7g of fat and 357 ± 36.8g of CHO respectively.

Manocha (1985) reported on dietary intake of obese vs non-obese adults. The results revealed no significant difference in the intakes of the two groups.

The research data reveal contradictory findings pertaining to dietary intakes in relation to the state of nutrition. While some studies show very high intakes for the obese in some other, the intakes of obese were found to be lower and there exist no difference between the intakes of lean and obese women.

The present study however revealed distinct trends in the nutrient intake of the three nutritional states studied. The differences observed in the above studies may be partially attributed to the nature of subjects and research design used to control the biological and other influencing intervening variables.

The mean nutrient intakes of rural adults from the NNMB (1988-90) survey was 2283 Kcal energy, 62 g of protein, 28 mg of iron, 294 µg of vitamin A, 0.94 mg of riboflavin and 37 mg of vitamin C. The mean calorie intake (Kcal) based on occupation was 2043 for agriculture labour, 2123 of other labourers, 2514 for cultivators and 2244 for others.

NNMB (1996) survey shows that the mean nutrient intake of adults for both males and females in rural Andhra Pradesh is 2430 Kcal of energy, 58 g of protein, 26 mg of iron, 352 µg of vitamin A, 0.77mg of riboflavin and 34 mg of vitamin C. While the consumption of protein, energy and iron was satisfactory, the intake of riboflavin and vitamin A was about 50 percent of the RDA.
The empirical evidences related to dietary intakes reveal that several socio-economic, biological and environmental factors influence the food intake behaviour and thus the nutrient intakes of population in general and women in specific. Further, the present nutritional state, which is a consequence of both past and present nutrition, also is shown to influence the food and the subsequent nutrient intakes.

Thus, it is evident from the findings of the study that despite all the above mentioned influences the women in CED, obese and normal groups showed distinct differences for several nutrients. This indicates that the undernutrition and overnutrition situations are being sustained by the food and nutrient intakes observed.

In the present context though the nutrient intake data is compared with RDA, with a purpose to focus on the distance from a stand point, that is the normal state, the variation in percent deficits focusing on intraindividual variation in each group is discussed. The data reveal that the intake of individual in one state does encroach into those observed for other states, while the central tendencies appear to be resulting in distinct differences.

4.5 Energy expenditure and energy balance of rural women subjects:

In the present study physical activity assessments were made to arrive at the energy expenditure pattern of the CED, obese and normal subjects. Further, BMR was calculated using the recommended prediction equations. The results are discussed in relation to the plane of nutrition of the subjects.

4.5.1 General physical activity pattern of the subjects

The study was conducted during the months of May, June and July. The general physical activity pattern usually reflects the activity demands of the season. It was observed that the whole rural women community was quite active attending to farm related activities both at home and on the farm. The general pattern that includes both leisure time and occupational activities is briefly presented here.
Majority of the rural women were observed to wake up around 5 a.m. Women who possess milching cows if they intend to sell or supply milk to the co-operatives were beginning their day with this activity. Women in general were observed to attend to household chores such as cleaning the house and its surroundings, fetching water, washing utensils and providing food to the animals in the morning hours. After attending to the personal needs they were participating in activities such as cooking, feeding of young children providing food to elders, carrying food to the adult family members and labourers who were involved in the farming operations.

Fetching water, cooking feeding were the activities repeated by the women in the evening hours of the day. Collecting fodder for animals, picking and carrying vegetables to distant market places and selling them were some of the activities performed by some women daily, once (or) twice in a week depending on the need. During peak periods of farming activity a majority of LSL women and some of MSL women were engaged in farm activities along with men. During these days the household chores were observed to be completed by distributing the work in the morning and in the evening by the women themselves or by the mutual help of the other family members such as elders in the family, young children, particularly the adolescent girls.

During lean seasons and when not actively participating in family farm works, the women have some leisure time to themselves. Some of the leisure time activities observed were chatting with friends, social visits, attending to less strenuous activities like cleaning grains such as rice, dhal and nuts and watching T.V. Though only a few families possess T.V. sets friends and neighbours also gather together to watch popular programmes like movies and serials etc. Those women in the habit of watching T.V. were going to bed around 10.00 p.m. For others the general bedtime was around 9.00 p.m.
4.5.2 Time spent for different activities in relation to the state of nutrition:

The physical activity observations were made on three days. Various physical activities were classified into nine-work intensity zones based on the energy expenditure in Kcal/min of activity (Appendix ii). In the present study the physical activities of the three groups of women were found to be within the range of 7th zone of activities. The trends pertaining to time spent by CED, obese and normal groups are focused in fig. 20, 21 and 22.

The mean time spent for different activities by CED, obese and normal groups of women were presented in table 27. Differences between three groups were evident for the time spent for activities in the zones 1, 4 and 7 only. The variation between the groups was significant (P < 0.01 and P < 0.05).

For the activities in zone 1 that is for sleep and rest hours CED and obese groups were observed to spend more time when compared with the normal group. For the activities in zone 4 covering activities such as filling water, watering animalism, cleaning grins, sewing and feeding pets, the time spent by normal was higher than those observed for the CED and obese. The differences between the groups were significant (P<0.01).

The mean time spent for the activities in other zones did not show any specific trend as related to the nutritional status. The differences evident for the three groups for the remaining activities were not significant. The activities in the 7th activity zone require 5.5 kcal energy/minute of the activity. These are relatively strenuous activities when compared with those in other zones. It was observed that CED group was spending more time for activities in the 7th zone when compared to the obese and normal groups. And it was also evident that the time spent by normal group was less in this activity zone when compared with both obese and CED group.
**Table 27: Mean time spent by rural women for different physical activities**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Time spent for activities (minutes)</th>
<th>&quot;F&quot; value</th>
</tr>
</thead>
<tbody>
<tr>
<td>CED</td>
<td>OBESE</td>
<td>NORMAL</td>
</tr>
<tr>
<td>Mean ± SD (minutes)</td>
<td>Mean ± SD (minutes)</td>
<td>Mean ± SD (minutes)</td>
</tr>
<tr>
<td>Mean (hrs)</td>
<td>Mean (hrs)</td>
<td>Mean (hrs)</td>
</tr>
<tr>
<td>1</td>
<td>519.6±50.99</td>
<td>516.8±45.6</td>
</tr>
<tr>
<td>2</td>
<td>225.1±65.70</td>
<td>250.0±66.0</td>
</tr>
<tr>
<td>3</td>
<td>254.0±41.50</td>
<td>240.0±47.5</td>
</tr>
<tr>
<td>4</td>
<td>108.5±51.30</td>
<td>121.9±45.8</td>
</tr>
<tr>
<td>5</td>
<td>169.5±49.00</td>
<td>166.0±62.3</td>
</tr>
<tr>
<td>6</td>
<td>97.3±46.50</td>
<td>95.2±47.8</td>
</tr>
<tr>
<td>7</td>
<td>66.0±64.70</td>
<td>50.1±51.2</td>
</tr>
</tbody>
</table>

* 'F' - Significant < 0.01 – 1 % level
** 'F' - Significant < 0.05 – 5 % level
N.S. – Not Significant

It was also evident that the CED and obese groups who were spending relatively more time for strenuous activities also showed longest rest and sleep hours when compared with the normal group. Because of their involvement in strenuous activities probably they need longer rest hours, which might be an adaptation to their state of nutrition. In these two extreme conditions of malnutrition of CED and obesity it is possible for severe exhaustion to occur due to low reserves in the former and due to larger body size in the latter respectively. This exhaustion is observed to be compensated through long rest and sleep hours.
Fig. 20: Mean time (hrs) spent for physical activities by CED women

Fig. 21: Mean time (hrs) spent for physical activities by obese women

Fig. 22: Mean time (hrs) spent for physical activities by normal women
The studies in Guatemalan men by the Institute of Nutrition for Central America (INCAP) revealed that those men who had lower muscle masses were able to carry out the specific agricultural task allocated to them but took much lower time to do it. Additional interesting changes in their activity behaviour were then observed; these individuals took a significantly longer time to walk home after work and they spent approximately 3 hours each day taking a nap, or sitting, playing cards or doing other sedentary activities. In contrast the better nourished age matched males did not sleep during the day and proved to be active at home in addition to playing soccer for their recreation. The latter group, therefore, remained physically active for a significantly greater proportion of the day (Torun et al., 1989). These findings collaborate with the findings of the present study where it is found that some modifications in activity pattern are prevalent in each of the nutritional state.

With regard to the obese/overweight group it was observed that the 7th category of activities is performed by them but to a lesser degree. As indicated earlier some may be short and stature wise have disadvantage in involving in some strenuous activities, while those who are tall and thus may be overweight rather than obese may involve with ease in the strenuous activities too. Though, energy expenditure have been shown to be high among the elite obese groups the physical activity pattern of obese/overweight women in the rural context is not clearly focused.

The activities, which require 2.8 kcal/minute of activity, are grouped in zone 4. The normal group was observed to be spending more time when compared to the other two groups. For the remaining activity zones the time spent by all three groups was similar. This implies that the women in the normal group were utilizing the time saved from sleep and rest hours. This extra time gained was used for doing strenuous activities and activities including personal care, care of other members in the household and animal care.
Ferro-luzzi et al., (1990) analyzed the data on studies by Norgan et al., (1993) and Branca et al., (1993). The seasonal variations in activity pattern of men and women in rural India and Ethiopia showed that individuals with varying degrees of CED spent fewer hours per day walking than did individuals in the same socio-cultural milieu and whose BMI was > 18.5.

The present study was conducted during May, June and July months of the year during which period the agricultural activity was picking momentum. The women spent a significant amount of time for the occupational activity, which is agriculture. Various occupational activities were covered in the activity zone 5,6 and 7. While there was similar trend in the time spent for the 7th category of activities by the three groups of women for rest of the categories the time spent ranged from 6 to 7 hours. Inclusive of 7th category the hours of activity range from 8 to 9 hours / day for all three groups. On the basis of the level of activity observed the women were classified into moderately active group. Based on this moderate activity level the energy intake of 2225 calories (ICMR, 1991) is considered as the standard for the group to judge the calorie adequacy.

Satyanarayana et al., (1988) observed a similar physical activity pattern during summer season. The cropping pattern of the village created activity for the women even during summer season. In the present study the crops of sugarcane and groundnuts were being grown during the months of June and July. The water resources at the time of the study were adequate and the farming activities pertaining to paddy, vegetable growing, picking of flowers were in progress.

Obligatory activities are those tasks, which must be performed by the individual to sustain his/her life. Discretionary activities are those, which the individual may choose to enrich the quality of his/her life. Thus, obligatory activities have behaviour priority so that discretionary activity is the most likely candidates for change (Grosky, 1983). In the present study too the agricultural and farming activities were performed by all women irrespective of income and age status, as these are linked to their survival.
The differences observed in the various groups may be attributed to the prioritization and performance of activities in relation to their bodily capabilities and availability of resources.

4.5.3 The energy expenditure pattern of the subjects

The energy expenditure (EE) pattern reveals that there were distinct differences between the three groups differing in their nutritional status. The mean daily EE of CED was the lowest (1930 kcal). When compared with that of obese/overweight and normal groups. Highest EE was observed for the obese group. The normal group registered a mean energy expenditure of 2630 kcal. The differences between the groups were found to be significant (P < 0.01).

The mean EE recorded for each activity zone by the women belonging to CED obese and normal grades of nutrition is presented in Table 28. The data reveal that the energy expenditure of CED was almost similar for each activity with exception of activity zone 2. The EE for the remaining activity zones ranged from 251 to 351 kcal. For the 2nd and 4th zones of activities the EE of the CED was 203 and 182 kcal respectively. The EE / activity was variable for the obese and the normal group. The range of values observed for obese was 346 to 643 kcal. In the case of normal group the range of values observed was 181 to 485. However, for all the activities the CED group registered lower EE values when compared with either normal or obese. The highest EE / activity was evident for obese group.

The variation in energy expenditure however, was not significant when the energy expenditure was calculated per kilogram of body weight. The EE (kcal) per kg body weight was 53.1, 51.5 and 52.5 respectively for the CED, obese and normal groups (table 29).
Stein et al., (1988) observed that the women from better socio-economic group registered higher energy expenditure. And the researchers expressed that about half the difference can be attributed to size. Waterlow (1986) suggested that the most important adaptation to low energy intake is to have a low body weight. Therefore, in the present study too the differences observed between the CED, obese and normal groups may be attributed primarily to the significant differences in their anthropometry, body weight in particular.

Bianca et al., (1992) expressed that in studies of metabolic adaptation, anthropometric status being an important determinant of energy expenditure, comparisons are inherently difficult to make when there are differences in anthropometry. The research studies reviewed by the researcher also revealed that in a majority of the studies published, the differences in weight and percent fat free mass between groups were considerable. The results of the present study collaborate with the findings of the above research workers. Thus, amongst all other parameters weight

<table>
<thead>
<tr>
<th>Activity code</th>
<th>Energy expenditure (K.cal)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CED</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>1</td>
<td>318.78</td>
</tr>
<tr>
<td>2</td>
<td>203.14</td>
</tr>
<tr>
<td>3</td>
<td>351.81</td>
</tr>
<tr>
<td>4</td>
<td>182.52</td>
</tr>
<tr>
<td>5</td>
<td>341.20</td>
</tr>
<tr>
<td>6</td>
<td>282.83</td>
</tr>
<tr>
<td>7</td>
<td>251.27</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1930.58</strong></td>
</tr>
</tbody>
</table>

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might be the most influencing determinant of the total energy expenditure observed in the present study.

The present investigation has revealed equivalence in energy expenditure per kg body weight among groups with differing body mass. However, equivalence of BMR/kg body weight as well as BMR/kg LBM both has revealed trends observed in different research works (table 29). It is to be noted that while body weight remains as the direct objective measurement, both BMR and LBM were calculated using indirect methods. The differences in sample characteristics of earlier works and the present study and the validity of application of the methods of assessment used, both might have some influence on the results obtained in the present study.

Waterlow (1986) stated that in addition to the adaptation of body weight to low energy intakes, of the other adaptations, the most important is likely to be a reduction in the BMR, which may correspond to about 10 percent.

The equivalence of basal metabolism between lean and obese people when expressed as functioning fat free active tissue appears to be well established (Schutz et al., 1984; Garrow et al., 1980; Halliday et al., 1979 and James et al., 1978; Prentice et al., 1986).

Garrow and Webster (1985) showed that when fat free mass held constant fatter people actually had slightly higher metabolic rate per kg fat free mass than thin people making it unlikely that they were more energy thrifty in the pre-obese state. In the present investigation the BMR (kcal) per kg LBM was 35.33, 29.29 and 33.27 respectively for CED, obese and normal groups. The obese were observed to have slightly lower BMR when compared with CED and also the normal group. Among the CED the influence of age was evident while in the other two groups the influence was insignificant.
Table 29: Energy expenditure pattern of the rural women subjects in relation to BMR, body composition and EI

<table>
<thead>
<tr>
<th>Parameters</th>
<th>CED</th>
<th>Obese</th>
<th>Normal</th>
<th>F' Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean±SD</td>
<td>Range</td>
<td>Mean±SD</td>
<td>Range</td>
</tr>
<tr>
<td>TEE (Kcal)</td>
<td>1930.58±37.33</td>
<td>1185-3083.12</td>
<td>3675.26±545.08</td>
<td>2376.6-5168.8</td>
</tr>
<tr>
<td>EE (Kcal/Kg body wt)</td>
<td>53.1±6.83</td>
<td>39.55-65.95</td>
<td>51.5±6.02</td>
<td>42.43-65.29</td>
</tr>
<tr>
<td>EE(Kcal)/Kg LBM</td>
<td>65.19±8.25</td>
<td>48.44-80.78</td>
<td>75.27±8.95</td>
<td>61.63-99.56</td>
</tr>
<tr>
<td>BMR (Kcal)</td>
<td>1033.7±72.9</td>
<td>891-1178.1</td>
<td>1422.8±83.02</td>
<td>1252.8-1619</td>
</tr>
<tr>
<td>BMR (Kcal/kg body wt)</td>
<td>28.75±2.5</td>
<td>23.6-34.56</td>
<td>20.02±1.25</td>
<td>16.5-22.37</td>
</tr>
<tr>
<td>TEI (Kcal)</td>
<td>1680.8±141.8</td>
<td>1432.1-2000</td>
<td>2458.8±286.3</td>
<td>2053-3043</td>
</tr>
<tr>
<td>EI (Kcal/kg body wt)</td>
<td>46.89±6.01</td>
<td>36.73-62.9</td>
<td>34.79±5.61</td>
<td>25.05-31.75</td>
</tr>
<tr>
<td>EBAL (Kcal)</td>
<td>-249.76±39.22</td>
<td>-1283-525.48</td>
<td>-1216.42±631.05</td>
<td>-2763.6-521.38</td>
</tr>
<tr>
<td>EBAL (Kcal)/kg body wt</td>
<td>-6.21±10.09</td>
<td>-15.9-26.16</td>
<td>-16.7±8.46</td>
<td>-9.31-31.47</td>
</tr>
</tbody>
</table>

* 'F' - Significant < 0.01 ~ 1 % level
N.S. -- Not Significant
Physical activity energy expenditure is next to BMR energy expenditure in determining the energy needs of individuals. It has been shown that some behavioural adaptations do occur as a consequence of low energy intakes in addition to alterations in body weight and basal metabolism.

Satyanarayana et al., (1988) found that in the summer months the average energy output by the women was 48.5 kcals/kg/day. In the present study, the grand mean EE of all the three groups combined was 51.0 kcals/kg/day. This would place them in the category of moderate to heavy workers group.

The activity cost was given for a 60 kg person, when compared with weight of 60 kg, women in CED group registered lower weights and the differences in weight were in the range 30-11 kg. The normal had weights low by 21 kg and in excess by 11 kgs and the obese had weights lower by 4 kgs and in excess by 36 kgs. While calculating the energy expenditure in each activity zone body weight correction was made. It is probable that extrapolation of these values to different field situations in which the present group of women were operating may to some extent lead to either overestimation or underestimation of EE in the case of obese, CED and the normal subjects.

The energy cost of activities of Indian women from poor socio-economic group reported by Sujatha et al., (2000) reveals that except walking, the standard activities (lying, sitting, standing and walking) and occupational work could be classified into the light category (2.2 BMR). Most of the household activities except cooking were classified into moderate to heavy (2.2 to 2.8 BMR). It was also evident that the energy expenditure of activities did not differ significantly between the women with different occupations in the urban context.
The activity costs utilized in the present context if substituted by the above values may result in some changes in TEE of rural women subjects.

In the present study it was observed that irrespective of the state of nutrition the mean time spent by women decreased as the energy cost of activities increased; otherwise as the activities became more strenuous the time spent decreased. The general pattern reveals that behavioural modification pertaining to physical activity in this group was evident at the level of ‘adaptation’ but not at the level of ‘accommodation’.

4.5.3.1. Energy balance of the subjects:

The mean energy balance of all three groups revealed negative balance. The mean values recorded for CED, obese and normal were $-249.8$, $-1216.12$ and $486.3$ Kcalories / day respectively (table 29). The range of values observed for CED, obese and normal groups were from $-1283.12$ to $-525.45$, $-2763.6$ to $+521.38$ and $-1558.85$ to $-298.026$ Kcal respectively. It is thus evident that while a majority in the CED group was in a negative balance, a majority in the normal group showed positive energy balance. At lower body weights the energy balance figures were in a lower negative energy balance; high body weights resulted in higher negative energy balance.

The body needs energy for maintaining temperature, metabolic activity supporting growth and physical work. The input must equal the output in order to be in an energy balance, which corresponds to a steady state.

In the present study both food intake and physical activity assessments were done very meticulously as per the standard procedures. Even if correction is made for 3 to 5 percent of over or under estimation in either of the above two measurement, the energy balance values registered are too unrealistic, particularly in the case of obese group.
Durnin (1990) stated that it is not surprising that malnourished populations, with all their possible adaptations have low intakes or expenditures of energy. What is of considerable nutritional importance is that low energy intakes are possible in population in a state of energy balance, who do not appear to be malnourished and who live an existence, which includes at least moderate physical activity.

In the present investigation it was observed that the CED had lower intakes of energy when compared with the normal and obese groups. Energy intakes measured as the energy content of the total average day’s diet gives a reasonable indication of energy expenditure if certain criteria are expected. If intakes do not equal expenditure the imbalance may be so small that it will make little difference to the final condition that changes will occur in body weight or body composition.

The disparity between EI and EE observed in the present context, which is resulting in, a negative energy balance with regard to the obese/overweight in particular does not explain the steady state of obesity or overweight being maintained by the obese women. Whereas, the negative balance observed in the case of CED and normal it has to be realistically concluded that a balance might be struck which include fasting and feasting with regard to energy intake and peak work versus lean season, with regard to energy expenditures. It may be thus stated that indirect energy expenditure assessments when dealing with obese persons, too much weight may result in overestimation of energy expenditure.

4.5.4. Basal metabolic rate of the subjects:

BMR is a major contributor to energy expenditure of an individual. In the present study the BMR of women in CED, obese and normal state of nutrition is projected using the prediction equations proposed by ICMR expert group for Indians (1978, 1989). BMR contributes 60 to 70 percent of total energy expenditure. BMR can
be predicted with reasonable accuracy from predictive equations. The mean BMR recorded by the three groups of women was 1033.76, 1422.84 and 1185.41 Kcal/24 hours respectively (table 29). The mean values differed significantly ($P<0.01$) among the three groups. The CED and obese groups differed significantly ($P<0.01$) with regard to BMR when compared with the normal group. The CED group registered lower values when compared to the normal and obese group. Obese group recorded the highest value.

The BMR is fairly constant for individuals of the same age and sex in a state of health (Taylor et al., 1963 and De Amour, 1969). For the young adults of average size it has been found that the BMR lies very close to 1 Kcal/kg/hour. The normal BMR of woman was shown to be 36 Kcal/kg body weight/day (Rama Rao, 1990). Piers and Shetty (1993) showed that the mean BMR of Indian adult women from Bangalore, was 46.85 Kcal/hour. In the present context the BMR for normal women was 49.39 Kcal/hour. The age of the present group of women ranged from 18 to 50 years. Several anthropometric parameters such as body weight, height as well as their transformations, such as BMI show associations with BMR. However, extensive analysis by several researchers (Schofield, Schofield and James, 1985; Francois, 1981 and Soares and Shetty, 1988) showed that BMR has a stronger correlation with body weight than with any other anthropometric index used as a single independent variable. In the present context too the three groups showed a distinct difference in their body weight, which is also reflected in the mean BMR's recorded by each group.

Shetty (1996) commented that the relationship between body weight and BMR is not necessarily one of simple linearity. Nevertheless, the correlation between body weight and BMR are good. The differences may be accounted for by differences in the body composition affecting not only the ratio of fat-to-fat free mass (FFM) but also
differences in the contribution of muscle and visceral tissues within the FFM. The body composition of CED and obese, which are the extreme malnutrition states and that of the normal was shown to be different. In the preceding section the data on body composition clearly indicated that there are differences in both fat and fat free mass or lean body mass in all the three nutritional states. The ranges of values observed in each group with a low deviation from mean body weights may not show a linear relationship.

BMR is more closely related to the 'lean body mass' than to the surface area, a person with well-developed muscles has a higher BMR than obese persons (Davidson and Passmore, 1970; Vijaya, 1994). Garrow and Webster (1985) found that fatter people actually had a slightly higher metabolic rate per kg fat free mass than thin people, making it unlikely that they were more "energy thrifty" in the pre-obese state.

Prentice et al., (1986) observed that among the people following normal pattern of activity the average group resulting from an increase in the energy cost of both basal metabolism and physical activity. BMR and EE on thermogenesis plus activity were identical in the two groups when corrected for differences in fat free mass and total body mass.

BMR is shown to be directly proportional to the surface area of the subject. Larger the surface area the greater will be the heat loss and equally higher will be the heat production (Shrivastava and Das, 1993; Chatterjee, 1994; Ramakrishnan et al., 1994). In adults, BMR for healthy females was focused to be 37 Kcal / sq.m/hour assuming the total body surface areas to be around 1.8 sq.m and 1.6 sq.m. (Chaudhuri, 1993). Neil (1993) showed that more than half of the variability in BMR between different individuals is accounted for by body size only. Thus, larger people have higher BMR. Contrary to the above findings Ramakrishnan et al., (1994) found that individuals with smaller body size have a higher BMR as compared to those with larger
body size. BMR correlated closely with surface area than with weight. A small body has greater surface in proportion to mass than a larger area. The relationship between mass and surface is affected by shape. On the basis of body surface the metabolism is the same but when one calculates this as Kcal/kg body weight the taller figure shows a metabolism higher by 9 percent (Taylor et al., 1963; De Amour, 1969).

In the present study the body surface area of CED group with a mean weight of 36.22 kg and height cm of 153.88 was having larger surface area. Though a majority of them have lower body weight when compared with the normal and obese groups, it has been observed that they have mean heights greater than normal and obese. This indicates that a significant number of CED group women are tall and lean. Such people tend to have a higher BMR as discussed above.

Several researchers have shown that BMR is influenced by the nutritional status per se. The BMR values of both normal and obese were higher than CED and significantly differed from CED. This suggests that BMR in the present study also may be a reflection of the body mass. Durnin et al., (1990) while studying the effects of marginal nutrition on Indian rural working groups of women encountered very low BMI values for these women. The women were weighing around 40 kgs registered a mean total BMR of 878 Kcals/24 hours.

A normal adult may have a BMR/kg more than one-and-half times that of an obese adult. This is due to two factors, the source of metabolic energy. The highly active organs constitute a smaller percent of total body weight in larger animals, and some of the highly active organs e.g., liver and kidney have lower organ metabolic rate per gram as the size of body increases (Halliday et al., 1969). The CED group recorded a BMR/kg body wt of 28 Kcals, which was higher than both that of obese and normal groups (about 20 and 23 Kcals respectively).
The better nourished Indians from the upper socio-economic groups in both urban and rural areas had BMR's higher than the age matched individuals from poor socio-economic groups who were likely to be undernourished (Soares and Shetty, 1988). It is interesting to note that a group of urban individuals from upper socio-economic strata with access to adequate energy and protein intake but with BMI < 18.5 have BMR's which are lower in absolute terms, but show no evidence of an enhanced metabolic economy, unlike the CED subjects with similar BMI (Shetty, Soares and James, 1994). Lower limits of acceptable BMI's depend not only on the fat mass and FFM of an individual but also on the level of physical activity, which would enhance their energy turnover. The likelihood of thin, tall, physically active adults having a lower than optimum range of BMI and presumably having normal or adequate energy intakes since even the NCHS data on adults suggest the presence of a reasonable number underweight (BMI<18.5) but not necessarily undernourished individuals in a community (Abraham, Johnson and Najjar, 1979).

In the present study women having BMI<16 (III grade of CED) only were studied. At these very low levels of body weight the existence of undernutrition becomes inevitable. The lower BMR's evident for this group may be directly attributed to the lower body size, which is a consequence of chronic undernutrition. However, deviation at the upper levels of BMR ranges may be due to tall stature and leanness of people.

4.6. Bio-chemical and clinical profiles of the rural women subjects:

Haemoglobin status is considered to indicate the general nutritional status of the individual. It has been shown that low levels of haemoglobin have been shown to be prevalent in almost every population group. Further, both in overnourished conditions and undernourished conditions the status of cholesterol and triglycerides were shown to
be altered. Therefore, haemoglobin and serum cholesterol and triglycerides were chosen as the bio-chemical parameters.

A clinical examination survey was also included to assess the severe nutritional deficiency states prevalent in these groups of women.

4.6.1. Haemoglobin status (Hb)

The mean Hb levels of CED, obese and normal groups of women were 8.2 ± 1.59, 10.1 ± 2.02 and 10.62 ± 2.6 g/dl (table 30). The differences between the groups were significant (P < 0.05). The mean values are depicted in fig. 23. The range of values occurring in each group reveals that while the lower range was similar the upper range was different for CED group when compared with the obese and normal groups. The upper range from CED was 10.6 g/dl while the same was 15.0 g/dl for both obese and normal groups.

A distribution of the values into different grades of anaemia (table 31) revealed that all the women (100 percent) in the CED group were suffering from different degrees of anaemia and none had levels in the normal range. It is interesting to note that a small percentage of women in the CED, obese and normal groups (10, 10 and 15 percent respectively) were suffering from a severe degree of anaemia. Only 25 and 35 percent of women in the obese and normal groups respectively had normal levels of haemoglobin. A majority of the women (40 and 35 percent respectively) in the above two groups were observed to be suffering mild degree of anaemia followed by 25 and 15 percent of women suffering from moderate degree. In the case of CED group however, it is observed that a majority (72.5 percent) suffer from moderate degree of anaemia followed by the severe (15.0 percent) and mild (12.5 percent) anaemia.
Table 30: Status of bio-chemical parameters of the subjects

<table>
<thead>
<tr>
<th>Parameter</th>
<th>CED</th>
<th>OBESE</th>
<th>NORMAL</th>
<th>ANOVA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean ± SD</td>
<td>Range</td>
<td>Mean ± SD</td>
<td>Range</td>
</tr>
<tr>
<td>Haemoglobin (g/dl)</td>
<td>8.2 ± 1.59</td>
<td>5.1-10.6</td>
<td>10.1±2.02</td>
<td>6.2-15</td>
</tr>
<tr>
<td>Triglycerides (mg/dl)</td>
<td>110.8±59.1</td>
<td>26-294</td>
<td>142.4±57.1</td>
<td>54-300</td>
</tr>
<tr>
<td>Cholesterol (mg/dl)</td>
<td>163.0±52.5</td>
<td>77.4-245</td>
<td>185.4±45.7</td>
<td>105-271.1</td>
</tr>
</tbody>
</table>

* - significant at <0.01 -1% level
** - significant at <0.05 - 5% level
NS - not significant

DISCUSSION:

The prevalence of anaemia in Asia is very high especially among women (WHO, 1992). Several research works among the Indian women reveal that the prevalence of anaemia is rather high among women from different sections of the population. NFHS-2 (2000) study on anaemia among rural Indian women shows that 53.9 percent of women were suffering from different degrees of anaemia. The percent distribution for mild, moderate and severe degree of anaemia was 36.1, 15.8 and 2.0 percent respectively.

Table No: 31 Distribution of women subjects into different levels of bio-chemical parameters

<table>
<thead>
<tr>
<th>Biochemical parameters</th>
<th>CED (%) n=40</th>
<th>OBESE (%) n=40</th>
<th>NORMAL (%) n=40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hb g/dl</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;12.0 normal</td>
<td>Nil</td>
<td>4 (10)</td>
<td>6 (25)</td>
</tr>
<tr>
<td>10.1-11.9 mild</td>
<td>5 (12.5)</td>
<td>10 (25)</td>
<td>14 (25)</td>
</tr>
<tr>
<td>7.0-9.9 moderate</td>
<td>29 (72.5)</td>
<td>16 (40)</td>
<td>14 (35)</td>
</tr>
<tr>
<td>&lt; 7.0 severe</td>
<td>6 (15.0)</td>
<td>10 (25)</td>
<td>6 (15)</td>
</tr>
<tr>
<td>Triglycerides mg/dl**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;150 desirable</td>
<td>29 (72.5)</td>
<td>25 (62.5)</td>
<td>31 (77.5)</td>
</tr>
<tr>
<td>150-500 Border line high</td>
<td>11 (27.5)</td>
<td>15 (37.5)</td>
<td>9 (22.5)</td>
</tr>
<tr>
<td>&gt;500 high risk</td>
<td>Nil</td>
<td>nil</td>
<td>nil</td>
</tr>
<tr>
<td>Cholesterol mg/dl**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;200 desirable</td>
<td>25 (62.5)</td>
<td>18 (45)</td>
<td>29 (72.5)</td>
</tr>
<tr>
<td>200-240 borderline high</td>
<td>12 (30)</td>
<td>18 (45)</td>
<td>9 (22.5)</td>
</tr>
<tr>
<td>&gt;240 high risk</td>
<td>3 (7.5)</td>
<td>4 (10)</td>
<td>2 (5)</td>
</tr>
</tbody>
</table>

*Centers for Disease Control and Prevention (1998)
**Ghafoorunissa and Kamala Krishnaswamy (1989)
In the study by Kamini (1992) in Baroda rapid ethnographic assessment was applied as a methodological approach to understand women's perceptions about their morbidity especially anaemia. Hb data of 482 women revealed that 80 percent of women were anaemic (Hb < 11 gm/dl). Madhanima (1992) studied haemoglobin level, anthropometry and parasitic infection among 50 women workers of 25 – 35 years of age in Assam. The mean haemoglobin level was about 10 mg/dl and out of the total sample 19.01 percent were between 8 – 9.9 gm/dl, 65.45 percent between 6-7.9 gm/dl and the rest 20.28 percent had haemoglobin level less than 6g/dl.

![Fig 20: The mean haemoglobin level of 25, 35 aged rural women as compared with the standard](image)

Amita and Nina (1993) conducted a study on the health and nutritional status of women workers in Mumbai, mild anaemia as indicated by Hb level of (10-11.9gm/dl) or severe anaemia of Hb (8gm/dl) was encountered only in 7.4 percent and 0.6 percent of the subjects respectively.

Gopalan et al., (1994) reported that prevalence of anaemia among the urban population seems to be of a much lower magnitude than among the rural communities. The percent prevalence of anaemia among Hyderabad and Delhi rural women was 68.8 and 48.8 for the age groups 25 - 44 years and above 44 years; the prevalence was still higher for rural women from Calcutta, 96.1 and 90.1 respectively.
The overall prevalence among the women in rural Bangladesh was 73 percent (Hyder et al., 1996). The prevalence of severe, moderate and mild anaemia was 1, 21 and 51 percent. The researchers reported that the prevalence of anaemia increased with each additional negative socio-economic indicator viz., household economic status, schooling of women and land ownership. In the present study all the three factors formed the components of the standard of living schedule used for the survey. The effect of standard of living was not evident in all the three groups however in the CED and obese groups there was a trend evident, LSL had low values for Hb and obese registered high value for Hb. This may be due to the fact that the sample is small more over the women were grouped on the basis of BMI.

NFHS-2 (2000) when the data was classified according to BMI, among women with a BMI <18.5, 37.0 percent mild, 17.1 percent moderate and 2.7 percent in severe anaemic condition. Among women with a BMI of >18.5, 34 percent mild, 13.7 moderate and 1.5 percent were in severe anaemia. The trends of results of this survey are in agreement with those of the present study. It may be noted that in the present study even with very low level of BMI (<16.0) which is indicative of severe form of CED the prevalence of severe form of anaemia is only slightly more. But, the prevalence of moderate anaemia was shown to be highest among these groups.

Untoro (1998) while studying the effect of very low BMI on productivity of women also focused on Hb as another nutritional factor that influences work productivity. By investigating the relationship between BMI, Hb concentration and work productivity the study aimed to improve knowledge on validity of the CED classification proposed by James et al., in 1988 and on the importance of iron status. In this context the BMI ranged from 15.1 - 25.0; 41 percent of subjects had BMI<18.5 and 12.2 percent has BMI <17. The percent prevalence of anaemia was 33.7 percent for the
women with BMI <18.5 and 45.2 percent for women BMI>18.5. This reveals that at lower BMI all women do not suffer anaemia. The present study however, reveals that a majority of women having a BMI<17 were anaemic. Thus, the compounding effect of BMI and anaemia, which was proved to be significantly affecting productivity, might be true, and the work productivity of significant section of the women population may also be affected.

The data from the study of Untoro (1998) imply that BMI may not be significantly correlated with anaemia. In the present study however, anaemia is shown to be significantly associated with BMI (p<0.05), when the data for all nutritional states is combined.

It is to be noted that anaemia is most often a temporary state, which is sensitive to fluctuations in the iron nutrition. Whereas, it may be considered as a more stable state and changes may occur over a period of time in the rural context where the diets appear to be monotonous. In the present study, the significant relationship revealed may be attributed to the compulsory inclusion of the three distinct nutritional states, unlike the 'as it occurred' study by Untoro (1998).

Andrea et al., (2001) focused on dietary intakes and nutritional status of women and pre-school children in the Republic Maldives. The haemoglobin level was in the normal range of 12.2 - 15.9 g/100ml (13.5 ± 1.1), well above the values recommended by WHO (>12 g/dl). Kretsch et al., (1998) while studying cognitive function, iron status and haemoglobin in obese dieting women showed that mean BMI was 31.5 ± 4.1kg/m², age range was 25 - 42 yrs, Hb level was 13.1 ± 0.4 g/dl respectively. These groups of women had no dietary deprivation. In the present context however, the dietary intakes of iron were observed to be low in all three nutritional states.
Iron deficiency anaemia is the most common nutritional disorder in the world affecting over a billion people. It is estimated that 90 percent of anaemic people reside in the developing countries with highest prevalence in South Asia including India. There are several researches conducted in the Indian context which reveal that a grossly inadequate intake of iron and lack of facilitating factors of its absorption lead to iron deficiency anaemia in a large section of the population. In adults anaemia has been shown to affect work capacity and other problems associated with severe degree are predisposing factors of morbidity among this group.

4.6.2 Level of Triglycerides among women subjects

The mean level of triglycerides was 118.0, 142 and 113 mg/dl for the CED, obese and the normal women. The differences observed between the groups were found to be statistically significant (P < 0.01). The mean values however, were within the desirable range. The distribution of the individual values into desirable, borderline high and high-risk groups (table 31) reveal that among the three groups of women none belonged to the high risk group. Approximately 73, 62 and 78 per cent of women from CED, obese and normal groups had values in the desirable ranges, followed by 27.5, 37.5 and 22.5 percent in the borderline high risk group respectively for the above three groups.

DISCUSSION:

The triglyceride values for Indian female slum dwellers was 130.1 ± 73.4 mg/dl carbohydrate intake as percentage energy, percent BF and BMI positively and significantly predicted the triacylglycerol levels in females (Misra et al., 2001). BMI showed a significantly positive correlation with total cholesterol, LDL-cholesterol, triglycerides, but a negative correlation with HDL - cholesterol (Kazue, 1999). Stene et
al., (2001) showed a borderline significant correlation between BMI and serum triglycerides.

The values of slum women when compared with that of the rural women of the present investigation were higher. The higher levels observed among slum dwellers may be attributed to their frequent consumption of pork meat, which was found as one of the reasons for high serum lipids and high body fat among these groups. It is evident in the present study that when the values were segregated as per the nutritional state only the obese group registered higher values when compared to the slum dwellers of Misra's. The dietary intake data reveal that fat intake of 29, 44 and 49 g (both visible and invisible combined) was observed among the women in the three nutritional states respectively, in the present study. And the percent energy contribution from fat and carbohydrate were observed to be around 15.5, 67.0 for the CED group; 16.1, 70.0 for the obese group and 20.5, 81.0 for the normal group respectively.

Several researchers have focused diet as the main environmental determinant of plasma lipid concentration. Among young Japanese females the triglyceride level was associated with BMI. The results suggested that the BMI, fat energy ratio and simple CHO intakes such as cakes and beverages appear to be the main factors influencing of hyperlipidemia in these groups. It has also been reported that high sucrose diet has a great impact on the deterioration of glucose tolerance and increased triglyceride levels in animal and human (Kazue, 1999).

NCEP (2001) recent meta analysis of prospective studies indicates that elevated triglycerides are also an independent risk factor for CHD. Factors contributing to elevated (higher than normal) triglycerides in the general population include obesity and overweight, physical inactivity, cigarette smoking, excess alcohol intake, high CHO
diets > 60 percent of energy intake, certain diseases and certain drugs and generic disorders.

Indians living at Singapore were shown to have significantly elevated fasting triglyceride levels (Rajaduri et al., 1992). Tanaka et al., (1994) showed that while there was a significant change in the cholesterol levels, total calorie protein and fat intake from 1978 to 1993, the TG levels did not change significantly. The TG levels were reported to be 171.56 mg in CAD and 146.68 mg in the normal (Krishnaswamy, 1989). Kenell et al., (1983) Ghafouranissa (1986, 1989) Oliver et al., (1992) reported that type and quantity of dietary CHO increase triglycerides. The finding that elevated triglycerides are independent CHD risk factors suggests that some triglycerides rich lipoproteins are atherogenic. The latter are partially degraded VLDL, commonly called remnant lipo-proteins.

NCEP (2001) recommends that when triglycerides are borderline high (150 - 199 mg/dl) emphasis should also be placed on weight reduction and increased physical activity.

In the present investigation nearly 22.5 – 37.5 have triglyceride levels in the borderline high range. The present group is physically active, and alcohol consumption and cigarette smoking are habits, which are not permitted to be practiced by women. Only certain groups of nomadic communities allow these habits among their women. Then, the borderline, high triglyceride levels may be attributed to their dietary intakes such as high CHO intake. The obese group had a slightly higher percent of women in borderline high range when compared to other groups. But it is to be observed that none of these women who were in the grade II obese condition had higher levels of triglycerides. In the normal group the percent energy from CHO is very high (80 %) and it is also observed that when compared to other groups their fat intake is higher (49 g/day) exceeding the RDA set for the group (40 g). But, a similar proportion of women
in CED and obese groups were having borderline high levels. Hence, food habits and physical activity might be the factors, which might be modulating the triglyceride levels of these groups of women.

4.6.3. Cholesterol status

The mean cholesterol level of CED, obese and normal groups of women were 163.0 ± 52.5, 185.48 ± 45.7 and 156.73 ± 52.5 mg/dl (table 30). The differences between the groups were not significant.

The distribution of the values into desirable (< 200 mg/dl), borderline high (200 - 240 mg/dl) and high risk levels (> 240 mg/dl) reveal that a majority of women in the CED (62.5%) and normal (72.5%) groups were in the desirable range. Whereas, in the obese group a majority of the women were equally distributed in the desirable (45%) and borderline high (45%) followed by (10%) the high risk group. In the CED and normal groups the percent of women in borderline high were 30 and 22.5 respectively followed by only 7.5 and 5.0 percent in the high risk category. In the grade II obesity also there were few persons with desirable levels of cholesterol when compared to other groups.

DISCUSSION:

Gundu Rao and White (1993) reported that the National Institute of Health Consensus Development Conference recommended 200 mg/dl cholesterol as acceptable levels for all people.

The cholesterol levels of women in the study were ranging from about 77 to 271 mg/dl. Barington et al., (1980) reported the serum cholesterol values for South Indian women belonging to different age groups. The mean total cholesterol levels were 164, 187, 195, 194 and 198 mg/dl for the age groups 0-19, 20-29, 30-39, 40-49, 50-59 and >60 years respectively. The range of values was 102 - 226, 77 - 263,130 - 244, 108-
282, 95 - 293 and 125 - 271 mg/dl respectively for the above groups. The range of values observed for these women are in agreement with those observed in the present study.

Singh et al., (1980) reported cholesterol levels of 186 ± 25 mg/dl for normal young healthy adult women. Males had higher levels compared to females and the values ranged from 120 - 181 mg/dl.

The total cholesterol of North Indian slum women were 184.7±50.8 mg/dl (Misra, 2001). Tanaka et al., (1994) showed that TC levels increased significantly from 168.2 ± 36.8 mg/dl in 1978 to 197.9 ± 36.4 mg/dl in 1993. Serum triglyceride (TG) levels did not change significantly. The total calorie intakes increased significantly from 1665 ± 364 Kcal in 1978 to 2026 ± 492 Kcal in 1993 (P < 0.001). The intake of protein and fat also increased from 53.0 ± 12.2 g and 28.6 ± 11.6 g in 1978 to 77.0 ± 18.4 g and 46.6 ± 14.5 g in 1993 respectively. The cholesterol levels reported from different parts of India found to vary widely and is partly due to the differing characteristics and size of the sample selected. Therefore, the values may have to be interpreted in the respective social, economic and dietary context.

Krishnaswamy (1989) reported that the levels of cholesterol in normal groups were 183.16 mg/dl. Cholesterol levels in all the five zones reported were comparable and there were no difference in the regional distribution of cholesterol and triglycerides. It was also noted that over 10 years of data collection, the cholesterol and triglyceride values at any year of estimation remained more or less the same without significant difference.

In general population of Agra it was shown 36.8, 47.6, 14.2, and 1.3 percent was having total cholesterol levels of 150, 151 - 200, 201 - 250 and 251 - 360 mg/dl respectively. It was also observed that the incidence of coronary heart disease was increasing with increasing levels of serum total cholesterol. The incidence was 3.7, 6.1, 9.4 and 8.3 for the above four levels of cholesterol (Sharma, 1989).
General food habits, total calories, quality and quantity of CHO, fat and protein were shown to influence the profile of cholesterol. In some studies the relationships were positive; in some they were negative probably due to the nature of sample and their environment and life style factors.

The serum cholesterol levels of Tamil vegetarians and non-vegetarians and Gujarati women in the age group of 40 - 60 years was reported to be 192, 225 and 226 mg percent respectively (Devdas, 1980).

Kazue et al, (1999) examined the relationship between serum total cholesterol level and nutritional status in Japanese young female. Results of the study indicated that the consumption of the diet such as fat and simple CHO has a significant effect on the serum total cholesterol level.

A diet containing more energy than is needed may lead to obesity. Serum cholesterol is significantly related to energy intake per kg body weight. Changes in body weight during 5-10 years of follow up were positively related to change in serum cholesterol during these periods. Krambrot (1983) stated that a change in kg body weight was accompanied by a corresponding change in serum cholesterol of 2 mg/dl.

Sola et al., (1994) studied the weight reduction achieved by a very low calorie diet, whether high protein or high carbohydrate, induced favourable change in total cholesterol (TC) and LDL-C levels. Decreases in LDL C and TC levels were obtained only with the high protein diet.

Rebellow et al., (1983) Ghafoorunisa (1986, 1989), Oliver et al., (1982) reported that type and quantity of dietary carbohydrate increases triglycerides. Higher concentration of sucrose increases total-C, LDL-C and lowers HDL-C, the activity of HMG COA reductase and incorporation of labeled acetate into cholesterol was highest in the case of sucrose and lowest with the diet fed cornstarch.
The saturated fat and kilo calories did not have any statistically significant relation on the cholesterol levels where as the CHO intake, proteins, fats and polyunsaturated fats and cholesterol in the diet appeared to have a significant relationship with the percent total cholesterol levels. The same relation was evident between dietary intake and triglycerides (Krishnaswamy 1989).

Sarada Ramdas and Parvati Eswaran (2000) showed that 63% of females had desirable levels of total cholesterol as against 36 % among male adults. Mean total cholesterol levels of adult non-vegetarians ranged between 222 to 227 mg/dl in vegetarians. The gender factor and the difference between vegetarian and non-vegetarians were statistically significant.

The women in the present study were observed to consume high CHO; they were occasional non-vegetarians, but where a moderately active group. The cholesterol status of the group might have been influenced by any one or a combination of these factors.

Stene et al., (2001) inferred from their study of obesity among semi-rural Palestinian population that the prevalence of obesity was very high compared to most other countries in the World and that it is considerably higher among women than among men. They predicted that together with the prevalence of type II diabetes a trend of increasing morbidity and mortality from cardiovascular diseases might emerge even in the semi-rural Palestinian population.

In the present study the proportion of females in the borderline high and high risk groups was found to be more in the obese when compared to the CED and normal groups.
The relation between cholesterol levels and BMI was focused by some to be positive and others to be negative. Saradha Ramdas and Parvati Eswaran (2000) showed that BMI did not affect the lipid profiles of women.

WHR was more important correlate with triglycerides in a Palestinian semi-rural population when compared with BMI (Stence et al, 2001).

Kazue et al., (1999) reported that in young Japanese adults a significant positive correlation was observed between BMI and Serum total cholesterol, LDL-C and a negative correlation to HDL-C.

Sigurdsson et al., (1994) reported that both BMI and WHR were positively correlated with TC, TG, and apo-B but negative correlation with HDL-C.

Along with the unique risk factors as smoking, hypertension, and cholesterol levels of >5.0 mmol/l, BMI also was one of the risk factors for CAD among Indian People at Singapore.

Misra et al, (2001) studied the adverse profile of lipids in urban slum dwellers of Northern India shows that the mean BMI was in the lower range (20.5 ± 14.23). Percent BF was high in females (26.7 ± 8.6) and high prevalence of abdominal obesity was 16%. Significant predictors for triglycerol include intake CHO as percent energy, age percent BF and BMI.

Cholesterol status is majorly investigated in relation to obesity and cardiovascular disease conditions. In the Indian context very minimal research is available on the levels of cholesterol as related to age, sex and physical activity and the nutritional status as well as in relation to BMI in particular in the general population.

Shetty (1984) reported the cholesterol values for normal and labourer men having a BMI of 20.7 and 16.6 respectively. The cholesterol values were 178.0 ± 7.28 and 148.0 ± 4.4 mg/dl respectively for the above two groups and the difference between
the groups was statistically significant. Inspite of all the anthropometric parameters being low the labourers were physically fit and had satisfactory cardiovascular function.

In general population of Agra it was shown that the incidence of coronary heart disease in relation to serum cholesterol showed significant \( P < 0.05 \) correlation (Sharma 1989).

Shankur Krishnaswamy (1989) in southern states among 630 patients, 417 proved to have CAD and 216 were normal. The mean cholesterol was 216.49 in CAD and triglycerides again were 171.56 in CAD. But the difference between the values of CAD and normal were statistically significant especially where large number were investigated. It was also found that people with severe CAD also have low cholesterol and triglyceride levels. The age of the patient and the weight of the patient appeared to be related to the development of the disease irrespective of the lipid profile.

Rajaduri et al., (1992) studied the unique risk factors as smoking, hypertension (diastolic pressure > 100 mm of Hg) lipid levels (cholesterol > 5.0 mmole/l) and body mass index that contribute to the increased development of CAD in Indian people in Singapore. It was found that fasting triglyceride levels were also significantly elevated in this group.

Saradha Ramdas and Parvathi Eswaran (2000) showed that 28% cholesterol in the LIG had high risk value of > 240 mg/dl and mean triglyrceride value (159.7mg/dl) was also high. This was attributed to high CHO intake.

The optimum intake level of TC appears to be 150 to 160 mg/dl especially for Asians, much lower than the 200 mg/dl considered for the western society.

Postmenopausal women were shown to have altered lipid profiles, which are potentially atherogenic and make them more vulnerable to CHD. Substantial age dependency in the occurrence of CHD in women in that are in nine aged 45-65 years.
have clinical manifestation of the disease, in contrast to one in three women older than 65 years.

Stevenson et al., (1993) found that among 542 healthy postmenopausal women 14% had higher TC, 12% higher triglycerides. Cener et al., showed that 48.2% of postmenopausal women has serum concentration > 260 mg/dl. Samanta (1998) studied a total of 82 healthy postmenopausal women. 35 healthy pre-menopausal women served as controls. The mean TC was higher when compared to controls. Though maximum number (90.2%) had TC levels less than 240 mg/dl and only 8 (9.8%) women had TC levels >240 mg/dl. Only 20 (24.3%) postmenopausal women had TC levels < 160 mg/dl considered desirable for Asians. Women loose their relative protection against coronary heart diseases at menopause because of changed lipid profile due to estrogen deficiency. The mean serum cholesterol concentrations were significantly higher in the postmenopausal women (178.5 ± 39.8 Vs 155.4 ± 24 mg/dl P<0.01). The serum cholesterol concentration in the study group was not related to social class, dietary habit and obesity.

In the present study the age of women range from 18 to 50, which include 2.5, 15.8 percent of women who underwent hysterectomy and who attained menopause respectively. The borderline high levels of TC may be due to the deficiency of estrogen, which causes changes in the lipid profile, particularly in the CED and normal groups.

4.6.4. Clinical signs and symptoms of nutrient deficiencies prevalent among the women subjects:

Clinical symptoms reveal a severe nutritional deficiency state. However, lack of specificity which is one of their limitations may be overcome when used in conjunction with other indicators of assessment of nutritional status. In the present study the percent
prevalence of the most common nutritional deficiencies was assessed for each nutritional state. The data reveal that a few of the nutrient deficiency symptoms were evident in all three nutritional states. However, the number of symptoms occurring and the number of individuals exhibiting the symptoms were high in the CED group. It was observed that while obese and normal showed eight clinical symptoms each, the CED group showed eleven symptoms related to different nutrient deficiency states (table 32).

Symptoms of ‘B’ complex deficiency and iron deficiency anaemia were observed to be highly prevalent among these women. Several research works conducted also reveal that the prevalence of ‘B’ complex deficiency to be high among women. Among industrial labourer women the prevalence of ‘B’ complex deficiency symptoms such as cheilosis and angular stomatitis were prevalent by 10.2 and 8.7 percent respectively (Lakshmi and Gayatri, 1997). Vitamin ‘C’ deficiency symptoms of bleeding gums were seen in 7 percent of the labourer women. In the present study bleeding gums was observed in 15, 7.5 and 10 percent for CED, obese and normal groups of women respectively.

With regard to Vitamin ‘A’ deficiency Bitot spots were seen in 15 percent of normal and 7.5 percent of obese women. Bitot spots develop during childhood but it persists into adulthood as scar of previous childhood deficiency. Xerosis of skin was observed in CED in only one woman. Dry skin sometimes occurs in essential fatty acid deficiency too.

Sunanda and Prema Kumari (1995) also showed that among women in sericulture farming, angular stomatitis was the major deficiency followed by bleeding gums and glazed tongue. Similar findings were reported by Chaliha et al., (1993) among the women involved in knitting activities. NNMB (1981 and 1982) reported that
the prevalence of ‘B’ complex deficiency was 2.94 and Bitot spot was 0.8 among rural women.

Table 32: Percentage prevalence of clinical signs and symptoms among the CED, obese and normal rural women subjects

<table>
<thead>
<tr>
<th>Clinical signs and symptoms</th>
<th>CED (%)</th>
<th>OBESE (%)</th>
<th>NORMAL (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n=40</td>
<td>N=40</td>
<td>n=40</td>
</tr>
<tr>
<td>Vitamin A deficiency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Xerosis of skin</td>
<td>1(2.5)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Bitot’s spots</td>
<td>6(15)</td>
<td>3(7.5)</td>
<td>5(12.5)</td>
</tr>
<tr>
<td>B-complex deficiency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angular stomatitis,</td>
<td>10(25)</td>
<td>4(10)</td>
<td>4(10)</td>
</tr>
<tr>
<td>angular scars, cheilosis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Megenta tongue</td>
<td>3(7.5)</td>
<td>2(5)</td>
<td>1(2.5)</td>
</tr>
<tr>
<td>Dry pigmentation of the hair</td>
<td>3(7.5)</td>
<td>2(5)</td>
<td>2(5)</td>
</tr>
<tr>
<td>Moon face</td>
<td>1(2.5)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Vitamin c deficiency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spongy bleeding gums</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Follicular hyperkeratosis</td>
<td>6(15)</td>
<td>3(7.5)</td>
<td>4(10)</td>
</tr>
<tr>
<td>Vitamin d deficiency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skeletal deformities</td>
<td>4(10)</td>
<td>10(25)</td>
<td>5(12.5)</td>
</tr>
<tr>
<td>Iron deficiency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pallor of mucous membrane</td>
<td>8(20)</td>
<td>5(12.5)</td>
<td>7(17.5)</td>
</tr>
<tr>
<td>Atrophic lingual papillae</td>
<td>8(20)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Iodine deficiency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enlargement of thyroid</td>
<td>4(10)</td>
<td>5(12.5)</td>
<td>3(7.5)</td>
</tr>
</tbody>
</table>

The prevalence rates observed in the general women population studied are lower than those observed in the present study this may be due to the selective sampling procedures followed.

The highest prevalence of ‘B’ complex deficiency among the CED, obese and normal women in the present study was 25, 10 and 10. This may be attributed to the general low intake of ‘B’ complex vitamins. It was observed that food preparation and cooking practices such as use of polished rice, washing and straining rice results in the loss of ‘B’ complex groups of vitamins. Further, the intake of milk and whole grains,
which are good sources of 'B' complex vitamins were observed to be low in these
groups.

The percent prevalence of symptoms of iron deficiency for pallor of mucous
membrane was 20, 12.5 and 17.5 for CED, obese and normal respectively. The
symptoms of atrophic lingual papillae occurred only in the CED group (20 per cent).
The data on anaemia revealed that women in all groups were suffering different
degrees of anaemia. Severe anaemic condition (Hb < 7 g/dl) was evident in the CED group. The
present data on clinical observation reinforces the biochemical condition as related to
iron nutriture.

Thus, while obese and normal women were also at risk of severe nutritional
deficiencies the percentage prevalence was rather high in the CED state. At these very
low nutrient intakes and at greater activity demands probably the failure of homeostasis
may result in the manifestation of severe deficiency states. It may be inferred that a
very low BMI is associated with high prevalence of severe states of micronutrient and
or mineral deficiencies. Further, these findings also reveal that while only in some
subjects the severe manifestation of nutrient deficiencies are observed many more may
be suffering the sub clinical or biochemical deficiency for the nutrients.

4.7. Effect of nutritional status parameters on BMI:

In each of the three BMI groups the average BMI is found to be influenced by
several variables like height, weight, biceps etc. A multiple linear regression model has
been fitted between BMI and the joint effect of the following explanatory variables:

Anthropometric:

Weight, height, biceps, triceps, subscapular, suprailliac, sum of SFT
midarm, waist circumference, hip circumference, WHR.
Body composition:

Body density, fat percent, fat (kg), LBM (kg), EE (Kcal/day).

Metabolic:

BMR (Kcal), BMR/kg body weight, EE / kg LBM, EB (Kcal/day).

Dietary:

Energy intake, protein, fat, CHO.

Bio-chemical:

Cholesterol, triglyceride and Hb.

These 26 variables were not independent and possessed high correlations among themselves. A stepwise regression has been run taking BMI as the dependent variable and all the 26 variables as explanatory variables.

This exercise has been run separately for the CED, obese and normal groups and all the groups combined. The competitions have been run using SPSS package. The relevant data is presented in Table iv (appendix) and the following results are obtained.

i) Regression analysis for CED group

The stepwise procedure was terminated after 5 iterations (steps) with the value of $r^2$ increased from 0.2456 to 0.9384. The variables that were included in the model in the last step were height, weight and fat (intake).

The regression model is found to be

$$\text{BMI} = 30.3304 - 0.1888 \text{ (Height)}^{(21.2516)} + 0.3907 \text{ (Weight)}^{(23.0212)} - 0.0072 \text{ (Fat)}^{(2.2165)}$$

Figures in the brackets indicate the 't' value of the regression coefficients.

* Indicates significance at 1% level.

Analysis of Variance for the regression gives $F = 182.7312$ with (3,36) degrees of freedom (DF). This F value is found to be significant with $P = 0.0000$. 

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From the above regression the following observations can be made:

- The major determinant of BMI in the CED group is height, weight and fat.
- These three variables explain about 94% of BMI variation.
- A comparison of the regression coefficient shows that weight has a positive influence on BMI whereas height and fat show a negative impact. When other parameters were held constant.
- It is observed that an increase in weight by 1 kg results in a marginal increase of 0.3906 of BMI.

**ii) Regression analysis for obese women**

The stepwise procedure was terminated after 3 iterations with value of $r^2$ increased from 0.59522 to 0.9934. The variables that were included in the model in the last step were fat kg, height cm and LBM kg. The regression model is found to be

$$
BMI = 63.5802 + 0.4719^* \text{ (fat in kg) (26.688)}^* - 0.4248^* \text{ (height) (46.586)}^* + 0.4331^* \text{ (LBM kg) (29.995)}^* 
$$

Figures in the brackets indicate the ‘t’ value of the regression coefficients. * Indicates significant at 1 % level.

**Analysis for the variance for the regression** gives $F = 1807.96$ with 3.36 DF. This $F$ value is found to be significant with $P = 0.0000$

From the above regressions the following observations can be made:

- The major determinants of BMI in the obese group were fat in kg, height and LBM kg.
- These three variables explain about 99% of BMI variation.
- The comparison of the regression coefficient shows that fat and LBM kg have positive impact while height has negative impact.
iii) Regression analysis for normal women

The stepwise procedure was terminated after five steps with the value of $r^2$ increased from 0.60 to 0.9949. The variables that were included in the model in the last step were height, weight, BMR, BMR/kg body weight and cholesterol.

The regression model found to be

$$\text{BMI} = 57.5146 + 0.1314 \cdot \text{weight} - 0.2876 \cdot \text{height} + 0.0133 \cdot \text{BMR} - 0.6166 \cdot \text{BMI} + 0.0011 \cdot \text{cholesterol}$$

Figures in the brackets indicate the t value of the regression coefficient.

*indicate significant analysis of variance for the three regression gives $F = 1671.88$ with 5, 34 DF. This ‘F’ value is found to be significant with $P = 0.0000$.

From the above regression the following observation can be made:

- The major determinants of BMI in the normal groups are weight, height, BMR, BMR/kg body weight and cholesterol.
- These five variables explain about 99% of BMI variation
- Positive influence on weight, BMR, cholesterol and negative influence on height, BMR/kg.

iv) Regression analysis for all the three groups combined

The stepwise procedure was terminated after eight steps. The variables that were included in the model in the last step were fat (kg), height (cm), LBM (kg), BMR/kg body weight, suprailliac (mm), BMR, fat % and hip circumference (cm).

$$\text{BMI} = 54.277 + 0.393 \cdot \text{fat} - 0.290 \cdot \text{height} + 0.1885 \cdot \text{LBM} - 0.383847 \cdot \text{BMR/kg} - 0.151415 \cdot \text{suprailliac} + 0.008599 \cdot \text{BMR} - 0.0144 \cdot \text{fat} + 0.013483 \cdot \text{hip circumference}$$

99 % of variation in BMI was explained by the above eight nutritional status parameters.
The analysis reveals that even within a close range of BMI in each nutritional state BMI correlated with a few nutritional status parameters. Consistently, height showed a negative correlation for the individual groups and when all the groups combined the positive association with weight was evident with CED and the normal group. It is observed that the number of correlates and their order differed from one group to the other.

In the present context the extreme grades of nutritional status were purposively chosen to restrict the spread of values within the range of BMI; hence to some extent the correlation may be affected. Further, when all groups combined though it may introduce wide range of values, influences may differ due to close BMI pockets. Hence the relationships are bound to change with each situation.

In spite of the limitations the results reveal some significant and valuable correlations, which have been discussed in the preceding sections. BMI is an important indicator of different nutritional states but there appears to be a need to also focus our attention to the different body types, which influence the distribution of both muscle and fat. Further, the lifestyles may modulate several body compositional and biochemical parameters. The strong correlations among the nutritional status parameters reveal that though BMI is a good predictor of nutritional status situationally other parameters also need to be focused to promote clear understanding of the prevailing state of nutrition.