

## *Results and Discussion*

## **IV RESULTS AND DISCUSSION**

The results of the study on “**Neural Tube Defects (NTDs) and the Effect of Counseling and Folic Acid Supplementation**” have been presented and discussed under the following headings.

- A. Prevalence of NTDs in Erode town
- B. Possible influence of maternal factors on NTDs and the problems faced by the pregnant mothers of NTD cases
- C. Impact of counseling prospective women to prevent occurrence of NTDs and
- D. Evaluation of the efficacy of periconceptual supplementation of folate alone as well as in combination with multivitamin or iron in preventing the recurrence of NTDs

### **PHASE 1**

#### **A. PREVALENCE OF NTDs IN ERODE TOWN**

##### **1) Incidence of NTDs in Erode town**

The year wise incidence of NTDs reported from selected hospitals of Erode town during 2000-2004 is presented in Table II and Appendix I.

**TABLE II**  
**YEAR WISE INCIDENCE OF NTDs AT SELECTED HOSPITALS\***  
**OF ERODE TOWN**

| <b>Particulars</b>      | <b>2000</b> | <b>2001</b> | <b>2002</b> | <b>2003</b> | <b>2004</b> | <b>Total</b> |
|-------------------------|-------------|-------------|-------------|-------------|-------------|--------------|
| Total births            | 19,336      | 20,083      | 19,744      | 18,297      | 18,275      | 95,735       |
| Anencephaly             | 12          | 20          | 21          | 21          | 28          | 102          |
| Spina bifida            |             |             |             |             |             |              |
| a) Meningomyelocele     | 07          | 10          | 08          | 14          | 15          | 54           |
| b) Meningocele          | 15          | 18          | 11          | 24          | 19          | 87           |
| Encephalocele           | 06          | 04          | 04          | 01          | 04          | 19           |
| Total NTD births        | 40          | 52          | 44          | 60          | 66          | 262          |
| Incidence /1000 births  | 2.06        | 2.59        | 2.23        | 3.28        | 3.61        | 2.74         |
| 3 Yearly Moving average | -           | 2.29        | 2.70        | 3.04        | -           | -            |

**\* 60 – Private Hospitals and One Government hospital**

It is evident from the table that among 95,735 live births and still births during the five year period (2000-2004), there were 262 babies with NTDs with an incidence of 2.74 per 1000 births. The year wise data on the incidence of NTDs have been analysed by a three year moving average method to delineate year to year variation. Although, there was a minimum of year to year variation, there was no evidence of a declining trend of the incidence of NTDs in Erode town over the last five years.

The total births in Erode as per the municipal birth register during 2000 was 37,980 and was found to increase over the five years to 39,203 in 2004. The rate of incidence of NTDs per 1000 births was 1.05 in the year 2000, which gradually increased and was found to be 1.68 being highest in 2004. (Appendix D)

## **2) Number and incidence rates of NTD cases in Erode Town**

The number of different types of NTD affected children among the new borns of selected hospitals in Erode Town during the five year period of 2000-2004 is presented in Table III and Figure 3.

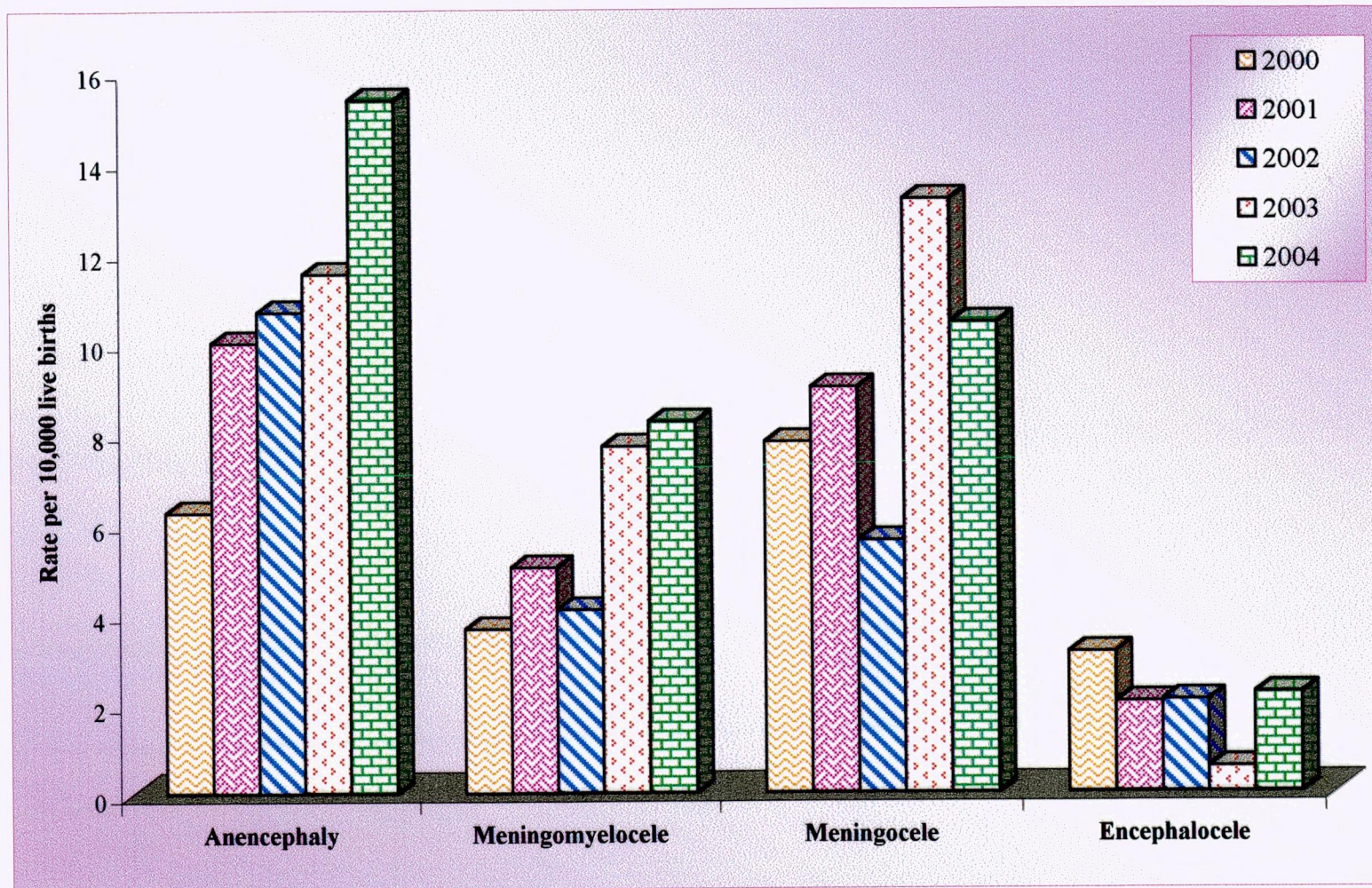
Prevalence of NTDs shows wide variation by geographic location, both within and between countries. Also, the distribution of the types of NTDs can vary between regions (Forester and Merz, 2000). It is evident from the table that among the reported NTD cases, the annual incidence rates per 10,000 live births for anencephaly was the highest (10.65), followed by meningocele (9.08), meningomyelocele (5.68) and encephalocele (1.94) during the study period. The annual incidence rates for anencephaly (6.21 in 2000 to 15.32 in 2004) and meningomyelocele (3.62 in 2000 to 8.21 in 2004) showed increasing trend which nearly doubled over the period whereas meningocele showed (5.57 in 2000 to 13.12 in 2003) a fluctuating trend and annual incidence rates of encephalocele showed a decreasing trend of 3.10 in 2000 to 0.55 in 2003 during the study period.

**TABLE III**

**TOTAL NUMBER AND INCIDENCE RATES OF REPORTED NTDs IN ERODE TOWN DURING 2000 -2004**

| Year         | Neural Tube Defects |                   |                     |                  |                   |                     |             |                   |                     |               |                   |                     |
|--------------|---------------------|-------------------|---------------------|------------------|-------------------|---------------------|-------------|-------------------|---------------------|---------------|-------------------|---------------------|
|              | Anencephaly         |                   |                     | Spina bifida     |                   |                     |             |                   |                     | Encephalocele |                   |                     |
|              |                     |                   |                     | Meningomyelocele |                   |                     | Meningocele |                   |                     |               |                   |                     |
|              | N                   | Rate <sup>1</sup> | 95% CI <sup>2</sup> | N                | Rate <sup>1</sup> | 95% CI <sup>2</sup> | N           | Rate <sup>1</sup> | 95% CI <sup>2</sup> | N             | Rate <sup>1</sup> | 95% CI <sup>2</sup> |
| <b>2000</b>  | 12                  | 6.21              | 2.7-9.72            | 7                | 3.62              | 0.94-6.3            | 15          | 7.76              | 3.84-11.68          | 6             | 3.10              | 0.62-5.58           |
| <b>2001</b>  | 20                  | 9.96              | 5.59-14.33          | 10               | 4.98              | 3.41-6.55           | 18          | 8.96              | 4.83-13.1           | 4             | 1.99              | 0.04-3.94           |
| <b>2002</b>  | 21                  | 10.64             | 6.1-15.18           | 8                | 4.05              | 1.24-6.86           | 11          | 5.57              | 2.28-8.86           | 4             | 2.03              | 0.02-4.04           |
| <b>2003</b>  | 21                  | 11.48             | 6.58-16.38          | 14               | 7.65              | 5.61-9.69           | 24          | 13.12             | 7.89-18.35          | 1             | 0.55              | 0-1.62              |
| <b>2004</b>  | 28                  | 15.32             | 9.66-20.98          | 15               | 8.21              | 6.09-10.33          | 19          | 10.39             | 5.72-15.06          | 4             | 2.19              | 0.04-4.34           |
| <b>Total</b> | 102                 | 10.65             | 6.59-12.71          | 54               | 5.64              | 4.87-6.407          | 87          | 9.08              | 7.17-10.99          | 19            | 1.94              | 1.06-2.82           |

<sup>1</sup>Rate per 10,000 live births ; Total live births = 95,735 ; CI<sup>2</sup> = 95% Confidence Interval for rates ; NS-Not Significant



**INCIDENCE RATES OF REPORTED NTDs IN ERODE TOWN DURING 2000-2004**  
**FIGURE 3**

### **3) Rates of NTDs by demographic factors**

The annual incidence rates of reported NTD cases in Erode town over the five years in total have been analysed by demographic factors like gender, maternal age and literacy.

#### **a) Gender**

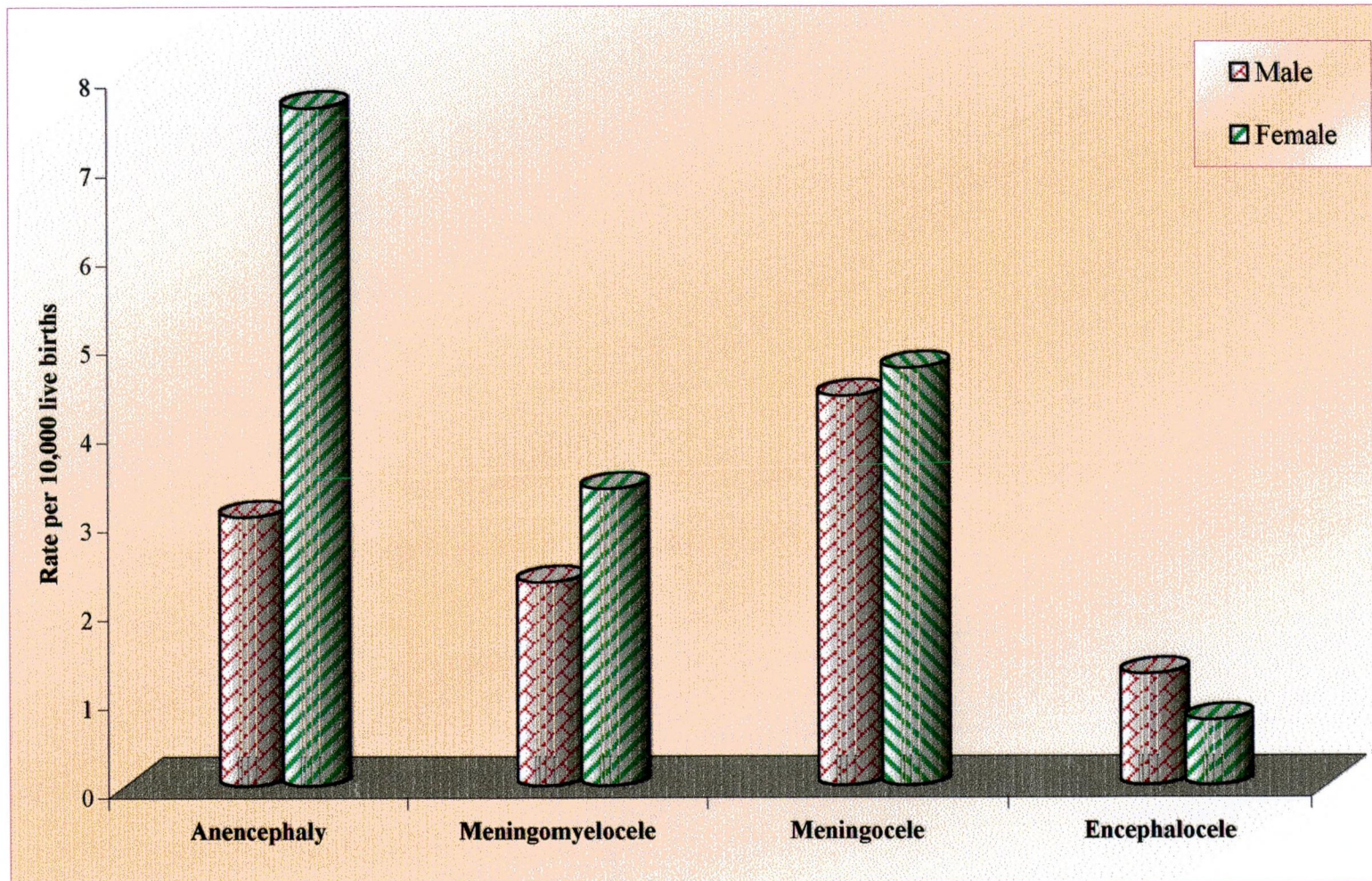
The total number and incidence rates of reported NTD cases by gender during the study period are presented in Table IV and Figure 4.

Table IV shows that 72 per cent of the anencephaly cases, 59 per cent of meningomyelocele cases and 52 per cent of meningocele cases were females supporting the fact the feminine gender is highly vulnerable to maternal assaults. Infant sex influences the risk for NTDs. The current data is in accordance with the literature that females are more likely than males, to have anencephaly and spina bifida (Fornoff *et al* 2004).

**TABLE IV**  
**TOTAL NUMBER AND INCIDENCE RATES OF REPORTED NTDs BY GENDER**  
**IN ERODE TOWN DURING 2000-2004**

| Gender   | Neural Tube Defects |                   |                     |                  |                   |                     |             |                   |                     |               |                   |                     |
|--|---------------------|-------------------|---------------------|------------------|-------------------|---------------------|-------------|-------------------|---------------------|---------------|-------------------|---------------------|
|  | Anencephaly         |                   |                     | Spina bifida     |                   |                     |             |                   |                     | Encephalocele |                   |                     |
|  |                     |                   |                     | Meningomyelocele |                   |                     | Meningocele |                   |                     |               |                   |                     |
|  | N                   | Rate <sup>1</sup> | 95% CI <sup>2</sup> | N                | Rate <sup>1</sup> | 95% CI <sup>2</sup> | N           | Rate <sup>1</sup> | 95% CI <sup>2</sup> | N             | Rate <sup>1</sup> | 95% CI <sup>2</sup> |
| <b>Male</b>  | 29                  | 3.03              | 1.93-4.13           | 22               | 2.29              | 1.34-3.24           | 42          | 4.39              | 3.06-5.72           | 12            | 1.25              | 0.54-1.96           |
| <b>Female</b>  | 73                  | 7.63              | 5.88-9.38           | 32               | 3.34              | 2.18-4.49           | 45          | 4.70              | 3.32-6.07           | 7             | 0.73              | 0.58-0.88           |
| <b>Total</b>   | 102                 | 10.65             | 8.59-12.71          | 54               | 5.64              | 4.87-6.40           | 87          | 9.08              | 7.17-10.99          | 19            | 1.94              | 1.06-2.82           |
| <b>F Value = 0.74<sup>NS</sup> (between gender and type of NTDs)</b> |                     |                   |                     |                  |                   |                     |             |                   |                     |               |                   |                     |

<sup>1</sup>Rate per 10,000 live births ; Total live births = 95,735 ; CI<sup>2</sup> = 95% Confidence Interval for rates ; NS-Not Significant



**INCIDENCE RATES OF REPORTED NTDs BY GENDER IN ERODE TOWN DURING 2000-2004  
FIGURE 4**

Whitemen *et al* (2000) found that in a case control study, about 70 per cent of the children with anencephaly were females and 60 per cent of the children with spina bifida were also females. Potential explanations for the preponderance among females include differences between the sexes in embryonic development, susceptibility to teratogenic insult and spontaneous abortion rates (Little and Elwood, 1991). The causal heterogeneity of anencephaly has been demonstrated in rare families due to single gene. The causes of anencephaly remain unknown and may represent X-linked inheritance ( Toriello *et al*1980)

Statistical analysis through 'F' test reveals that by gender there is no significant difference among the reported NTD cases in Erode town over the five years.

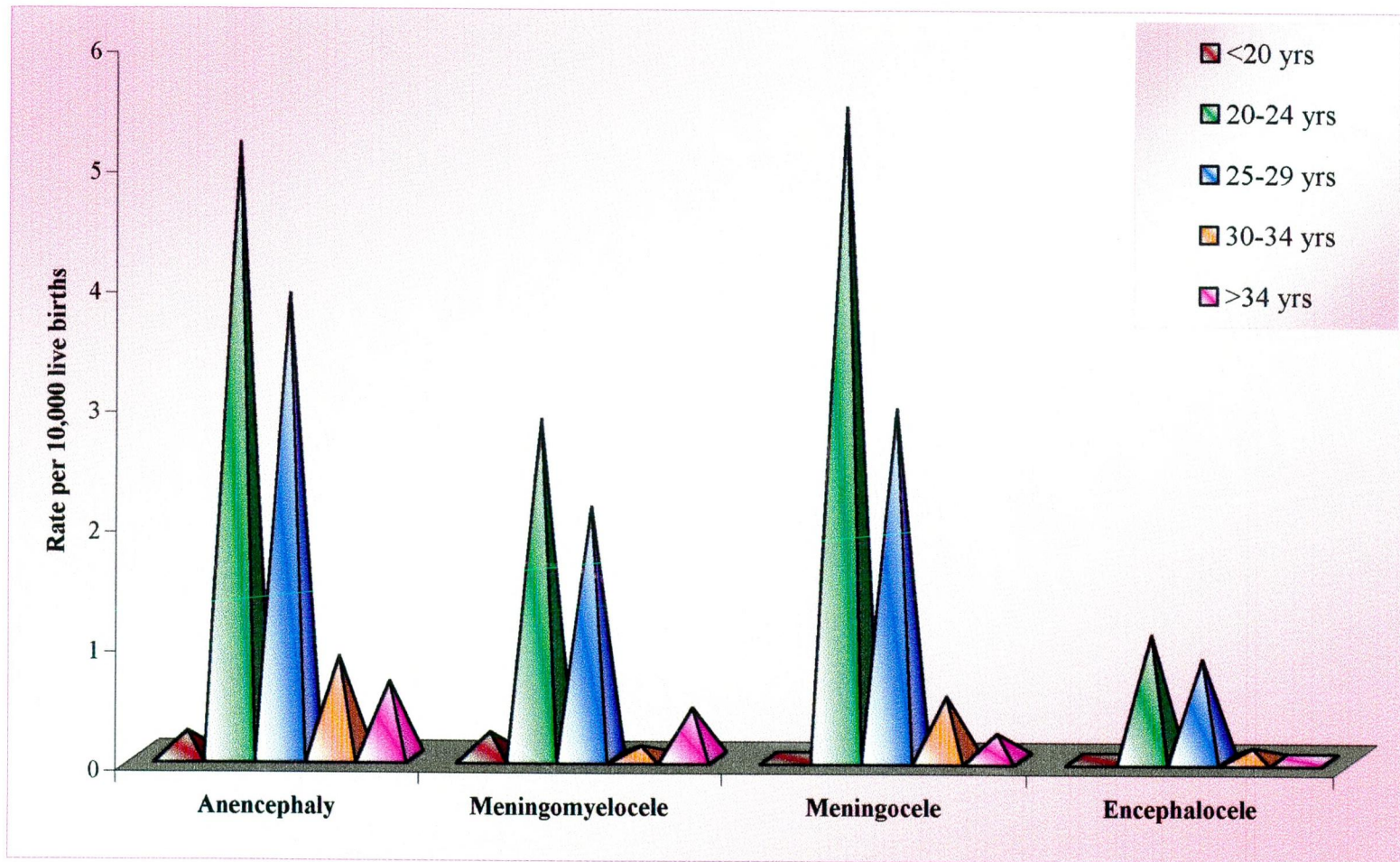
#### **b) Maternal age**

Table V and Figure 5 reveal that all the four types of reported NTD cases had a tendency towards an increasing incidence with maternal age of 25-29 years and later on a decreasing trend in the incidence after 30 years. The analysis also reveals that the maximum rate of incidence was higher in the age group of 20-24 years followed by 25-29 years among all the four types of NTDs.

**TABLE V**  
**TOTAL NUMBER AND INCIDENCE RATES OF REPORTED NTDs BY MATERNAL AGE**  
**IN ERODE TOWN DURING 2000 –2004**

| Age<br>(years)   | Neural Tube Defects |                   |                     |                  |                   |                     |             |                   |                     |               |                   |                     |
|--|---------------------|-------------------|---------------------|------------------|-------------------|---------------------|-------------|-------------------|---------------------|---------------|-------------------|---------------------|
|  | Anencephaly         |                   |                     | Spina bifida     |                   |                     |             |                   |                     | Encephalocele |                   |                     |
|  |                     |                   |                     | Meningomyelocele |                   |                     | Meningocele |                   |                     |               |                   |                     |
|  | N                   | Rate <sup>1</sup> | 95% CI <sup>2</sup> | N                | Rate <sup>1</sup> | 95% CI <sup>2</sup> | N           | Rate <sup>1</sup> | 95% CI <sup>2</sup> | N             | Rate <sup>1</sup> | 95% CI <sup>2</sup> |
| <20  | 2                   | 0.21              | 0-0.50              | 2                | 0.21              | 0-0.50              | 0           | 0                 | 0                   | 0             | 0                 | 0                   |
| 20-24  | 49                  | 5.12              | 3.69-6.55           | 27               | 2.82              | 1.75-3.88           | 52          | 5.43              | 3.96-6.9            | 10            | 1.04              | 0.4-1.68            |
| 25-29  | 37                  | 3.86              | 3.23-4.49           | 20               | 2.09              | 1.17-3.01           | 28          | 2.92              | 1.84-4.0            | 8             | 0.84              | 0.26-1.42           |
| 30-34  | 8                   | 0.84              | 0.67-1.01           | 1                | 0.10              | 0-0.3               | 5           | 0.52              | 0.07-0.9            | 1             | 0.10              | 0-0.3               |
| >34  | 6                   | 0.63              | 0.13-1.13           | 4                | 0.42              | 0.01-0.83           | 2           | 0.21              | 0-0.05              | 0             | 0                 | 0                   |
| <b>Total</b>   | 102                 | 10.64             | 8.59-12.71          | 54               | 5.64              | 4.87-6.40           | 87          | 9.08              | 7.17-10.99          | 19            | 1.94              | 1.06-2.82           |
| <b>F Value = 5.38* (between maternal age and type of NTDs)</b> |                     |                   |                     |                  |                   |                     |             |                   |                     |               |                   |                     |

<sup>1</sup>Rate per 10,000 live births ; Total live births = 95,735 ; CI<sup>2</sup> = 95% Confidence Interval for rates ; \* Significant at 5 per cent level.



**INCIDENCE RATES OF REPORTED NTDs BY MATERNAL AGE IN  
ERODE TOWN DURING 2000-2004  
FIGURE 5**

There are ample evidences in literature to support the association between maternal age and the incidence of NTDs. Owen *et al* (2000) and McDonnel *et al* (1999) found that the incidence of NTD affected pregnancy decreased with increasing maternal age.

'F' test reveals that there is a statistically significant difference in the reported NTD cases by maternal age in Erode town at five per cent level.

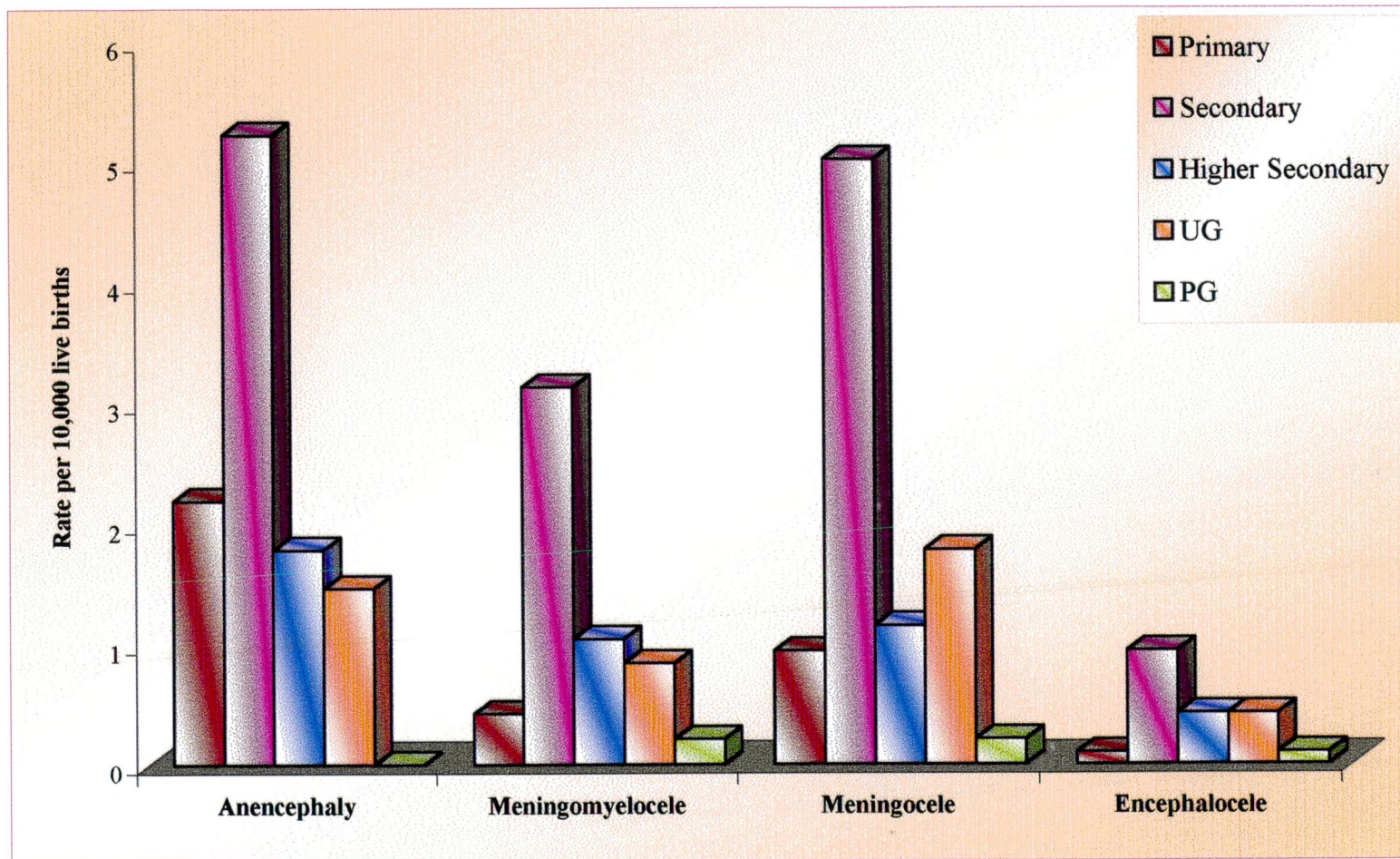
### **c) Maternal literacy**

Farley et al (2002) reported that low maternal education is an important predictor in having a child with NTDs. Table VI and Figure 6, present the distribution of the type of NTDs according to maternal education based on the data obtained from Erode town.

**TABLE VI**  
**TOTAL NUMBER AND INCIDENCE RATES OF REPORTED NTDs BY MATERNAL LITERACY**  
**IN ERODE TOWN DURING 2000-2004**

| Literacy Level  | Neural Tube Defects |                   |                     |                  |                   |                     |             |                   |                     |               |                   |                     |
|---|---------------------|-------------------|---------------------|------------------|-------------------|---------------------|-------------|-------------------|---------------------|---------------|-------------------|---------------------|
|   | Anencephaly         |                   |                     | Spina bifida     |                   |                     |             |                   |                     | Encephalocele |                   |                     |
|   |                     |                   |                     | Meningomyelocele |                   |                     | Meningocele |                   |                     |               |                   |                     |
|   | N                   | Rate <sup>1</sup> | 95% CI <sup>2</sup> | N                | Rate <sup>1</sup> | 95% CI <sup>2</sup> | N           | Rate <sup>1</sup> | 95% CI <sup>2</sup> | N             | Rate <sup>1</sup> | 95% CI <sup>2</sup> |
| Primary   | 2                   | 2.19              | 1.26-3.12           | 4                | 0.42              | 0.01-0.83           | 9           | 0.94              | 0.33-1.55           | 1             | 0.10              | 0-0.3               |
| Secondary   | 50                  | 5.22              | 3.78-6.66           | 30               | 3.13              | 2.01-4.25           | 48          | 5.01              | 3.6-6.42            | 9             | 0.94              | 0.33-1.55           |
| Higher Secondary  | 17                  | 1.78              | 0.94-2.62           | 10               | 1.04              | 0.4-1.68            | 11          | 1.15              | 0.48-1.82           | 4             | 0.42              | 0.01-0.83           |
| UG  | 14                  | 1.46              | 0.7-2.22            | 8                | 0.84              | 0.26-1.42           | 17          | 1.78              | 0.94-2.62           | 4             | 0.42              | 0.01-0.83           |
| PG  | 0                   | 0                 | 0                   | 2                | 0.21              | 0-0.50              | 2           | 0.21              | 0-0.50              | 1             | 0.10              | 0-0.3               |
| <b>Total</b>  | 102                 | 10.65             | 8.59-12.71          | 54               | 5.64              | 4.87-6.40           | 87          | 9.08              | 7.17-10.99          | 19            | 1.94              | 1.06-2.82           |
| <b>F Value = 5.31* (between maternal literacy and type of NTDs)</b> |                     |                   |                     |                  |                   |                     |             |                   |                     |               |                   |                     |

<sup>1</sup>Rate per 10,000 live births ; Total live births = 95,735 ; CI<sup>2</sup> = 95% Confidence Interval for rates ; \* Significant at 5 per cent level.



**INCIDENCE RATES OF REPORTED NTDs BY MATERNAL LITERACY IN ERODE TOWN DURING 2000-2004**

**FIGURE 6**

All the four types of reported NTD cases in Erode town had a tendency towards decreasing incidence with maternal education as reported by Farley *et al* (2002). The highest incidence rates were noticed among women with secondary school education level in all the four types of reported NTD cases. The prevalence rates of NTDs were found to be less among women with undergraduate or postgraduate education.

Statistical analysis by 'F' ratio reveals that there is a significant difference at five per cent level among the different levels of maternal education and reported NTD cases in Erode town.

#### **d) Rate of NTDs by delivery factors**

The annual incidence rate of reported NTD cases in Erode town has been studied by delivery factors like parity, weeks of gestation, birth weight, type of delivery and registration of pregnancy.

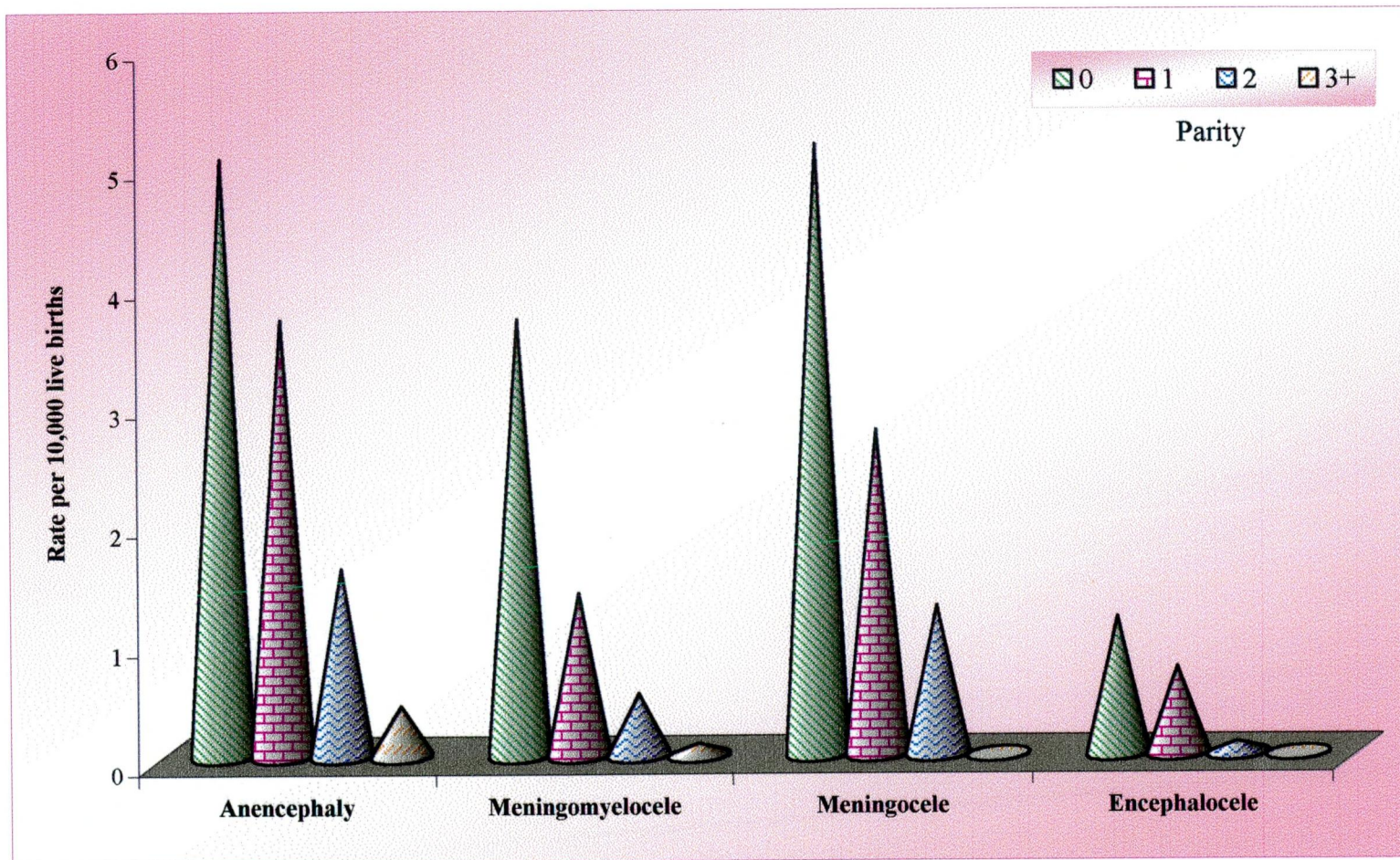
#### **i) Parity**

Parity is the number of pregnancy a woman has experienced prior to the one under consideration. Table VII and Figure 7 show the total number and incidence rates of NTDs by parity during the study period.

**TABLE VII**  
**TOTAL NUMBER AND INCIDENCE RATES OF REPORTED NTDs BY PARITY**  
**IN ERODE TOWN DURING 2000-2004**

| Parity  | Neural Tube Defects |                   |                     |                  |                   |                     |             |                   |                     |               |                   |                     |
|---|---------------------|-------------------|---------------------|------------------|-------------------|---------------------|-------------|-------------------|---------------------|---------------|-------------------|---------------------|
|   | Anencephaly         |                   |                     | Spina bifida     |                   |                     |             |                   |                     | Encephalocele |                   |                     |
|   |                     |                   |                     | Meningomyelocele |                   |                     | Meningocele |                   |                     |               |                   |                     |
|   | N                   | Rate <sup>1</sup> | 95% CI <sup>2</sup> | N                | Rate <sup>1</sup> | 95% CI <sup>2</sup> | N           | Rate <sup>1</sup> | 95% CI <sup>2</sup> | N             | Rate <sup>1</sup> | 95% CI <sup>2</sup> |
| <b>0</b>  | 48                  | 5.01              | 3.62-6.42           | 35               | 3.66              | 2.45-4.87           | 49          | 5.12              | 3.69-6.55           | 11            | 1.15              | 0.48-1.82           |
| <b>1</b>  | 35                  | 3.66              | 2.47-4.85           | 13               | 1.36              | 0.63-2.09           | 26          | 2.72              | 1.68-3.76           | 7             | 0.73              | 0.58-0.88           |
| <b>2</b>  | 15                  | 1.57              | 0.78-2.36           | 5                | 0.52              | 0.07-0.97           | 12          | 1.25              | 0.55-1.95           | 1             | 0.10              | 0-0.3               |
| <b>3+</b>   | 4                   | 0.42              | 0.01-0.83           | 1                | 0.10              | 0-0.3               | 0           | 0                 | 0                   | 0             | 0                 | 0                   |
| <b>Total</b>  | 102                 | 10.65             | 8.59-12.71          | 54               | 5.64              | 4.87-6.407          | 87          | 9.08              | 7.17-10.99          | 19            | 1.94              | 1.06-2.82           |
| <b>F Value = 4.61* (between parity and type of NTDs )</b> |                     |                   |                     |                  |                   |                     |             |                   |                     |               |                   |                     |

<sup>1</sup>Rate per 10,000 live births ; Total live births = 95,735 ; CI<sup>2</sup> = 95% Confidence Interval for rates ; \* Significant at 5 per cent level.



**INCIDENCE RATES OF REPORTED NTDs BY PARITY IN  
ERODE TOWN DURING 2000-2004  
FIGURE 7**

Incidence rate of reported NTD cases, decreased with parity in all the four types during the study period. A very high incidence of NTD was reported among first para of pregnancy followed by second para. These results are on par with Aguiar *et al* (2003).

Vieira (2004) performed a meta analysis looking at the risk of NTD with parity and found that pregnancy with higher parity was more likely to have a spina bifida defect than those with lower parity. This was not observed for other types of NTDs. However Aguiar *et al* (2003) reported that NTDs were less frequently seen among women who had more than three gestations ( $p = 0.007$ ). There are differences in the findings among researchers with regard to parity and NTD prevalence.

Statistical analysis reveals that there is a significant difference at five per cent level between the type of NTDs and parity.

## **ii) Weeks of gestation**

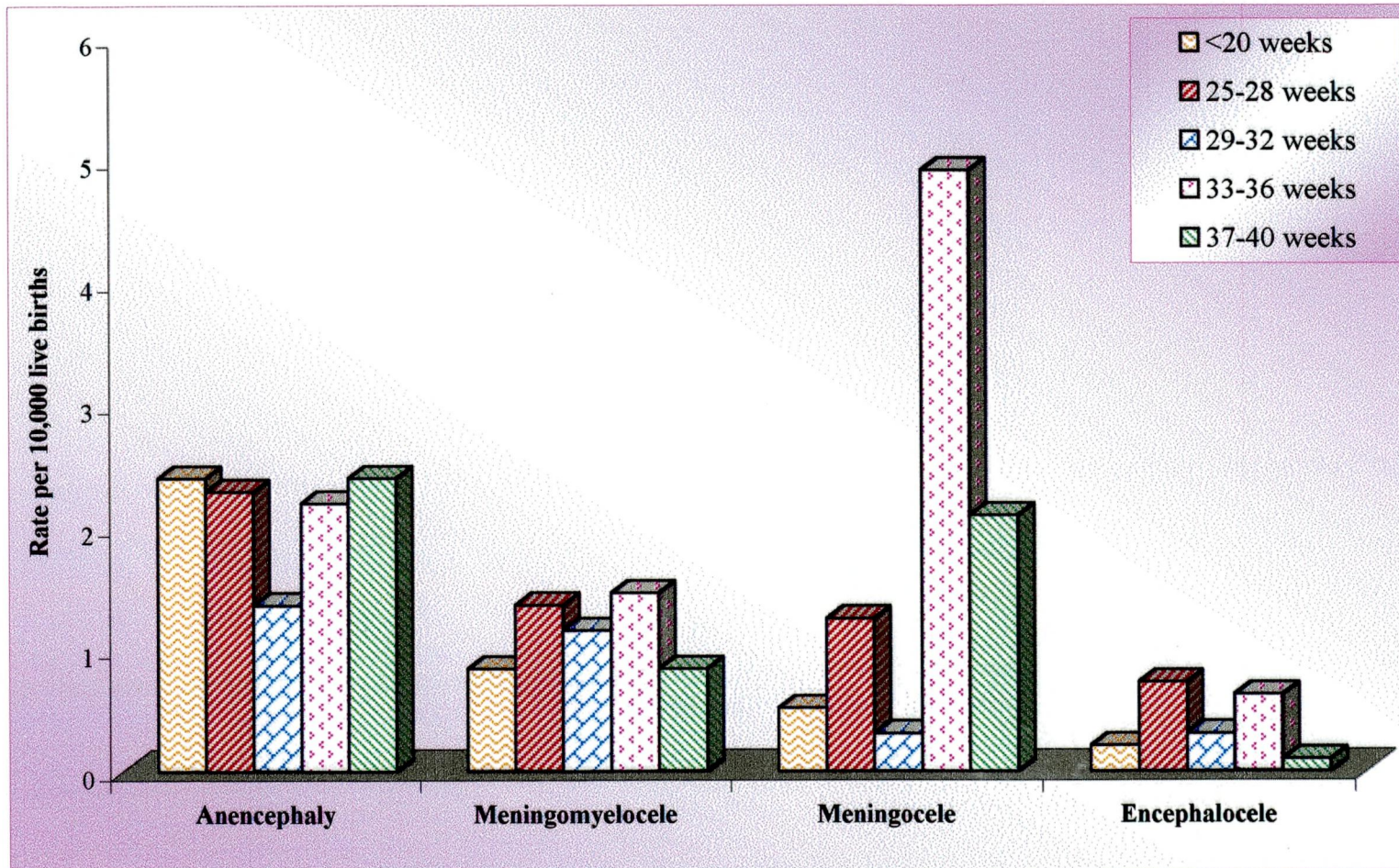
Table VIII and Figure 8 reveal the incidence of reported NTD cases in Erode town by weeks of gestation. Results indicate that 22.5 per cent of children with anencephaly, 14.8 per cent of children with meningomyelocele, 5.7 per cent with meningocele and 10.5 per cent with encephalocele were delivered before the 25<sup>th</sup> week of pregnancy. A woman pregnant with a child with severe birth defect is likely to deliver early. According to Rasmussen *et al* (2001) and Shaw *et al* (2001) NTD rates might be higher with lower gestational age at delivery. The data available from the present study supports this observation.

**TABLE VIII**

**TOTAL NUMBER AND INCIDENCE RATES OF REPORTED NTDs BY WEEKS OF GESTATION  
IN ERODE TOWN DURING 2000-2004**

| Weeks of Gestation   | Neural Tube Defects |                   |                     |                  |                   |                     |             |                   |                     |               |                   |                     |
|--|---------------------|-------------------|---------------------|------------------|-------------------|---------------------|-------------|-------------------|---------------------|---------------|-------------------|---------------------|
|  | Anencephaly         |                   |                     | Spina bifida     |                   |                     |             |                   |                     | Encephalocele |                   |                     |
|  |                     |                   |                     | Meningomyelocele |                   |                     | Meningocele |                   |                     |               |                   |                     |
|  | N                   | Rate <sup>1</sup> | 95% CI <sup>2</sup> | N                | Rate <sup>1</sup> | 95% CI <sup>2</sup> | N           | Rate <sup>1</sup> | 95% CI <sup>2</sup> | N             | Rate <sup>1</sup> | 95% CI <sup>2</sup> |
| <20  | 23                  | 2.40              | 1.42-3.38           | 8                | 0.84              | 0.26-1.42           | 5           | 0.52              | 0.07-0.97           | 2             | 0.21              | 0-0.50              |
| 25-28  | 22                  | 2.29              | 1.34-3.24           | 13               | 1.36              | 0.62-2.1            | 12          | 1.25              | 0.55-1.95           | 7             | 0.73              | 0.58-0.88           |
| 29-32  | 13                  | 1.36              | 0.63-2.09           | 11               | 1.15              | 0.48-1.82           | 3           | 0.31              | 0-0.64              | 3             | 0.31              | 0-0.64              |
| 33-36  | 21                  | 2.19              | 1.26-3.12           | 14               | 1.46              | 0.7-2.22            | 47          | 4.91              | 3.51-6.31           | 6             | 0.63              | 0.13-1.13           |
| 37-40  | 23                  | 2.40              | 1.42-3.38           | 8                | 0.84              | 0.67-1.01           | 20          | 2.09              | 1.18-3.0            | 1             | 0.10              | 0-0.3               |
| <b>Total</b>   | 102                 | 10.65             | 8.59-12.71          | 54               | 5.64              | 4.87-6.40           | 87          | 9.08              | 7.17-10.99          | 19            | 1.94              | 1.06-2.82           |
| <b>F Value = 1.08<sup>NS</sup> (weeks of gestation and type of NTDs)</b> |                     |                   |                     |                  |                   |                     |             |                   |                     |               |                   |                     |

<sup>1</sup>Rate per 10,000 live births ; Total live births = 95,735 ; CI<sup>2</sup> = 95% Confidence Interval for rates ; NS-Not Significant



**INCIDENCE RATES OF REPORTED NTDs BY WEEKS OF GESTATION  
IN ERODE TOWN DURING 2000-2004  
FIGURE 8**

Statistical analysis by 'F' ratio reveals that there is no significant difference between annual incidence rates of reported NTD cases and weeks of gestation.

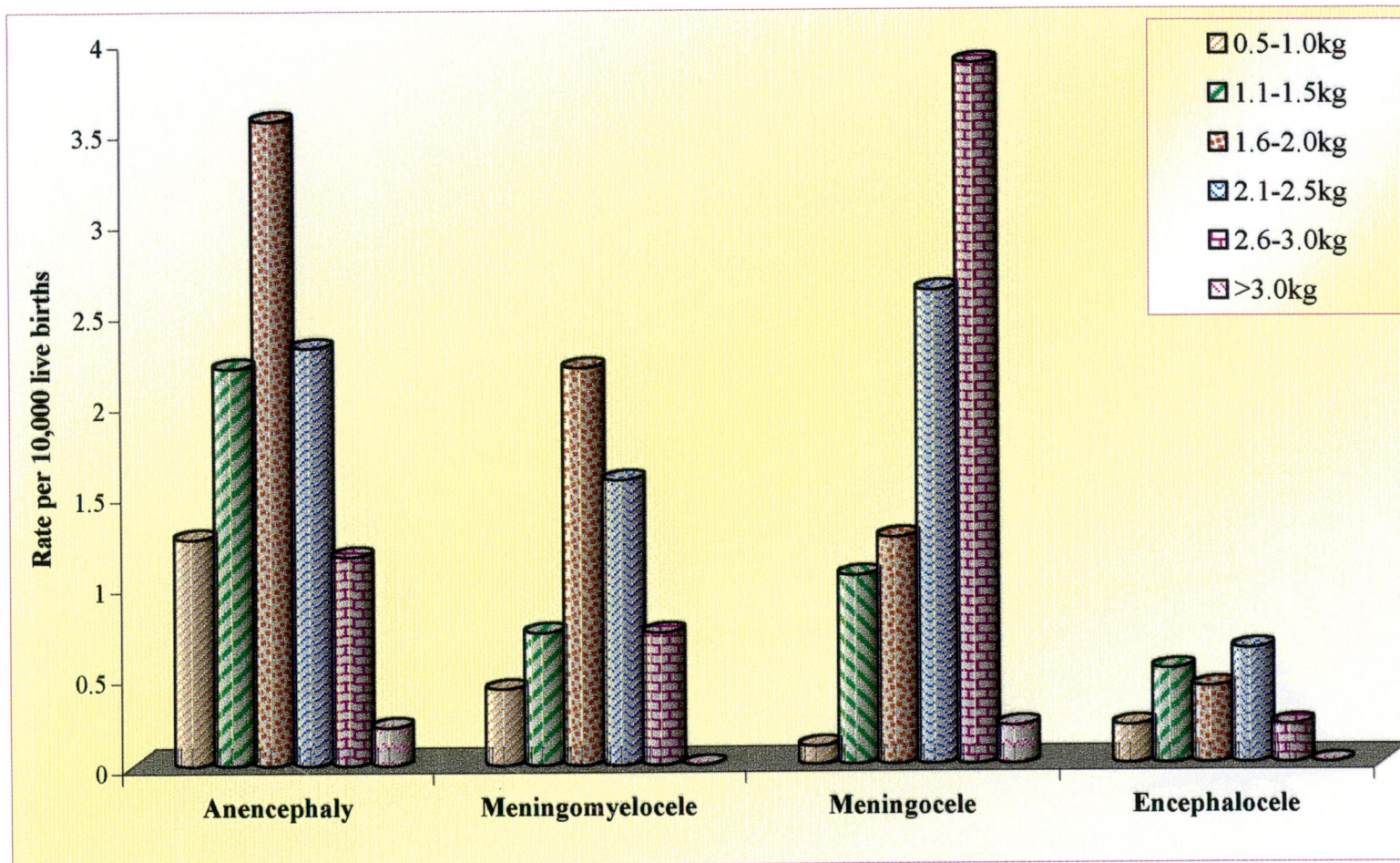
**iii) Birth weight**

Birth weight is of course, closely associated with gestational age. Table IX and Figure 9 present the total number and incidence rates of reported NTDs by birth weights in Erode town from 2000 to 2004.

**TABLE IX**  
**TOTAL NUMBER AND INCIDENCE RATES OF REPORTED NTDs BY BIRTH WEIGHTS**  
**IN ERODE TOWN DURING 2000 – 2004**

| Birth Weight (Kg)   | Neural Tube Defects |                   |                     |                  |                   |                     |             |                   |                     |               |                   |                     |
|---|---------------------|-------------------|---------------------|------------------|-------------------|---------------------|-------------|-------------------|---------------------|---------------|-------------------|---------------------|
|   | Anencephaly         |                   |                     | Spina bifida     |                   |                     |             |                   |                     | Encephalocele |                   |                     |
|   |                     |                   |                     | Meningomyelocele |                   |                     | Meningocele |                   |                     |               |                   |                     |
|   | N                   | Rate <sup>1</sup> | 95% CI <sup>2</sup> | N                | Rate <sup>1</sup> | 95% CI <sup>2</sup> | N           | Rate <sup>1</sup> | 95% CI <sup>2</sup> | N             | Rate <sup>1</sup> | 95% CI <sup>2</sup> |
| <b>0.5-1.0</b>  | 12                  | 1.25              | 0.55-1.95           | 4                | 0.42              | 0.01-0.83           | 1           | 0.10              | 0-0.3               | 2             | 0.21              | 0-0.05              |
| <b>1.1-1.5</b>  | 21                  | 2.19              | 1.26-3.12           | 7                | 0.73              | 0.58-0.88           | 10          | 1.04              | 0.4-1.68            | 5             | 0.52              | 0.07-0.9            |
| <b>1.6-2.0</b>  | 34                  | 3.55              | 2.36-4.74           | 21               | 2.19              | 1.26-3.12           | 12          | 1.25              | 0.55-1.95           | 4             | 0.42              | 0.01-0.83           |
| <b>2.1-2.5</b>  | 22                  | 2.30              | 1.34-3.26           | 15               | 1.57              | 0.78-2.36           | 25          | 2.61              | 1.59-3.63           | 6             | 0.63              | 0.13-1.13           |
| <b>2.6-3.0</b>  | 11                  | 1.15              | 0.48-1.82           | 7                | 0.73              | 0.58-0.88           | 37          | 3.86              | 2.62-5.1            | 2             | 0.21              | 0-0.50              |
| <b>&gt;3.0</b>  | 2                   | 0.21              | 0-0.50              | 0                | 0                 | 0                   | 2           | 0.21              | 0-0.05              | 0             | 0                 | -                   |
| <b>Total</b>  | 102                 | 10.65             | 8.59-12.71          | 54               | 5.64              | 4.87-6.40           | 87          | 9.08              | 7.17-10.99          | 19            | 1.94              | 1.06-2.82           |
| <b>F Value = 1.29<sup>NS</sup> (between birth weights and type of NTDs)</b> |                     |                   |                     |                  |                   |                     |             |                   |                     |               |                   |                     |

<sup>1</sup>Rate per 10,000 live births ; Total live births = 95,735 ; CI<sup>2</sup> = 95% Confidence Interval for rates ; NS-Not Significant



**INCIDENCE RATES OF REPORTED NTDs BY BIRTH WEIGHT IN  
ERODE TOWN DURING 2000-2004  
FIGURE 9**

Except 1.96 per cent of children with anencephaly, all other types of NTD affected children had birth weight below 3 kg. There is a higher rate of NTDs among the children delivered with low birth weight. This suggests that NTDs are a likely cause of early miscarriage.

Owen *et al* (2000) and Whitemen *et al* (2000) had observed that NTD rates were higher with low birth weight. The test by 'F' ratio showed that the difference between NTD cases and birth weight in Erode town was insignificant.

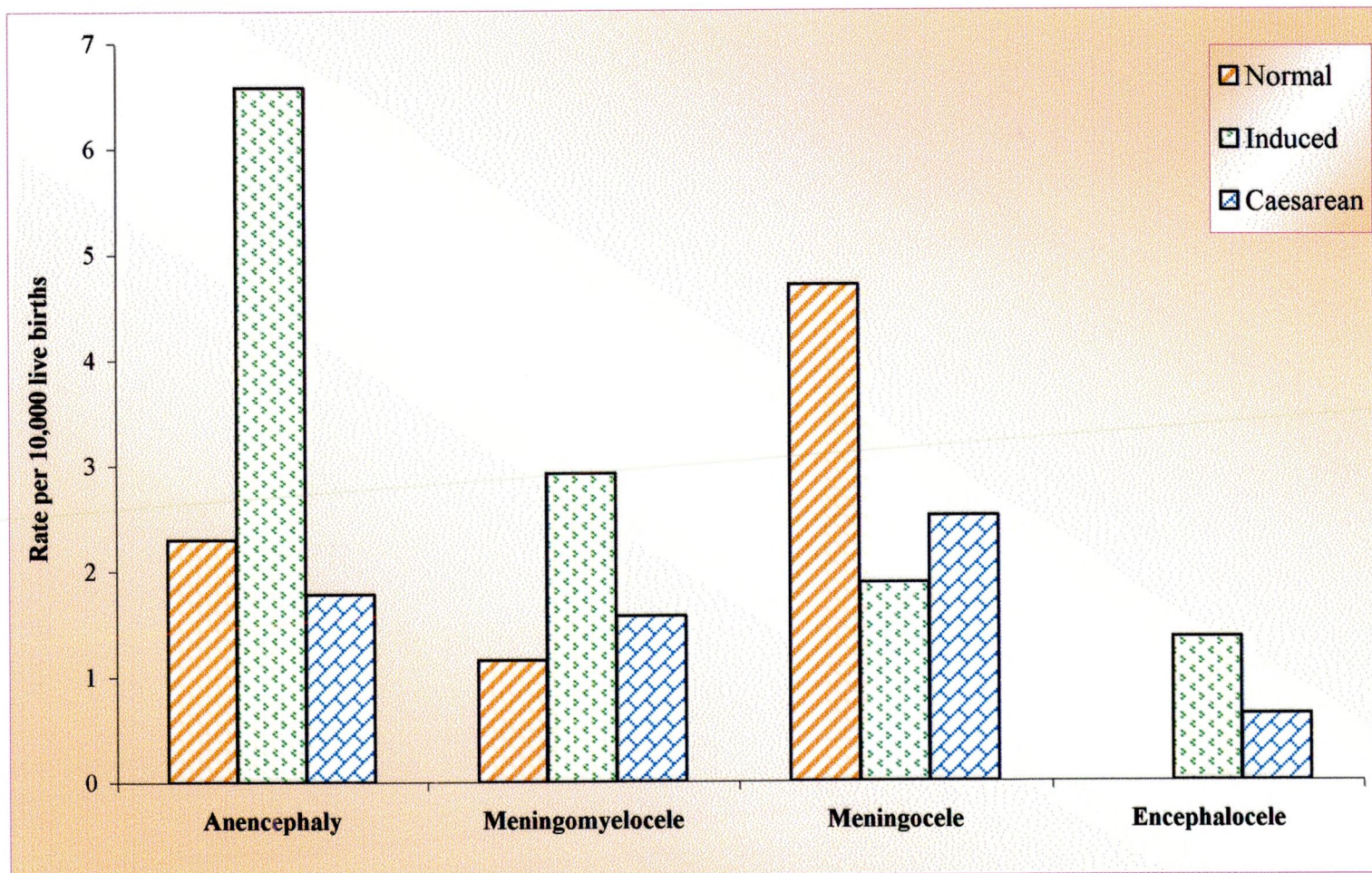
#### **iv) Type of delivery**

Table X and Figure 10 present the total number and incidence rate of reported NTD cases by type of delivery.

**TABLE X**  
**TOTAL NUMBER AND INCIDENCE RATES OF REPORTED NTDs BY TYPE OF DELIVERY**  
**IN ERODE TOWN DURING 2000-2004**

| Type of Delivery   | Neural Tube Defects |                   |                     |                  |                   |                     |             |                   |                     |               |                   |                     |
|--|---------------------|-------------------|---------------------|------------------|-------------------|---------------------|-------------|-------------------|---------------------|---------------|-------------------|---------------------|
|  | Anencephaly         |                   |                     | Spina bifida     |                   |                     |             |                   |                     | Encephalocele |                   |                     |
|  |                     |                   |                     | Meningomyelocele |                   |                     | Meningocele |                   |                     |               |                   |                     |
|  | N                   | Rate <sup>1</sup> | 95% CI <sup>2</sup> | N                | Rate <sup>1</sup> | 95% CI <sup>2</sup> | N           | Rate <sup>1</sup> | 95% CI <sup>2</sup> | N             | Rate <sup>1</sup> | 95% CI <sup>2</sup> |
| <b>Normal</b>  | 22                  | 2.30              | 1.34-3.26           | 11               | 1.15              | 0.48-1.82           | 45          | 4.70              | 3.32-6.07           | 0             | 0                 | 0                   |
| <b>Induced</b>   | 63                  | 6.58              | 4.96-8.2            | 28               | 2.92              | 1.84-4.0            | 18          | 1.88              | 1.02-2.74           | 13            | 1.36              | 0.63-2.09           |
| <b>Caesarean</b>   | 17                  | 1.78              | 0.94-2.62           | 15               | 1.57              | 0.78-2.36           | 24          | 2.51              | 1.51-3.51           | 6             | 0.63              | 0.13-1.13           |
| <b>Total</b>   | 102                 | 10.65             | 8.59-12.71          | 54               | 5.64              | 4.87-6.40           | 87          | 9.08              | 7.17-10.99          | 19            | 1.94              | 1.06-2.82           |
| <b>F Value = 0.82<sup>NS</sup> (between type of delivery and type of NTDs)</b> |                     |                   |                     |                  |                   |                     |             |                   |                     |               |                   |                     |

<sup>1</sup>Rate per 10,000 live births ; Total live births = 95,735 ; CI<sup>2</sup> = 95% Confidence Interval for rates ; NS-Not Significant



**INCIDENCE RATES OF REPORTED NTDs BY TYPE OF DELIVERY IN ERODE TOWN DURING 2000-2004**

**FIGURE 10**

It is evident from the table that majority of NTD cases were delivered either by inducing or by caesarean except meningocele where normal deliveries were more. There is no statistically significant difference according to 'F' ratio in the rates of NTDs between different types of delivery.

**v) Registration of pregnancy**

The total number and incidence rate of reported NTD cases by registration of pregnancy are presented in Table XI.

Table clearly show that about 7.8 per cent (8 out of 102) of mothers with anencephaly, 1.8 per cent (1 out of 54) of mothers with meningomyelocele, 2.29 per cent (2 out of 87) of mothers with meningocele and 5.2 per cent (1 out of 19) of mothers with encephalocele affected pregnancies had not registered during early trimesters and had reported only for parturition in Erode town during the study period.

**TABLE XI**  
**TOTAL NUMBER AND INCIDENCE RATES OF REPORTED NTDs REGISTERED**  
**IN ERODE TOWN DURING 2000-2004**

| Registration of pregnancy | Neural Tube Defects |                   |                     |                  |                   |                     |             |                   |                     |               |                   |                     |
|---------------------------|---------------------|-------------------|---------------------|------------------|-------------------|---------------------|-------------|-------------------|---------------------|---------------|-------------------|---------------------|
|                           | Anencephaly         |                   |                     | Spina bifida     |                   |                     |             |                   |                     | Encephalocele |                   |                     |
|                           |                     |                   |                     | Meningomyelocele |                   |                     | Meningocele |                   |                     |               |                   |                     |
|                           | N                   | Rate <sup>1</sup> | 95% CI <sup>2</sup> | N                | Rate <sup>1</sup> | 95% CI <sup>2</sup> | N           | Rate <sup>1</sup> | 95% CI <sup>2</sup> | N             | Rate <sup>1</sup> | 95% CI <sup>2</sup> |
| <b>Registered</b>         | 94                  | 9.82              | 7.84-11.8           | 53               | 5.54              | 4.05-7.03           | 85          | 8.88              | 7.0-10.76           | 18            | 1.88              | 0-1.02              |
| <b>Not Registered</b>     | 8                   | 0.84              | 0.26-1.42           | 1                | 0.10              | 0-0.3               | 2           | 0.21              | 0-0.50              | 1             | 0.10              | 0-0.3               |
| <b>Total</b>              | 102                 | 10.65             | 8.59-12.71          | 54               | 5.64              | 4.87-6.40           | 87          | 9.08              | 7.17-10.99          | 19            | 1.94              | 1.06-2.82           |

<sup>1</sup>Rate per 10,000 live births ; Total live births = 95,735 ; CI<sup>2</sup> = 95% Confidence Interval for rates.

**e) Incidence rates of NTDs – A comparison**

The comparison of the incidence rates of different types of NTDs is presented in Table XII

**TABLE XII**  
**INCIDENCE RATES OF NTDs – A COMPARISON (2000-2004)**

| Factors                      | Anencephaly | Spina bifida     |             | Encephalocele |
|------------------------------|-------------|------------------|-------------|---------------|
|                              |             | Meningomyelocele | Meningocele |               |
| <b>Gender</b>                |             |                  |             |               |
| Male                         | 3.03        | 2.29             | 4.39        | 1.25          |
| Female                       | 7.63        | 3.34             | 4.70        | 0.73          |
| <b>Maternal age (in yrs)</b> |             |                  |             |               |
| <20                          | 0.21        | 0.21             | 0           | 0             |
| 20 – 24                      | 5.12        | 2.82             | 5.43        | 1.04          |
| 25 – 29                      | 3.86        | 2.09             | 2.92        | 0.84          |
| 30 – 34                      | 0.83        | 0.10             | 0.52        | 0.10          |
| >34                          | 0.63        | 0.42             | 0.21        | 0             |
| <b>Literacy level</b>        |             |                  |             |               |
| Primary                      | 2.19        | 0.42             | 0.94        | 0.10          |
| Secondary                    | 5.22        | 3.13             | 5.01        | 0.94          |
| Higher Secondary             | 1.78        | 1.04             | 1.15        | 0.42          |
| UG                           | 1.46        | 0.84             | 1.78        | 0.42          |
| PG                           | 0           | 0.21             | 0.21        | 0.10          |
| <b>Parity</b>                |             |                  |             |               |
| 0                            | 5.01        | 3.66             | 5.12        | 1.15          |
| 1                            | 3.66        | 1.36             | 2.72        | 0.73          |
| 2                            | 1.57        | 0.52             | 1.25        | 0.10          |
| 3                            | 0.42        | 0.10             | 0           | 0             |
| <b>Weeks of gestation</b>    |             |                  |             |               |
| <20                          | 2.40        | 0.84             | 0.52        | 0.21          |
| 25 – 28                      | 2.29        | 1.36             | 1.25        | 0.73          |
| 29 – 32                      | 1.36        | 1.15             | 0.31        | 0.31          |
| 33 – 36                      | 2.19        | 1.46             | 4.91        | 0.63          |
| 37 – 40                      | 2.40        | 0.84             | 2.09        | 0.10          |
| <b>Birth weight (kg)</b>     |             |                  |             |               |
| 0.5 – 1.0                    | 1.25        | 0.42             | 0.10        | 0.21          |
| 1.1 – 1.5                    | 2.19        | 0.73             | 1.04        | 0.52          |
| 1.6 – 2.0                    | 3.55        | 2.19             | 1.25        | 0.42          |
| 2.1 – 2.5                    | 2.30        | 1.57             | 2.61        | 0.63          |
| 2.6 – 3.0                    | 1.15        | 0.73             | 3.86        | 0.21          |
| >3.0                         | 0.21        | 0                | 0.21        | 0             |

Among the anencephaly cases it is noted that higher incidence rates of NTDs is reported among females, of 20-24 years of maternal age, with secondary level of education, in primiparas, less than 20 weeks of gestation and among 1.6-2.2 kg of birth weight of infants.

The same pattern of incidence level has been noted in meningomyelocele and meningocele cases during the study period except for the weeks of gestation, where higher incidence rates were reported in 30-36 weeks of gestation.

Further higher incidence rates of NTD was reported in male infants among 20-24 years of maternal age, with secondary level education, in primiparas, 25-28 weeks of gestation and among 1.6-2.0 kg of birth weight of infants in encephalocele cases during the study period.

The over all analysis revealed the same pattern of incidence with regard to demographic and maternal factors in anencephaly, meningomyelocele and meningocele whereas in encephalocele, a different pattern was noticed.

## PHASE 2

### B. POSSIBLE INFLUENCE OF MATERNAL FACTORS ON NTDs AND THE PROBLEMS FACED BY THE PREGNANT MOTHERS OF NTD CASES

Information collected from 116 pregnant women by the investigator in Erode town with a previous history of NTDs was analysed. An attempt was made to study the influence of maternal factors on NTDs and the complications faced by the women during pregnancy. Relevant statistical tests were applied to interpret the information gathered.

#### 1) Maternal factors and types of NTDs

##### a) Age

The present age of the selected women and their association to the prevalence and type of NTDs are given in Table XIII.

**TABLE XIII**  
**MATERNAL AGE AND PREVALENCE OF NTDs (N = 116)**

| Age (yrs)    | Anencephaly                | Spina bifida               |                            | Encephalocele            | Total                      | Chi square          |
|--------------|----------------------------|----------------------------|----------------------------|--------------------------|----------------------------|---------------------|
|              |                            | Meningocele                | Meningo myelocele          |                          |                            |                     |
| ≤ 20         | 4                          | 0                          | 1                          | 0                        | 5<br>(4.3)                 | 10.50 <sup>NS</sup> |
| 21-25        | 29                         | 18                         | 17                         | 3                        | 67<br>(57.8)               |                     |
| 26-30        | 10                         | 17                         | 8                          | 4                        | 39<br>(33.6)               |                     |
| 31-35        | 2                          | 2                          | 1                          | 0                        | 5<br>(4.3)                 |                     |
| <b>Total</b> | <b>45</b><br><b>(38.8)</b> | <b>37</b><br><b>(31.9)</b> | <b>27</b><br><b>(23.3)</b> | <b>7</b><br><b>(6.0)</b> | <b>116</b><br><b>(100)</b> |                     |

Figures in parentheses show percentage to total; NS – Not Significant

It is inferred from the table that a majority of the selected mothers of the NTD subjects belonged to the age group of 21-25 years (57.8 %) followed by 26-30 years (33.6 %). Occurrence of NTDs was highest among mothers of 21-30 years (57.8%) being the reproductive years of women. It is also noticed that the most common NTDs include spina bifida (55.2 %), followed by anencephaly (38.8 %) and encephalocele (6.0 %). No significant association between the age of the women and types of NTD was observed. It can be said that incidence of NTD affected pregnancy decreased with increased maternal age. The present study supports the findings of Owen *et al* (2001) and McDonnel *et al.*(1999).

**b) Age at marriage**

The age at marriage of the women and prevalence of NTDs are presented in Table XIV.

**TABLE XIV**  
**AGE AT MARRIAGE AND PREVALENCE OF NTDs (N = 116)**

| Age (yrs)    | Anencephaly | Spina bifida |                   | Encephalocele | Total        | Chi square         |
|--------------|-------------|--------------|-------------------|---------------|--------------|--------------------|
|              |             | Meningocele  | Meningo myelocele |               |              |                    |
| ≤ 18         | 0           | 3            | 1                 | 0             | 4<br>(3.4)   | 9.13 <sup>NS</sup> |
| 19-21        | 24          | 14           | 18                | 3             | 59<br>(50.9) |                    |
| > 21         | 21          | 20           | 8                 | 4             | 53<br>(45.7) |                    |
| <b>Total</b> | 45          | 37           | 27                | 7             | 116<br>(100) |                    |

Figures in parentheses show percentage to total; NS- Not Significant

From Table XIV it can be noted that, out of 116 mothers of NTD subjects, 59 women (50.9 %) got married at an age of 19-21 years, 53 women (45.7 %) at 21 years or more. Only four women (3.4 %) got married at the

adolescent age of less than 18 years. Adolescent pregnancies were found to be less in the study and hence prevalence of NTDs was also minimum. Statistical analysis did not show any significant association between age at marriage and type of NTDs.

### c) Type of Family

The association between the type of family and the prevalence of NTDs is given in Table XV.

**TABLE XV**  
**TYPE OF FAMILY AND INCIDENCE OF NTDs (N = 116)**

| Family type  | Anencephaly | Spina bifida |                  | Encephalocele | Total        | Chi square         |
|--------------|-------------|--------------|------------------|---------------|--------------|--------------------|
|              |             | Meningocele  | Meningomyelocele |               |              |                    |
| Joint        | 32          | 25           | 16               | 4             | 77<br>(66.4) | 1.35 <sup>NS</sup> |
| Nuclear      | 13          | 12           | 11               | 3             | 39<br>(33.6) |                    |
| <b>Total</b> | 45          | 37           | 27               | 7             | 116<br>(100) |                    |

Figures in parentheses show percentage to total; NS-Not Significant

Among the mothers of children with NTDs, a majority of 66.4 per cent belonged to joint families and the remaining 33.6 per cent belonged to nuclear family type. According to Agullion *et al* (1982) and Ballweg (1972) joint or large family size is significantly negatively associated with good nutritional status. Also, intra familial distribution of food was poor, with elder family members receiving the largest share. In both types of families, the most common defect was anencephaly, followed by meningocele, meningomyelocele and encephalocele. The types of family of women were not found to be significantly associated with NTD prevalence as revealed by chi-square test.

#### d) Family size

The family size of the selected women and type of NTDs are presented in Table XVI.

**TABLE XVI**  
**FAMILY SIZE AND INCIDENCE OF NTDs (N = 116)**

| Family size  | Anencephaly | Spina bifida |                   | Encephalocele | Total        | Chi square         |
|--------------|-------------|--------------|-------------------|---------------|--------------|--------------------|
|              |             | Meningocele  | Meningo myelocele |               |              |                    |
| 2            | 11          | 10           | 6                 | 3             | 30<br>(25.9) | 8.78 <sup>NS</sup> |
| 3            | 2           | 1            | 4                 | 0             | 7 (6.0)      |                    |
| 4            | 8           | 9            | 2                 | 1             | 20<br>(17.2) |                    |
| ≥ 5          | 24          | 17           | 15                | 3             | 59<br>(50.9) |                    |
| <b>Total</b> | 45          | 37           | 27                | 7             | 116<br>(100) |                    |

Figures in parentheses show percentage to total; NS- Not Significant

Majority of NTDs (50.9 %) occurred in big families of size five and above. Statistical analysis showed that there was no significant association between family size and incidence of NTDs. It is interesting to find that even among small sized families of two, the prevalence of NTDs was found to be 25.9 per cent.

#### e) Family income

Income wise classification of the selected women along with type of NTDs is presented in Table XVII.

**TABLE XVII**  
**MONTHLY FAMILY INCOME AND TYPE OF NTDs (N = 116)**

| Income*/<br>month<br>(Rs) | Anencephaly | Spina bifida |                      | Encephalocele | Total        | Chi<br>square      |
|---------------------------|-------------|--------------|----------------------|---------------|--------------|--------------------|
|                           |             | Meningocele  | Meningo<br>myelocele |               |              |                    |
| < 5500<br>(Low)           | 20          | 14           | 6                    | 1             | 41<br>(35.3) | 8.11 <sup>NS</sup> |
| 5500-10,000<br>(Middle)   | 22          | 16           | 18                   | 5             | 61<br>(52.6) |                    |
| > 10,000<br>(High)        | 3           | 7            | 3                    | 1             | 14<br>(12.1) |                    |
| <b>Total</b>              | 45          | 37           | 2                    | 7             | 116<br>(100) |                    |

Figures in parentheses show percentage to total; NS-Not Significant

\*HUDCO (1999)

In this study, 52.6 per cent of the selected women belonged to middle income group with a monthly income of Rs.5,500 to 10,000, followed by 35.3 per cent in low-income group with less than Rs.5,500 per month. The findings revealed that socio economic status of the selected women have profound influence on the type of NTDs. That is, prevalence of NTDs was more among low and middle-income groups or those belonging to low socio economic status. Statistical analysis did not show any significant difference between monthly income and prevalence of NTDs as per Chi-square analysis. According to Duttachoudhury and Pal (1997) increased incidence of NTDs was found among patients from low socio economic status. The reasons for higher prevalence could be due to gross nutritional deficiency and inadequate antenatal care.

#### **f) Educational status**

Table XVIII presents the distribution of the type of NTDs according to maternal education based on the data obtained.

**TABLE XVIII****EDUCATIONAL STATUS AND TYPE OF NTDs (N= 116)**

| Education    | Anencephaly | Spina bifida |                   | Encephalocele | Total | Chi square         |
|--------------|-------------|--------------|-------------------|---------------|-------|--------------------|
|              |             | Meningocele  | Meningo myelocele |               |       |                    |
| Primary      | 6           | 3            | 2                 | 0             | 11    | 8.71 <sup>NS</sup> |
| SSLC         | 21          | 18           | 12                | 2             | 53    |                    |
| HSC          | 6           | 6            | 5                 | 3             | 20    |                    |
| UG           | 11          | 7            | 5                 | 2             | 25    |                    |
| PG           | 1           | 3            | 3                 | 0             | 7     |                    |
| <b>Total</b> | 45          | 37           | 27                | 7             | 116   |                    |

NS - Not Significant

It is interesting to know that there were no illiterates among the study group. However, all the four types of NTD cases showed a decreasing trend with the maternal educational level. Chi-square analysis did not show any significant association between maternal education and type of NTDs. Low maternal education is an important predictor in having a child with NTD (Farley *et al* 2002).

**g) Consanguinity**

Consanguinity is referred as marriage between blood relatives, who have at least one common ancestor, who is no more remote than a grand parent. It has long been recognized that off spring of consanguineous couples have an increased risk of birth defects. The selected women were classified with the type of NTDs based on consanguinity and presented in Table XIX.

**TABLE XIX**  
**CONSANGUINITY AND TYPE OF NTDs (N=116)**

| Criteria           | Anencephaly | Spina bifida |                   | Encephalocele | Total        | Chi square         |
|--------------------|-------------|--------------|-------------------|---------------|--------------|--------------------|
|                    |             | Meningocele  | Meningo myelocele |               |              |                    |
| <b>Related</b>     | 4           | 10           | 6                 | 2             | 22<br>(19.0) | 5.14 <sup>NS</sup> |
| <b>Not related</b> | 41          | 27           | 21                | 5             | 94<br>(81.0) |                    |
| <b>Total</b>       | 45          | 37           | 27                | 7             | 116<br>(100) |                    |

Figures in parentheses indicate percentage to total

A majority of 81 per cent of the selected women with NTDs were not closely related couples. With respect to consanguinity Little and Elwood (1991) reported that NTD rates were higher when the parents were related, although some other studies did not identify this association (Rittler *et al* 2001 and Stoltenberg *et al* 1997). The findings of the present study also reveal that consanguinity and prevalence of NTDs are not related to each other.

#### **h) Parity**

The association between type of NTDs and parity of the NTD affected women is presented in Table XX.

**TABLE XX**  
**PARITY AND TYPE OF NTDs (N=116)**

| Parity       | Anencephaly | Spina bifida |                   | Encephalocele | Total        | Chi square |
|--------------|-------------|--------------|-------------------|---------------|--------------|------------|
|              |             | Meningocele  | Meningo myelocele |               |              |            |
| <b>I</b>     | 33          | 14           | 19                | 3             | 69<br>(59.5) | 17.59*     |
| <b>II</b>    | 10          | 14           | 5                 | 4             | 33<br>(28.4) |            |
| <b>III</b>   | 2           | 9            | 3                 | 0             | 14<br>(12.1) |            |
| <b>Total</b> | 45          | 37           | 27                | 7             | 116<br>(100) |            |

Figures in parentheses indicate percentage to total; \* significant at 5 per cent level

It is observed from the table that a higher incidence of 59.5 per cent of NTDs was seen among first-born children compared to II and III para of pregnancy which support the findings of Nugud *et al* (2003) who reported that a high incidence of NTDs was found among the first born children. Statistical analysis shows that there is a significant association between parity and type of NTDs.

#### **i) Birth Spacing**

The prevalence of NTDs according to birth spacing is presented in Table XXI.

**TABLE XXI****BIRTH SPACING AND TYPE OF NTDs (N=47\*)**

| Birth Spacing (in Years) | Anencephaly | Spina bifida |                   | Encephalocele | Total | Chi square         |
|--------------------------|-------------|--------------|-------------------|---------------|-------|--------------------|
|                          |             | Meningocele  | Meningo myelocele |               |       |                    |
| 1                        | 0           | 6            | 2                 | 1             | 9     | 8.18 <sup>NS</sup> |
| 2                        | 3           | 6            | 1                 | 1             | 11    |                    |
| 3                        | 3           | 3            | 2                 | 1             | 9     |                    |
| 4                        | 5           | 7            | 2                 | 0             | 14    |                    |
| ≥5                       | 1           | 1            | 1                 | 1             | 4     |                    |
| <b>Total</b>             | 12          | 23           | 8                 | 4             | 47    |                    |

NS - Not Significant ; \* Mothers with more than one pregnancy.

It is revealed that birth spacing was not found to be significantly associated with prevalence and type of NTDs as revealed by Chi-square analysis. Studies examining a potential link between the length of time between pregnancies and NTD risk have also found mixed results ( Todoroff and Shaw, 2000).

**j) Time of identification**

Early identification of mothers at risk of giving birth to an NTD affected infant will help them to avoid pregnancy wastage and provide extra care needed for utilizing available health care services, which include preconceptional folic acid supplementation as well. The selected women according to the time of identification of NTDs are presented in Table XXII.

**TABLE XXII****TIME OF IDENTIFICATION AND TYPE OF NTDs (N=116)**

| Time of Identification (Weeks) | Anencephaly | Spina bifida |                   | Encephalocele | Total        |
|--------------------------------|-------------|--------------|-------------------|---------------|--------------|
|                                |             | Meningocele  | Meningo myelocele |               |              |
| 20-24                          | 12          | 3            | 3                 | 0             | 18<br>(15.5) |
| 25-29                          | 10          | 9            | 7                 | 1             | 27<br>(23.3) |
| 30-34                          | 12          | 9            | 7                 | 6             | 34<br>(29.3) |
| 35-39                          | 10          | 15           | 9                 | 0             | 34<br>(29.3) |
| ≥40                            | 1           | 1            | 1                 | 0             | 3<br>(2.6)   |
| <b>Total</b>                   | 45          | 37           | 27                | 7             | 116<br>(100) |

Figures in parentheses indicate percentage to total

It is noted that identification of the NTDs during the early weeks of gestation (20-24 weeks) was reported only by a minimum number of women (15.5%) and majority of women (51.2%) identified the defect only after 30 weeks of gestation. This late diagnosis will not help to undertake any preventive strategies but will lead to pregnancy wastage and other losses.

## **2) Problems faced and supplements taken during NTD affected pregnancy**

Information regarding physiological and psychological problems faced and type and time of supplements taken during NTD affected pregnancy as reported by the mothers are collected and discussed in the following paragraphs.

### **a) Physiological problems**

Physiological problems faced during NTD affected pregnancy are presented in Table XXIII.

**TABLE XXIII**  
**PHYSIOLOGICAL PROBLEMS FACED BY WOMEN**  
**DURING NTD AFFECTED PREGNANCY**

| <b>Problems</b>           | <b>No</b> | <b>Percent</b> |
|---------------------------|-----------|----------------|
| Vomiting and nausea       | 54        | 47             |
| Giddiness                 | 34        | 29             |
| Aversion of certain foods | 26        | 22             |
| Loss of appetite          | 22        | 19             |
| Heart burn                | 12        | 10             |
| Fever                     | 12        | 10             |
| Odema                     | 12        | 10             |
| Hypertension              | 7         | 6              |
| Indigestion               | 5         | 4              |
| Albuminuria               | 4         | 3              |
| Muscle cramps             | 3         | 3              |
| Disturbed sleep           | 2         | 2              |
| Frequent urination        | 2         | 2              |
| Diabetes                  | 1         | 1              |

The most common physiological problems reported before the diagnosis of NTD affected pregnancy included nausea and vomiting (54 women), giddiness (34 women), aversion to certain foods (26 women), loss of appetite (22 women), and heart burn (12 women). Problems like vomiting, giddiness, aversion to certain foods, and loss of appetite have probably contributed to decreased food and nutrient intake resulting in NTD affected pregnancy. According to Medveczy *et al* (2004), maternal fever is a possible cause of NTD in early trimesters.

## b) Psychological problems

Psychological problems faced during NTD affected pregnancy are presented in Table XXIV.

**TABLE XXIV**  
**PSYCHOLOGICAL PROBLEMS FACED BY WOMEN**  
**DURING NTD AFFECTED PREGNANCY**

| <b>Psychological Problems</b>                     | <b>No</b> | <b>Percent</b> |
|---|-----------|----------------|
| Financial problems                                | 14        | 12             |
| Maternal concern about the well being of the baby | 13        | 11             |
| Worry about the sex of the baby                   | 2         | 2              |
| Marital difficulties                              | 2         | 2              |
| Family concern (lack of support)                  | 2         | 2              |
| Worry about the existing complications            | 2         | 2              |
| Worry about the future after the baby is born     | 2         | 2              |
| Lack of happiness in activities                   | 1         | 1              |
| Depressed symptoms                                | 1         | 1              |
| Occupational stress                               | 1         | 1              |

The most common psychological problems reported during the NTD affected pregnancy included financial problems (14 cases) and stress about well being of the baby (13 cases). Maternal psychosocial or emotional stress during pregnancy may increase the risk of having an infant with NTDs (Suarez *et al* 2003). An increased incidence of NTD with psychological stress suggest a meagre economic resource, in turn reflected in purchase of nutritious foods and consumption pattern that may exacerbate the risk in population.

### c) Time of intake of supplements

The time of intake of supplements by mothers of NTD affected subjects is presented in Table XXV.

**TABLE XXV**  
**TIME OF INTAKE OF SUPPLEMENTS BY MOTHERS**  
**DURING NTD AFFECTED PREGNANCY (N=116)**

| <b>Time of Intake</b>    | <b>No</b>  | <b>Percent</b> |
|--------------------------|------------|----------------|
| Before conception        | 1          | 1              |
| I Trimester              | 25         | 22             |
| II Trimester             | 64         | 55             |
| III Trimester            | -          | -              |
| Did not take supplements | 26         | 22             |
| <b>Total</b>             | <b>116</b> | <b>100</b>     |

Seventy eight per cent of mothers were taking supplements. Among them, only one per cent took the supplements preconceptionally, 22 per cent during first trimester and 55 per cent during second trimester. It is evident that the major cause of NTD may be due to the inadequacy of folate and intake of supplements only after conception.

### d) Type of supplements

Information on the type of supplements taken during NTD affected pregnancy by the mothers is presented in Table XXVI.

**TABLE XXVI**  
**TYPE OF SUPPLEMENTS TAKEN DURING NTD AFFECTED**  
**PREGNANCY (N=90)**

| <b>Type of supplements</b> | <b>No</b> | <b>Percent</b> |
|----------------------------|-----------|----------------|
| B-Vitamins                 | 29        | 32             |
| Iron                       | 20        | 22             |
| Folate                     | 16        | 18             |
| Iron and multivitamin      | 16        | 18             |
| Iron and folate            | 7         | 8              |
| Zinc and vitamin B         | 1         | 1              |
| B-complex and calcium      | 1         | 1              |
| <b>Total</b>               | <b>90</b> | <b>100</b>     |

Among the mothers who took the supplements based on physician's advice, a majority of 32 per cent took B-complex vitamins, 22 per cent took iron, and 18 per cent each, took folate, folate and iron and multivitamin tablets.

### **3) Outcome of NTD affected pregnancy**

Information regarding the mode of delivery, weeks of gestation at the time of delivery, medical expenses incurred and the survival of the NTD affected child collected from the selected mothers is presented and discussed in the following pages.

#### **a) Mode of delivery**

The mode of delivery of the NTD affected infants of the selected mothers is presented in Table XXVII.

**TABLE XXVII**  
**MODE OF DELIVERY OF THE NTD AFFECTED INFANTS**

| Mode                 | No         | Percent    |
|----------------------|------------|------------|
| Medical termination  | 60         | 52         |
| Caesarean            | 30         | 26         |
| Normal delivery      | 23         | 20         |
| Spontaneous abortion | 3          | 2          |
| <b>Total</b>         | <b>116</b> | <b>100</b> |

A majority (52 per cent) of pregnancies were terminated after identification of the defect through ultra scanning according to physician's advice. However, 26 per cent of the women underwent caesarean and 20 per cent of women delivered the affected infants normally. Only two per cent had spontaneous abortion.

**b) Weeks of gestation at the time of delivery of NTD children**

Table XXVIII depicts the weeks of gestation at the time of delivery of NTD affected infants.

**TABLE XXVIII**  
**WEEKS OF GESTATION AT THE TIME OF DELIVERY OF NTD**  
**AFFECTED INFANTS**

| Weeks / Delivery | No         | Percent    |
|------------------|------------|------------|
| 20 – 24          | 16         | 14         |
| 25 – 29          | 23         | 20         |
| 30 – 34          | 26         | 22         |
| 35 – 39          | 48         | 41         |
| ≥40              | 3          | 3          |
| <b>Total</b>     | <b>116</b> | <b>100</b> |

About 41 per cent of the women delivered during 35-39 weeks of gestation, 22 per cent at 30-34 weeks of gestation, 20 per cent at 25-29 weeks of gestation and 14 per cent at 20-24 weeks of gestation and only three per cent delivered after 40 weeks of gestation. The time of delivery coincided with the diagnosis of the NTD affected infant. Early diagnosis could have prevented such pregnancy wastages.

**c) Medical expenses incurred**

The cost of medical expenses incurred by the selected mothers towards the NTD affected pregnancy is presented in Table XXIX.

**TABLE XXIX**  
**MEDICAL EXPENSES INCURRED DURING NTD AFFECTED**  
**PREGNANCY (N=116)**

| Amount ( in Rs) | No         | Percent    |
|-----------------|------------|------------|
| 1001 – 3000     | 6          | 5          |
| 3001 – 5000     | 48         | 42         |
| 5001 – 7000     | 30         | 26         |
| 7001 – 9000     | 12         | 10         |
| 9000 and above  | 20         | 17         |
| <b>Total</b>    | <b>116</b> | <b>100</b> |

Forty two per cent spent nearly Rs. 3001-5000 followed by 26 per cent who spent Rs.5001-7000 towards the NTD affected pregnancy for medical check up, supplements, biochemical tests, ultra scanning and delivery. More than Rs.9000 was spent by nearly 17 per cent of mothers towards the pregnancy, which would have affected their financial position. Only five per cent spent Rs.1001-3000 being a reasonable amount.

#### d) Survival of NTD affected infants

The life expectancy of NTD affected infants after delivery is presented in Table XXX.

**TABLE XXX**

#### **SURVIVAL OF THE NTD AFFECTED INFANTS (N=116)**

| Survival of the NTD affected children | Anencephaly | Spina bifida |                   | Encephalocele | Total      |
|---------------------------------------|-------------|--------------|-------------------|---------------|------------|
|                                       |             | Meningocele  | Meningo myelocele |               |            |
| Still births                          | 25          | 10           | 14                | 4             | 53<br>(46) |
| Less than a day                       | 20          | 9            | 4                 | 0             | 33<br>(28) |
| Less than a week                      | -           | 5            | 4                 | 1             | 10<br>(9)  |
| 2 - 3months                           | -           | 13           | 5                 | 2             | 20<br>(17) |
| <b>Total</b>                          | <b>45</b>   | <b>37</b>    | <b>27</b>         | <b>7</b>      | <b>116</b> |

Figures in parentheses indicate percentage to total

Among the 116 NTD affected infants, 46 per cent were still born, about 28 per cent and nine per cent of them survived less than a day and a week respectively. Only 17 per cent reported to have survived more than a month but reported to suffer from incontinence, paralysis of legs and Kyphosis (hunchback).

### **PHASE 3**

#### **C. IMPACT OF COUNSELING WOMEN TO PREVENT THE OCCURRENCE OF NTDs**

The results of this phase are discussed relating to the details like socio economic profile, food habits and dietary pattern, nutritional assessment, clinical assessment, biochemical assessment, assessment of nutritional knowledge of the selected women and impact of counseling on the serum folate levels of the 50 selected women.

##### **a) Socio economic profile of the selected subjects**

The socio economic profile of the selected 50 women aspiring for pregnancy is presented in Table XXXI.

Among the selected women, 64 per cent were in the age group of 25-30 years and a majority of 84 per cent were married at an age of 21-25 years. Further, a majority of 62 per cent belonged to joint family system. According to Brewer (2001) lower income denotes the consumption of foods cheaper in quality and low in quantity which causes increased maternal and neonatal complications. In this study, among the women, a majority of 76 per cent belonged to low and middle-income group based on HUDCO (1999) classification. Only 24 per cent had a monthly income above Rs.10,000. Regarding the educational status of the selected 50 women, 42 per cent were post graduates, 20 per cent each were under graduates or studied up to High school level and the remaining 18 per cent had studied up to higher secondary level. Among them, 62 per cent were involved in sedentary work and the remaining were agricultural labourers involved in moderate activity. None of the women was involved in heavy manual labour.

**TABLE XXXI**

**SOCIO ECONOMIC PROFILE OF THE SELECTED WOMEN (N=50)**

| <b>Criteria</b>                | <b>No</b> | <b>Percent</b> |
|--------------------------------|-----------|----------------|
| <b>Age (yrs)</b>               |           |                |
| 20 – 25                        | 18        | 36             |
| 25 – 30                        | 32        | 64             |
| <b>Age at marriage (yrs)</b>   |           |                |
| ≤ 20                           | 7         | 14             |
| 21 – 25                        | 42        | 84             |
| 26 – 30                        | 1         | 2              |
| <b>Type of family</b>          |           |                |
| Nuclear                        | 19        | 38             |
| Joint                          | 31        | 62             |
| <b>Monthly income (in Rs)*</b> |           |                |
| < 5500                         | 11        | 22             |
| 5500 – 10,000                  | 27        | 54             |
| > 10,000                       | 12        | 24             |
| <b>Educational status</b>      |           |                |
| High School                    | 10        | 20             |
| Higher Secondary               | 9         | 18             |
| Under graduates                | 10        | 20             |
| Post graduates                 | 21        | 42             |
| <b>Type of activity</b>        |           |                |
| Sedentary                      | 31        | 62             |
| Moderate                       | 19        | 38             |
| Heavy                          | -         | -              |

\*HUDCO (1999)

## 2) Food habits and dietary pattern of the selected women

### a) Type of diet consumed

The type of diet consumed by the selected women is presented in Table XXXII.

**TABLE XXXII**  
**TYPE OF DIET CONSUMED (N=50)**

| Type of diet   | No | Percent |
|----------------|----|---------|
| Vegetarian     | 5  | 10      |
| Non-vegetarian | 44 | 88      |
| Ovo-vegetarian | 1  | 2       |

Among the selected women, a majority (88 per cent) were non-vegetarians, 10 per cent vegetarians and only two per cent were ovo-vegetarians. Though a majority of them belonged to non-vegetarian category the general frequency of consumption of non-vegetarian foods was once in a week and the amount consumed was very less (to the tune of 100 g only).

### b) Consumption pattern of Folic Acid rich foods

Consumption pattern of folic acid rich foods by the selected women is given in Table XXXIII.

TABLE XXXIII

FOOD CONSUMPTION PATTERN OF FOLIC ACID RICH FOODS BY  
THE SELECTED WOMEN (N=50)

| Food Items                  | Folic*<br>Acid<br>(mcg/<br>100g) | Frequency of consumption (in number) |                |                 |                       |                 |
|-----------------------------|----------------------------------|--------------------------------------|----------------|-----------------|-----------------------|-----------------|
|                             |                                  | Daily                                | Weekly<br>once | Weekly<br>twice | Once<br>in 15<br>days | Once<br>a month |
| <b>Cereals</b>              |                                  |                                      |                |                 |                       |                 |
| Bajra                       | 46                               | -                                    | 2              | 1               | 18                    | 16              |
| Jowar                       | 20                               | -                                    | 2              | 3               | 6                     | 15              |
| Oat meal                    | 34                               | -                                    | 2              | 1               | 1                     | 3               |
| Rice (parboiled)            | 11                               | 50                                   | -              | -               | -                     | -               |
| Wheat flour                 | 36                               | -                                    | 7              | 42              | 1                     | -               |
| <b>Pulses</b>               |                                  |                                      |                |                 |                       |                 |
| Bengal gram dhal            | 148                              | -                                    | 9              | 36              | 5                     | 1               |
| Black gram dhal             | 132                              | -                                    | 31             | 31              | 4                     | -               |
| Cow pea                     | 133                              | -                                    | 3              | 3               | 6                     | 14              |
| Green gram                  | -                                | -                                    | 14             | 14              | 11                    | 2               |
| Green gram dhal             | 140                              | -                                    | 27             | 15              | 5                     | 2               |
| Lentil                      | 136                              | -                                    | 1              | 3               | 1                     | 1               |
| Red gram dhal               | 103                              | -                                    | 14             | 27              | 3                     | 5               |
| Roasted Bengal<br>gram dhal | 139                              | -                                    | 43             | 43              | 5                     | -               |
| Soya bean                   | 100                              | -                                    | 4              | 3               | 5                     | 17              |
| <b>Leafy vegetables</b>     |                                  |                                      |                |                 |                       |                 |
| Amaranth                    | 149                              | -                                    | 24             | 10              | 4                     | 9               |
| Cabbage                     | 23                               | -                                    | 19             | 18              | 9                     | 1               |
| Curry leaves                | 94                               | 50                                   | -              | -               | -                     | -               |
| Mint                        | 114                              | -                                    | 15             | 10              | 18                    | 4               |
| Spinach                     | 123                              | -                                    | 7              | 1               | 5                     | 9               |

| Food Items                    | Folic*<br>Acid<br>(mcg/<br>100g) | Frequency of consumption (in number) |                |                 |                       |                 |
|-------------------------------|----------------------------------|--------------------------------------|----------------|-----------------|-----------------------|-----------------|
|                               |                                  | Daily                                | Weekly<br>once | Weekly<br>twice | Once<br>in 15<br>days | Once<br>a month |
| <b>Roots and Tubers</b>       |                                  |                                      |                |                 |                       |                 |
| Carrot                        | 15                               | -                                    | 20             | 25              | 3                     | -               |
| Colocasia                     | 54                               | -                                    | 4              | 10              | 12                    | 10              |
| Potato                        | 7                                | -                                    | 12             | 22              | 15                    | -               |
| <b>Other vegetables</b>       |                                  |                                      |                |                 |                       |                 |
| Brinjal                       | 34                               | -                                    | 9              | 41              | -                     | -               |
| Cluster beans                 | 144                              | -                                    | 7              | 3               | 16                    | 5               |
| Finger beans                  | 46                               | -                                    | 4              | 4               | 9                     | 3               |
| Ladies finger                 | 105                              | -                                    | 14             | 25              | 3                     | -               |
| Snake gourd                   | 16                               | -                                    | 13             | 16              | 14                    | 6               |
| <b>Nuts and oil seeds</b>     |                                  |                                      |                |                 |                       |                 |
| Coconut fresh                 | 13                               | 35                                   | 10             | -               | 3                     | -               |
| Gingelly seeds                | 134                              | -                                    | 5              | 9               | 7                     | 2               |
| <b>Fruits</b>                 |                                  |                                      |                |                 |                       |                 |
| Orange                        | 54                               | -                                    | 9              | 16              | 13                    | 12              |
| Tomato                        | 30                               | 43                                   | 7              | -               | -                     | -               |
| <b>Meat and Poultry</b>       |                                  |                                      |                |                 |                       |                 |
| Chicken                       | 50                               | -                                    | 24             | 3               | 10                    | 3               |
| Egg (hen)                     | 74                               | -                                    | 10             | 25              | 8                     | -               |
| Egg (duck)                    | 80                               | -                                    | -              | -               | -                     | 2               |
| Liver (goat)                  | 176                              | -                                    | 9              | 2               | 5                     | 3               |
| <b>Milk and Milk products</b> |                                  |                                      |                |                 |                       |                 |
| Buffalo's milk                | 6                                | 3                                    | -              | -               | -                     | -               |
| Cow's milk                    | 9                                | 47                                   | -              | -               | -                     | -               |
| Curd                          | 13                               | 46                                   | -              | -               | -                     | -               |

\* ICMR (2004)

## **Cereals**

Among cereals, rice was the main staple food for almost all the women. However, 42 of them consumed wheat flour twice a week. Majority of the women (18) consumed bajra only once in 15 days and 15 women reported to consume jowar only once in a month. Oat meal was rarely consumed by the women. Only two women reported to consume oat meal weekly once and three women consumed it once in a month.

## **Pulses**

Bengal gram dhal, red gram dhal and roasted bengal gram were consumed twice weekly by 36, 43 and 27 women respectively. Folic acid rich pulses such as soybean, lentils and cow pea were rarely consumed by the selected women.

## **Leafy vegetables**

Among leafy vegetables, curry leaves were consumed by 50 women daily through various preparations. Twenty four women reported to take amaranth weekly once and 19 women took cabbage once a week. Spinach which is rich in folic acid was used weekly once only by seven women and once a month by nine women. This may be due to the lack of awareness about the importance of leafy vegetables.

## **Roots and tubers**

Among roots and tubers, a majority of 25 women included carrot weekly twice in their diet. About 22 women included potato weekly twice in their preparation. Only four women included colocasia once a week.

### **Other vegetables**

Among other vegetables, 25 women took ladies fingers twice in a week. Only about seven and 14 women included cluster beans and snake gourd weekly once respectively. About four women included French beans once in a week and twice a week and nine women once in 15 days. Brinjal was consumed by nine and 41 women weekly once and twice respectively.

### **Nuts and oil seeds**

Fresh coconut was included daily in various preparations by 35 women. Gingelly seed in powder form was consumed by nine women twice weekly.

### **Fruits**

Forty three women consumed tomato daily and 13 women consumed orange only once in 15 days because of its cost.

### **Meat and Poultry**

Chicken was consumed by 24 women once a week. Hen's egg was consumed twice weekly by 25 women. Five subjects consumed goat's liver and only one women reported to consume duck's egg once in 15 days.

### **Milk and milk products**

Forty seven women included cow's milk daily and only three women included buffalo's milk daily. A majority (46 women) included curds daily in their diet.

### **c) Intake of medicinal supplements**

Information regarding medicinal supplements taken by the selected women during periconceptual period is presented in Table XXXIV.

**TABLE XXXIV**  
**MEDICINAL SUPPLEMENTS TAKEN DURING**  
**PERICONCEPTIONAL PERIOD (N = 50)**

| <b>Supplements</b> | <b>No</b> | <b>Percent</b> |
|--------------------|-----------|----------------|
| Multivitamins      | 4         | 8              |
| Iron and folate    | 4         | 8              |
| Folic acid         | 2         | 4              |
| No supplements     | 40        | 80             |
| <b>Total</b>       | <b>50</b> | <b>100</b>     |

A majority, (80 per cent) reported that they did not take any special supplements periconceptionally. Eight per cent of the women consumed multivitamin and folic acid tablets each for a period of three months periconceptionally as per the physician's advice. Only four per cent of the women reported to consume folic acid periconceptionally.

**d) Mean food intake**

The mean food intake of the selected women before and after counseling is given in Table XXXV, Figure 11 and Appendix IX

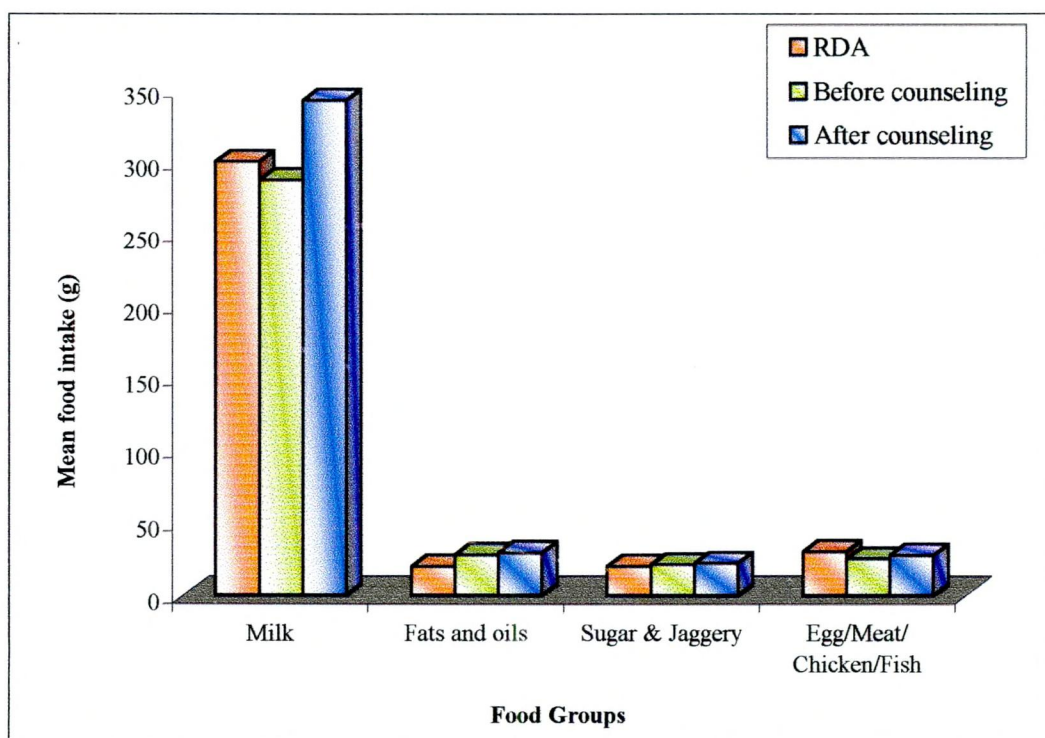
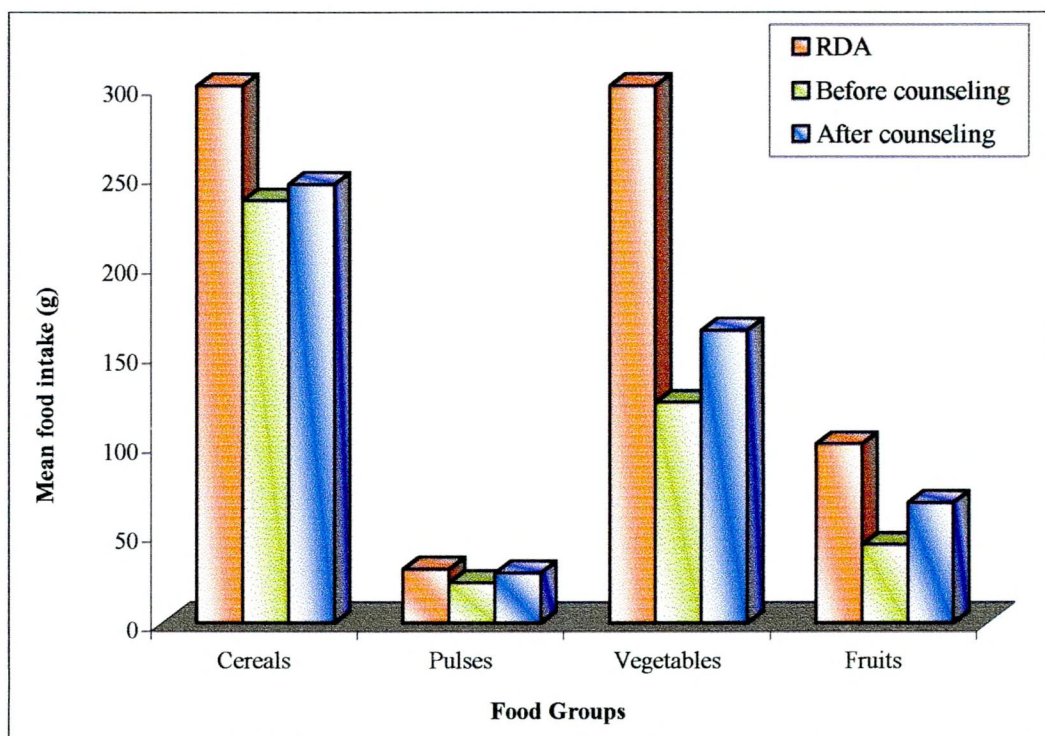
The mean intake of all the foods by the selected women assessed through three day recall survey increased after counseling. However such an increase was statistically significant in the case of vegetables, fruits, pulses and milk. Before and after counseling the consumption of all the foods was found to be lower than the RDA, except for fats and oils and sugar and jaggery. But after counseling, the consumption of milk increased significantly. This shows that continuous counseling and education are important to improve the food intake of the women.

TABLE XXXV

MEAN FOOD INTAKE OF THE SELECTED WOMEN (N=10)

| Foods (in g)          | RDA** | Before counseling |                             | After counseling |                             | t value            |
|-----------------------|-------|-------------------|-----------------------------|------------------|-----------------------------|--------------------|
|                       |       | Mean ± S.D        | Percentage deficit / excess | Mean ± S.D       | Percentage deficit / excess |                    |
| Cereals               | 300   | 235.70 ± 49.39    | -21.43                      | 244.8±60.64      | -18.4                       | 0.33 <sup>NS</sup> |
| Pulses                | 30    | 22.40± 2.87       | -25.33                      | 27.76±5.92       | -7.46                       | 2.52*              |
| Vegetables            | 300   | 123.30±47.2       | -58.9                       | 163.3±34.42      | -45.6                       | 2.06*              |
| Fruits                | 100   | 43.66±25.91       | -56.34                      | 67.06±16.65      | -32.94                      | 2.39*              |
| Milk and its products | 300   | 287.40±38.11      | -4.2                        | 342.00±44.98     | +14.0                       | 2.30*              |
| Fats and oils         | 20    | 27.88±6.360       | +39.4                       | 29.14±8.735      | +45.7                       | 0.58 <sup>NS</sup> |
| Sugar & jaggery       | 20    | 21.09±3.25        | +5.45                       | 21.87±3.286      | +9.35                       | 0.60 <sup>NS</sup> |
| Egg/meat/chicken/fish | 30    | 25.02±3.74        | -16.6                       | 27.52±5.94       | -8.26                       | 0.25 <sup>NS</sup> |

\* Significant at 5 per cent level ; NS - Not Significant; \*\* ICMR.( 2003)



**FOOD INTAKE OF THE SELECTED WOMEN  
BEFORE AND AFTER COUNSELING  
FIGURE 11**

### **e) Mean Nutrient intake**

The mean nutrient intake of the selected women before and after counseling is presented in Table XXXVI, Figure 12 and Appendix X

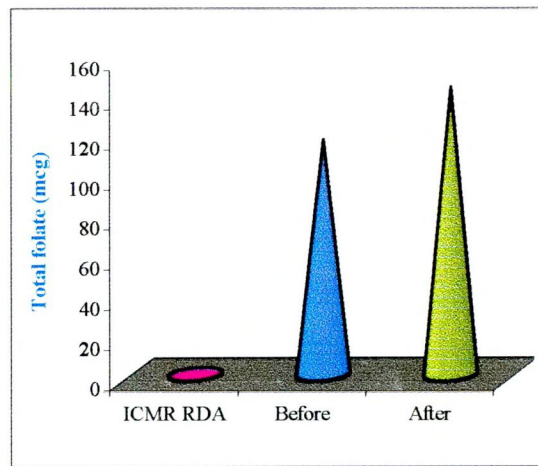
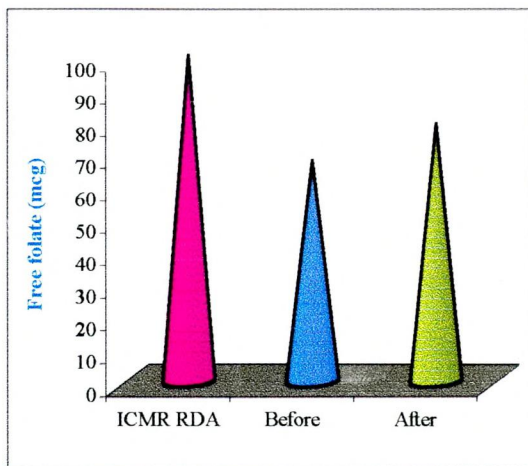
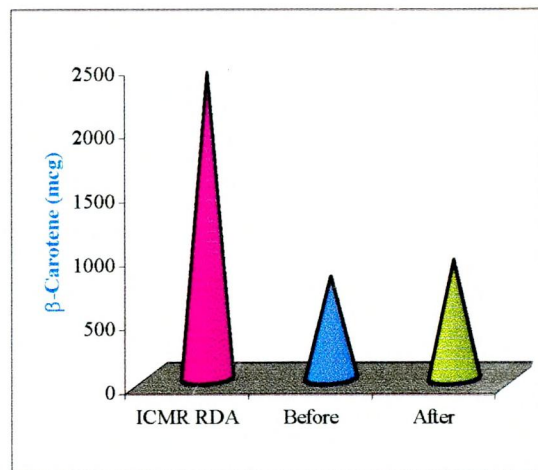
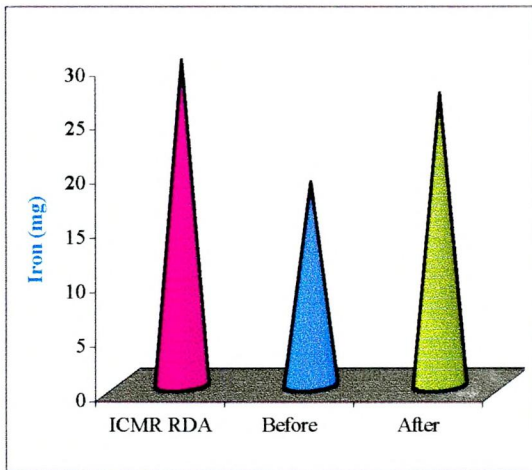
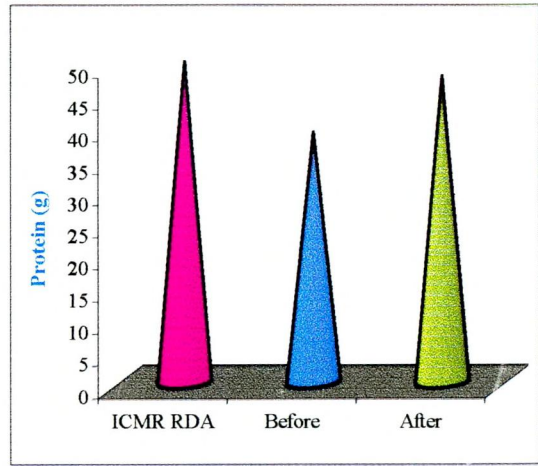
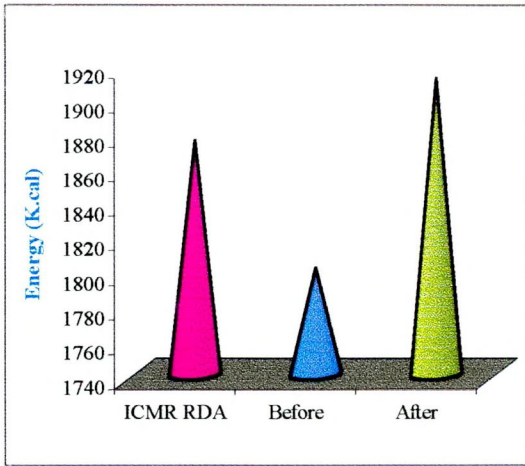
The mean intake of all nutrients by the selected women increased after counseling. The energy consumption by the selected subjects was higher than the RDA only after counseling. All other nutrients such as protein, iron, beta carotene and free folate were inadequately consumed by the women before counseling. However, after counseling the intake increased but the increase was statistically significant only in the case of protein, iron and free folate. This is due to seasonal availability of folic acid rich green leafy vegetables, low purchasing power of non-vegetarian foods, consumption of available foods and vegetables inspite of counseling are the reasons observed and enquired for the relatively poor response to counseling.

**TABLE XXXVI**

**MEAN NUTRIENT INTAKE OF THE SELECTED WOMEN (N=10)**

| Nutrient           | RDA** | Before counseling |                             | After counseling |                             | t value            |
|--------------------|-------|-------------------|-----------------------------|------------------|-----------------------------|--------------------|
|                    |       | Mean ± S.D        | Percentage deficit / excess | Mean ± S.D       | Percentage deficit / excess |                    |
| Energy (K.cal)     | 1875  | 1801 ± 252.3      | -3.94                       | 1911 ± 199.8     | 1.92                        | 4.7*               |
| Protein (g)        | 50    | 38.89 ± 6.12      | -22.2                       | 47.63 ± 8.79     | -4.74                       | 2.78*              |
| Iron (mg)          | 30    | 18.70±10.19       | -37.6                       | 26.93 ± 11.59    | -10.23                      | 5.72*              |
| β - carotene (mcg) | 2400  | 799.5±142.6       | -66.7                       | 929.0 ± 191      | -61.29                      | 1.57 <sup>NS</sup> |
| Free folate (mcg)  | 100   | 67.59±6.179       | -32.41                      | 78.91±19.38      | -21.09                      | 2.38*              |
| Total folate (mcg) | -     | 116.7±15.64       | -                           | 143.1±18.05      | -                           | 3.66*              |

\* Significant at 5 per cent level; NS - Not Significant; \*\*Gopalan *et al.* (2004)



**NUTRITENT INTAKE OF SELECTED WOMEN  
BEFORE AND AFTER COUNSELING  
FIGURE 12**

### 3) Nutritional assessment

#### a) Mean anthropometric measurement

The mean height, weight and BMI of the selected women are given in Table XXXVII and the individual height, weight and BMI are given in Appendix XI.

**TABLE XXXVII**  
**MEAN ANTHROPOMETRIC MEASUREMENTS OF THE**  
**SELECTED WOMEN (N=50)**

| <b>Parameters</b>         | <b>Standard</b> | <b>Mean ± S.D</b> |
|---------------------------|-----------------|-------------------|
| Height (cm)               | -               | 157.24±5.56       |
| Weight (kg)*              | 50              | 54.56±5.93        |
| BMI(kg/m <sup>2</sup> )** | 18.5 - 23       | 21.99±2.23        |

\*ICMR(2002) \*\*Indian Consensus Group(1998)

The mean height of the selected women was 157.24 cm. The mean weight of the selected women was higher than the Indian Reference woman's weight of 50 kg and the mean BMI of the women were within the normal range of 18.5 – 23.

#### b) BMI of the selected women

According to Gopalan *et al* (1989) normal well to-do Indian men and women have a BMI of 18.5-25. The categorization of the 50 selected women based on BMI values is presented in Table XXXVIII.

**TABLE XXXVIII**

**BMI OF THE SELECTED WOMEN (N=50)**

| <b>Classification *</b>              | <b>BMI</b> | <b>No</b> | <b>Percent</b> |
|--------------------------------------|------------|-----------|----------------|
| Chronic Energy Deficiency (Grade II) | 16.0-17.0  | -         | -              |
| Chronic Energy Deficiency (Grade I)  | 17.0-18.5  | 4         | 8              |
| Low Normal                           | 18.5-20.0  | 7         | 14             |
| Normal                               | 20.0-25.0  | 36        | 72             |
| Obesity (Grade I)                    | 25.0-30.0  | 3         | 6              |
| <b>Total</b>                         |            | <b>50</b> | <b>100</b>     |

\*NNMB (2002)

About 72 per cent of the selected women had normal BMI, however eight per cent were in grade I Chronic Energy Deficiency (mild), 14 per cent were in low weight category and six per cent were categorized under grade I obesity. Obesity has been linked to increase NTD rates ( Kallen, 1998 and Shaw *et al* 1996). But in the present study only six per cent were in grade I obesity category.

**4) Clinical assessment**

The clinical signs and symptoms found among the selected women are given in Table XXXIX.

The clinical examination of the selected women revealed that 86 per cent of the women expressed general weakness and 62 and 44 per cent of the women had pale nail buds and conjunctiva respectively. About 38 per cent had dental caries and 32 per cent had glossitis. Other clinical symptoms found were bleeding gums (26 %), angular stomatitis (20 %) and poor musculature (24 %). Clinical symptoms like burning feet (32%) numbness (40%) and pins and needles (32%) might indicate a deficiency of B complex vitamins. Greater prevalence of general weakness could be due to mild or moderate anaemia which needs to be substantiated with blood hemoglobin values.

## 5) Biochemical assessment of the selected women

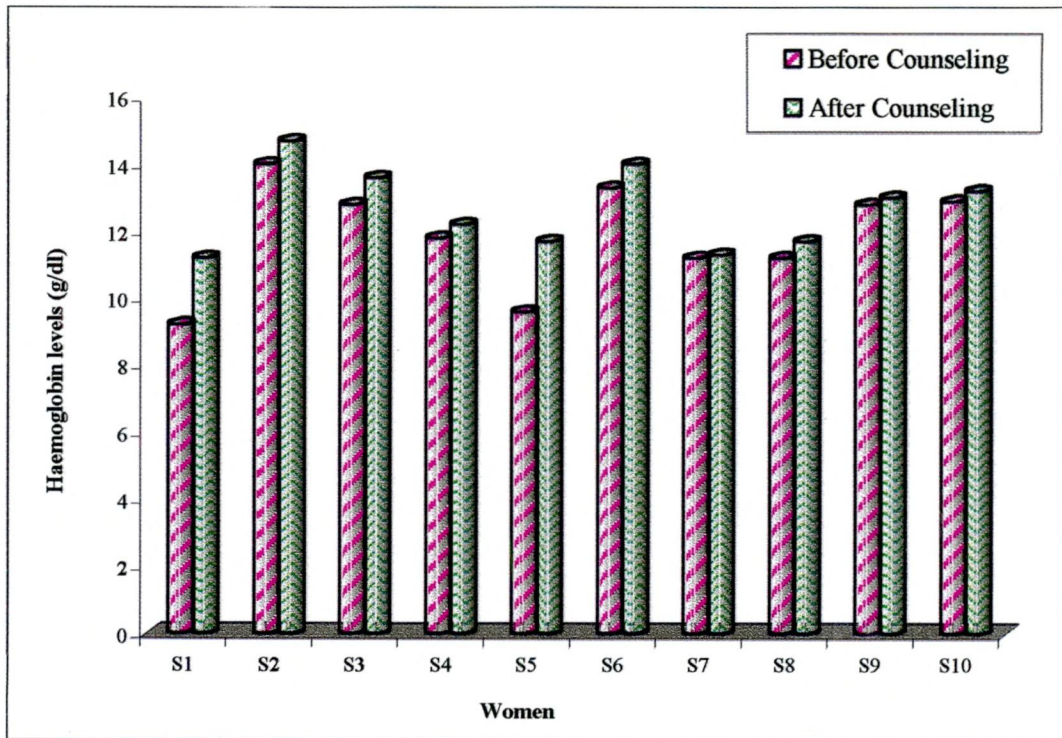
### a) Haemoglobin levels

Table XL and Figure 13 and 14 give the haemoglobin levels and the classification of women based on haemoglobin levels according to WHO classification both before and after counseling and the individual haemoglobin levels of the women are given in Appendix XII.

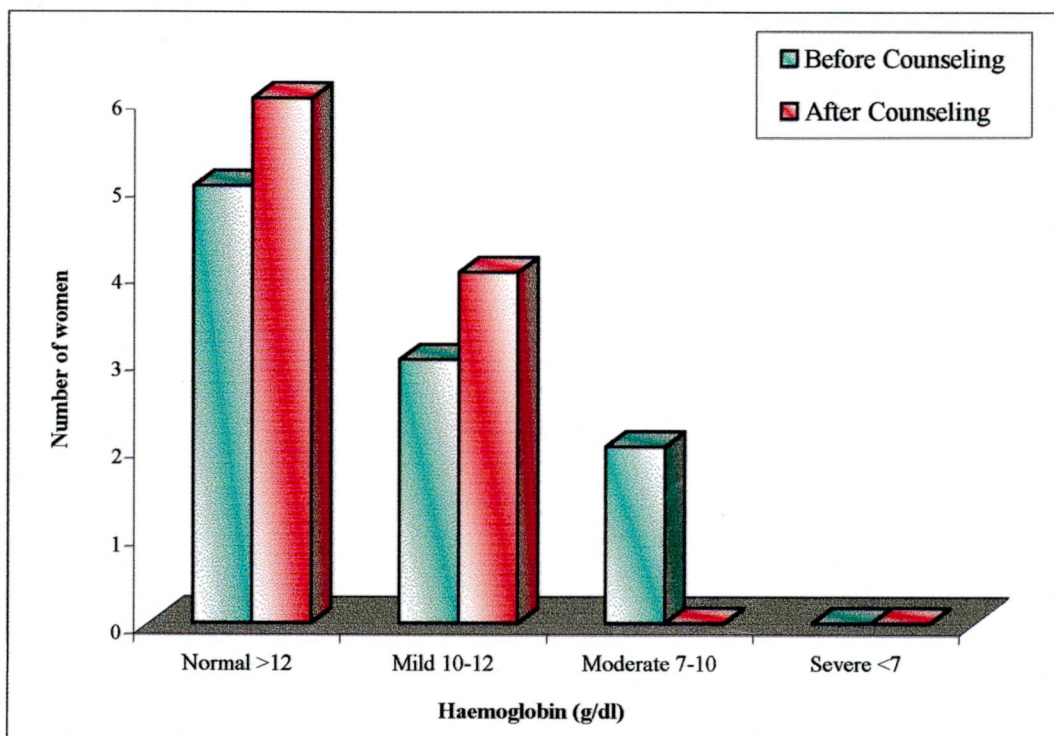
**TABLE XL**  
**MEAN HAEMOGLOBIN LEVELS OF THE SELECTED WOMEN (N=10)**

| <b>Anaemia (g/dl)*</b> | <b>Before counseling</b> | <b>After counseling</b> | <b>t value</b> |
|------------------------|--------------------------|-------------------------|----------------|
| Normal (> 12)          | 5                        | 6                       | 3.49**         |
| Mild (10 – 12)         | 3                        | 4                       |                |
| Moderate (7 -10)       | 2                        | -                       |                |
| Severe(< 7)            | -                        | -                       |                |
| <b>Mean ± S.D</b>      | <b>11.88 ± 1.583</b>     | <b>12.66 ± 1.215</b>    |                |

\* WHO (1989); \*\* Significant at 5 per cent level



**IMPACT OF COUNSELING ON THE HAEMOGLOBIN LEVELS OF THE SELECTED WOMEN**  
**FIGURE 13**



**HAEMOGLOBIN LEVELS OF THE SELECTED WOMEN BASED ON WHO CLASSIFICATION**  
**FIGURE 14**

Nearly 5 of the selected women had normal haemoglobin levels and 3 and 2 women were categorised under mild and moderate anemia respectively before counseling. Clinical symptoms of general weakness found among 86 per cent of women are supported by the haemoglobin levels as mild and moderate anaemia. However after counseling the haemoglobin levels of women improved and no one was in moderate category. Further, the mean haemoglobin levels of the selected women increased after counseling. Statistical analysis before and after counseling revealed that the differences were significant at five per cent level.

#### b) Serum folate levels

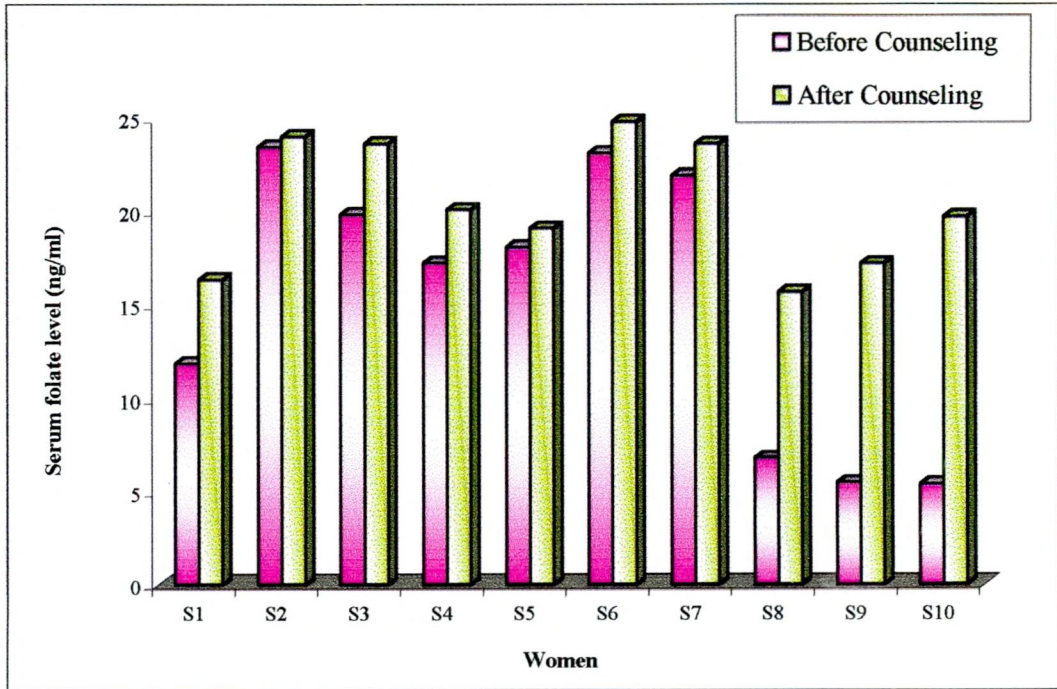
Serum folate levels of the selected women before and after counseling are given in Table XLI. Figures 15 and 16 give the serum folate levels and the classification of women based on serum folate levels before and after counseling. The individual folate levels of the women are given in Appendix XII.

**TABLE XLI**

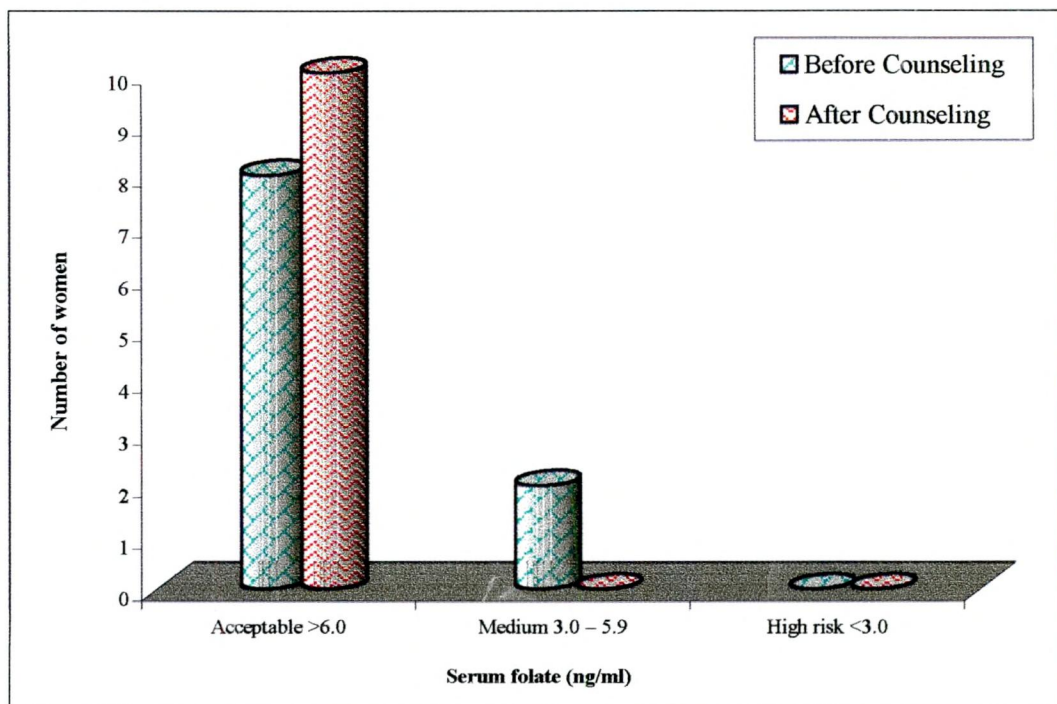
**MEAN SERUM FOLATE LEVELS OF THE SELECTED WOMEN (N=10)**

| <b>Serum folate levels<br/>(ng/ml)*</b> | <b>Before<br/>counseling</b> | <b>After<br/>counseling</b> | <b>t<br/>value</b> |
|---|------------------------------|-----------------------------|--------------------|
| Acceptable (>6.0)                       | 8                            | 10                          | 3.34**             |
| Medium (3.0 -5.9)                       | 2                            | -                           |                    |
| High Risk (<3.0)                        | -                            | -                           |                    |
| <b>Mean ± S.D</b>                       | <b>15.32 ± 7.31</b>          | <b>20.42 ± 3.40</b>         |                    |
| <b>Median ± S.D</b>                     | <b>17.65 ± 7.31</b>          | <b>19.90 ± 3.40</b>         |                    |
| <b>Range</b>                            | <b>5.40 – 23.45</b>          | <b>15.70 – 24.8</b>         |                    |

\* Bamji (2003); \*\*Significant at 5 per cent level



**IMPACT OF COUNSELING ON THE SERUM FOLATE LEVELS OF THE SELECTED WOMEN**  
**FIGURE 15**



**SERUM FOLATE LEVELS OF THE SELECTED WOMEN**  
**FIGURE 16**

It is evident from Table XLI that 2 of the selected women were in the medium risk group and the remaining had acceptable levels of serum folate before counseling. All the selected women had acceptable levels after counseling. This increase is statistically significant at five per cent level. The results obtained from this study are comparable with the results of DeWeerd *et al* (2002). The median serum folate level before counseling was  $17.65 \pm 7.31$  ng/ml and it increased to  $19.90 \pm 3.40$  ng/ml, three months after counseling. The range of the serum folate level before counseling was found to be 5.40 to 23.45 ng/ml and after counseling it was 15.70 to 24.8 ng/ml.

Statistical analysis of haemoglobin level and serum folate level of the selected women indicated that counseling women during periconceptional period will help remarkably in raising the levels of these nutrients, which probably bring out a successful pregnancy outcome.

### c) Nutrient intake Vs Biochemical levels-correlation analysis

The association of specific nutrient intake and biochemical levels has been analysed by correlation analysis and presented in Table XLII.

**TABLE XLII**  
**CORRELATION COEFFICIENT VALUES BETWEEN SPECIFIC**  
**NUTRIENT INTAKES AND BIOCHEMICAL LEVELS (N=10)**

| Parameters                           | Correlation value   |                     |
|--------------------------------------|---------------------|---------------------|
|                                      | Before Counseling   | After Counseling    |
| Iron intake Vs Haemoglobin levels    | 0.271 <sup>NS</sup> | 0.356 <sup>NS</sup> |
| Folate intake Vs Serum folate levels | 0.199 <sup>NS</sup> | 0.222 <sup>NS</sup> |

NS – Not Significant

The results of the analysis showed that there was a positive correlation between iron intake and haemoglobin levels and dietary folate intake and serum folate levels before and after counseling, which was not significant.

#### 6) Nutritional knowledge of the selected women

The level of knowledge on folic acid of the selected women and its significance before and after counseling is given in Table XLIII and the individual knowledge scores are given in Appendix XIII.

**TABLE XLIII**  
**NUTRITIONAL KNOWLEDGE SCORES OF THE**  
**SELECTED WOMEN (N=50)**

(Maximum scores -100)

| Knowledge Level (%)*    | Before counseling |         | After counseling |         |
|-------------------------|-------------------|---------|------------------|---------|
|                         | No                | Percent | No               | Percent |
| Low (0 - 33 scores)     | 25                | 50      | -                | -       |
| Medium (34 - 66 scores) | 23                | 46      | -                | -       |
| High (67 - 100 scores)  | 2                 | 4       | 50               | 100     |

\* Kumar *et al* (2004)

Before counseling, about 50 per cent of the women had low baseline knowledge, 46 per cent had medium level of knowledge and only four per cent had high level of knowledge on folic acid. However after counseling knowledge scores of all the women improved and were found to be more than 67 per cent.

## **PHASE 4**

### **D. EVALUATION OF THE EFFICACY OF PERICONCEPTIONAL SUPPLEMENTATION OF FOLATE ALONE AS WELL AS IN COMBINATION WITH MULTIVITAMIN OR IRON IN PREVENTING THE RECURRENCE OF NTDs**

The results of this phase are discussed regarding the parameters such as socio economic profile, obstetric history, food habits, dietary pattern, food and nutrient intake before and after counseling, supplementation and evaluation of the impact of supplementation on pregnancy outcomes of the selected women of the experimental groups.

#### **1) Socio economic profile and obstetric history**

##### **a) Demographic profile**

The experimental groups were first enquired about the demographic details which might have some influence on the onset of NTDs. The demographic details of the 30 selected women are presented in Table XLIV.

Among the experimental groups, majority of the women in group A and B (7 and 9 respectively) were in the age group of 20-25 years and about 6 women in group C belonged to 26-30 years of age. Marital age of the experimental groups revealed that 6 and 8 women in groups A and C respectively were married during 21-25 years whereas in group B, 7 women were married at less than 20 years of their age. Adoption of joint family system was common among all the three groups and a family size more than four members were common. Regarding educational status, 5 women in all the three groups had studied up to secondary school level and only minority of the women had studied up to higher education.

**TABLE XLIV**  
**DEMOGRAPHIC DETAILS OF THE EXPERIMENTAL GROUPS (N=30)**

| Criteria                          | Group A  | Group B  | Group C  |
|-----------------------------------|----------|----------|----------|
|                                   | (N = 10) | (N = 10) | (N = 10) |
| <b>Present age (yrs)</b>          |          |          |          |
| 20-25                             | 7        | 9        | 4        |
| 26-30                             | 3        | 1        | 6        |
| <b>Age at marriage (yrs)</b>      |          |          |          |
| ≤ 20                              | 4        | 7        | 2        |
| 21-25                             | 6        | 3        | 8        |
| 26-30                             | -        | -        | -        |
| <b>Type of family</b>             |          |          |          |
| Joint                             | 9        | 6        | 7        |
| Nuclear                           | 1        | 4        | 3        |
| <b>Family size</b>                |          |          |          |
| 2 members                         | 1        | 4        | 3        |
| 3 members                         | -        | -        | -        |
| 4 members                         | 1        | -        | 2        |
| ≥ 5                               | 8        | 6        | 5        |
| <b>Educational status</b>         |          |          |          |
| Primary school                    | 1        | 1        | -        |
| Secondary school                  | 4        | 4        | 5        |
| Higher secondary school           | 4        | 3        | 1        |
| Undergraduate                     | 1        | 2        | 3        |
| Postgraduate                      | -        | -        | 1        |
| <b>Family income (per month)*</b> |          |          |          |
| < Rs.5500                         | 6        | 2        | 1        |
| Rs. 5500-Rs.10,000                | 4        | 8        | 9        |
| > Rs.10,000                       | -        | -        | -        |

\*HUDCO Classification (1999); Group A-folic acid alone; Group B –folic acid and multi–vitamin; Group C - folic acid and iron

Based on HUDCO classification 8 and 9 women in group B and group C respectively, belonged to middle income group and 6 women in group A belonged to low income group. None of the women in all the three groups were found to be in high income group. Various studies have suggested that NTD risk is higher among families of low socio economic status, although other studies failed to support this (Vrijheid *et al* 2000 and Wasserman *et al* 1998).

#### **b) Obstetric history**

The obstetric history regarding NTD pregnancy of the experimental groups is presented and discussed in the following pages.

#### **i) Consanguinity**

Consanguinity among the experimental groups is presented in Table XLV.

**TABLE XLV**

#### **CONSANGUINITY AMONG THE EXPERIMENTAL GROUPS (N=30)**

| <b>Consanguinity</b>           | <b>Group A</b> | <b>Group B</b> | <b>Group C</b> |
|--------------------------------|----------------|----------------|----------------|
| <b>Consanguineous marriage</b> |                |                |                |
| Uncle / Niece                  | 2              | 1              | 1              |
| First cousin                   | 1              | 2              | -              |
| Beyond first cousin            | 1              | -              | 1              |
| Non consanguineous marriage    | 6              | 7              | 8              |
| <b>Total</b>                   | <b>10</b>      | <b>10</b>      | <b>10</b>      |

Group A-folic acid alone ; Group B-folic acid and multi-vitamin; Group C-folic acid and iron

It is evident from the table that majority of the women in all the three groups had non-consanguineous marriage. However, 4 women in group A, 3 women in group B and 2 women in group C had consanguineous marriage with uncle, first cousin and beyond first cousin etc. With respect to consanguinity, NTD rates have been found to be higher when the parents are related to each other (Little and Elwood, 1991), although not all studies identified this association (Rittler *et al* 2001 and Stoltenberg *et al* 1997). Consanguinity is a relatively common feature of some societies in Asia and elsewhere, but in Western population it is low. For women who previously have had a NTD affected infant, the risk for having another is 1-3 per cent or 10-30 times the risk among the general population (MRC, 1991).

**ii) Information regarding NTD pregnancy**

Table XLVI shows the information regarding NTD pregnancy of the selected women of the three groups.

**TABLE XLVI**  
**INFORMATION REGARDING NTD AFFECTED PREGNANCY**

| Particulars                       | Group A | Group B | Group C |
|-----------------------------------|---------|---------|---------|
| <b>Age during first pregnancy</b> |         |         |         |
| ≤ 20 yrs                          | 3       | 5       | 1       |
| 21-23 yrs                         | 3       | 3       | 3       |
| 24-26 yrs                         | 4       | 2       | 6       |
| <b>Parity</b>                     |         |         |         |
| I                                 | 7       | 9       | 8       |
| II                                | 3       | 1       | 2       |
| III                               | -       | -       | -       |
| <b>Type of birth</b>              |         |         |         |
| Alive at birth                    | -       | -       | 1       |
| Still birth                       | -       | -       | -       |
| Spontaneous abortion              | 3       | 1       | 1       |
| <b>Birth spacing</b>              |         |         |         |
| < 1 yr                            | 1       | -       | 1       |
| 1 yr                              | 2       | -       | -       |
| 2 yrs                             | -       | 1       | 1       |

Group A-folic acid alone ; Group B-folic acid and multi-vitamin; Group C-folic acid and iron

Four women in groups A and 6 women in group B had their first pregnancy at the age of 24-26 years. In group B, majority of the women (5) had their first pregnancy at the age of 20 years. However 3 women in all the three groups had their first pregnancy at the age of 21-23 years. The parity of NTD affected infant revealed that more NTD occurrence was noted among lower parity. Parity has shown either U-shaped pattern of NTD risk, i.e, risk being higher for the lowest and highest number of births (Little and Elwood, 1991 and Campell *et al* 1986).

Among the women with second parity, one in group C had live birth and no still births were reported. However, three women each in group A and one in group B and C had spontaneous abortion. Regarding birth spacing among women who had second parity, one in group A and C had less than one year of birth spacing and two in group A had birth spacing of one year and one each in group B and C had a birth spacing of two years respectively.

### **iii) Type of NTDs**

Table XLVII and Plate 9 present the type of NTDs prevalent in the experimental groups.

It is observed that anencephaly was the most common type of NTD in group A (6 women) followed by meningocele (1 woman) and meningomyelocele (3 women). In group B, anencephaly was noticed in 4 women followed by meningocele (3 women), meningomyelocele (2 women) and one had combined defects of encephalocele and hydrocephalus. However in group C, four meningocele cases followed by anencephaly (2 cases) and meningomyelocele (1 case) were seen. The remaining three cases in group C had combined defects. Among the experimental groups, the most common type of NTDs in group A and B was anencephaly and in group C it was meningocele.

**TABLE XLVII****TYPE OF NTDs PREVALENT IN THE EXPERIMENTAL GROUPS (N=30)**

| Type of NTDs                               | Group A   | Group B   | Group C   |
|--|-----------|-----------|-----------|
|  | (N = 10)  | (N = 10)  | (N = 10)  |
| <b>Anencephaly</b>                         | 6         | 4         | 2         |
| <b>Spina bifida</b>                        |           |           |           |
| Meningocele                                | 1         | 3         | 4         |
| Meningomyelocele                           | 3         | 2         | 1         |
| <b>Encephalocele</b>                       | -         | -         | 1         |
| Encephalocele hydrocephalus                | -         | 1         | 1         |
| <b>Meningomyelocele with hydrocephalus</b> | -         | -         | 2         |
| <b>Total</b>                               | <b>10</b> | <b>10</b> | <b>10</b> |

Group A-folic acid alone; Group B-folic acid and multi-vitamin;

Group C-folic acid and iron

**iv) Period of survival of NTD affected infants**

Only four women in group A, three women in group B and four in group C had full term delivery. This was due to the late identification of the defect and lack of awareness among the women. The period of survival of NTD affected infants after delivery is presented in Table XLVIII.



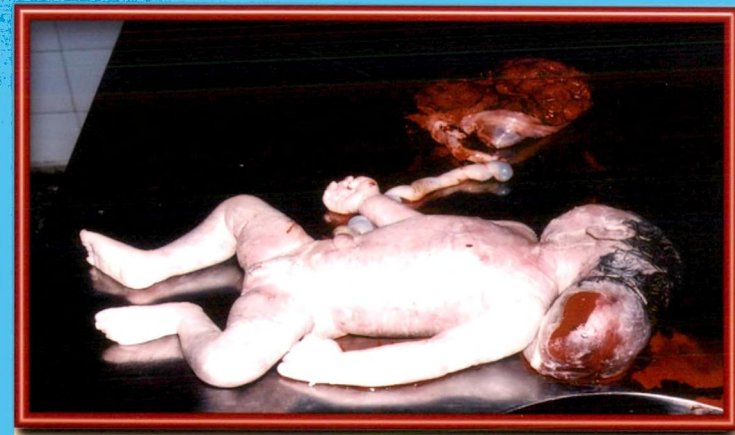
**ANENCEPHALY**



**MENINGOCELE**



**MENINGOMYELOCELE**



**ENCEPHALOCELE**

**TYPE OF NTDs  
PLATE - 9**

**TABLE XLVIII**

**PERIOD OF SURVIVAL OF THE NTD AFFECTED INFANTS IN THE  
EXPERIMENTAL GROUPS (N=11)**

| <b>Period of survival</b> | <b>Group A</b>  | <b>Group B</b>  | <b>Group C</b>  |
|---------------------------|-----------------|-----------------|-----------------|
|                           | <b>(N = 10)</b> | <b>(N = 10)</b> | <b>(N = 10)</b> |
| Still born                | 1               | 1               | -               |
| < 24 hours                | 2               | 1               | -               |
| 1 day                     | 1               | -               | -               |
| 2 day                     | -               | -               | 2               |
| < 7 days                  | -               | 1               | 2               |
| <b>Total</b>              | <b>4</b>        | <b>3</b>        | <b>4</b>        |

Group A-folic acid alone; Group B –folic acid and multi-vitamin;  
Group C -folic acid and iron

It is inferred from the table that one newborn each in group A and B respectively survived less than 24 hours, one in group A survived for one day, two in group C survived for two days and one in group B and two in group C survived for more than two days. It is observed that majority of the full term NTD children survived only less than one week.

**v) Physiological problems**

The type of physiological problems faced by the experimental groups during NTD affected pregnancy is presented in Table XLIX.

**TABLE XLIX**  
**PHYSIOLOGICAL PROBLEMS FACED BY THE EXPERIMENTAL**  
**GROUPS WITH NTDs (N=30)**

| Physiological problems*  | Group A  | Group B  | Group C  |
|--------------------------|----------|----------|----------|
|                          | (N = 10) | (N = 10) | (N = 10) |
| Vomiting and nausea      | 7        | 6        | 5        |
| Giddiness                | 1        | 2        | 3        |
| Loss of appetite         | 1        | 3        | 1        |
| Aversion to certain food | 1        | 2        | -        |
| Odema                    | -        | -        | 2        |
| Albuminuria              | -        | -        | 1        |
| Fever                    | 3        | 2        | -        |
| Frequent urination       | 1        | 1        | -        |
| Disturbed sleep          | 2        | -        | -        |
| Diabetes mellitus        | 2        | -        | 1        |
| Low blood pressure       | -        | 1        | -        |

Group A-folic acid alone; Group B-folic acid and multi-vitamin;  
 Group C- folic acid and iron; \*Multiple response

In the present study the most common physiological problems faced by mothers of the experimental groups with NTD included vomiting and nausea, giddiness and loss of appetite. Few mothers also reported that they suffered from fever and diabetes mellitus. Fever has been linked to increased risk of NTDs (Shaw *et al* 1998 and Lynberg *et al* 1994). Maternal diabetes has been associated with increased risk of NTDs (Shaw *et al* 2003).

## vi) Psychological Problems

Table L presents the psychological problems faced by the experimental groups during NTD affected pregnancy.

**TABLE L**  
**PSYCHOLOGICAL PROBLEMS FACED BY THE EXPERIMENTAL**  
**GROUPS WITH NTDs**

| Psychological problems                            | Group A  | Group B  | Group C  |
|---|----------|----------|----------|
|   | (N = 10) | (N = 10) | (N = 10) |
| Maternal concern about the well being of the baby | 3        | 2        | 1        |
| Lack of family support                            | -        | 1        | -        |
| Recent adverse events                             | 2        | -        | 1        |
| Marital difficulties                              | 1        | -        | 2        |
| Financial problems                                | 1        | 1        | 1        |

Group A-folic acid alone; Group B-folic acid and multi-vitamin;  
Group C - folic acid and iron

Maternal psychological or emotional stress during pregnancy may increase the risk of having infant with NTD (Carmichael and Shaw, 2000). It is evident from the table that the most common psychological problems expressed by the mothers with NTD pregnancy included maternal concern about the well being of the baby, recent adverse events and financial problems.

## vii) Time of identification and termination of NTD affected pregnancy

The time of identification and termination of the NTD affected pregnancy by the experimental groups are presented in Table LI.

**TABLE LI**

**TIME OF IDENTIFICATION AND TERMINATION OF NTD AFFECTED PREGNANCY BY THE EXPERIMENTAL GROUPS (N=30)**

| <b>Weeks of gestation</b> | <b>Time of Identification</b> |                |                | <b>Time of Termination</b> |                |                |
|---------------------------|-------------------------------|----------------|----------------|----------------------------|----------------|----------------|
|                           | <b>Group A</b>                | <b>Group B</b> | <b>Group C</b> | <b>Group A</b>             | <b>Group B</b> | <b>Group C</b> |
| 20 – 24                   | 6                             | 4              | 1              | 5                          | 4              | 1              |
| 25 – 29                   | 1                             | 2              | 2              | 1                          | 2              | 2              |
| 30 – 34                   | 1                             | 4              | 3              | 1                          | 4              | 3              |
| 35 – 39                   | 2                             | -              | 4              | 3                          | -              | 4              |
| <b>Total</b>              | <b>10</b>                     | <b>10</b>      | <b>10</b>      | <b>10</b>                  | <b>10</b>      | <b>10</b>      |

Group A-folic acid alone; Group B-folic acid and multi –vitamin;  
Group C -folic acid and iron

Nearly six women in group A and four women in group B first identified the defect during 20-24 weeks of gestation, whereas in group C, four women identified the defects only after 35 weeks of gestation. Regarding termination of NTD affected pregnancy, all the women had medically terminated their pregnancy soon after identification except two women in group A, who had continued the pregnancy until 37 weeks of gestation with the belief that the pregnancy was normal, but the result was negative.

**viii) Time and type of supplements taken by the selected women**

The time and type of supplements taken by the experimental groups are presented in Table LII.

**TABLE LII**  
**TIME AND TYPE OF SUPPLEMENTS TAKEN BY THE**  
**EXPERIMENTAL GROUPS (N=30)**

| Details                              | Group A  | Group B  | Group C  |
|--------------------------------------|----------|----------|----------|
|                                      | (N = 10) | (N = 10) | (N = 10) |
| <b>Time of intake of supplements</b> |          |          |          |
| Before conception                    | -        | -        | -        |
| After conception                     |          |          |          |
| I trimester                          | 3        | 3        | 1        |
| II trimester                         | 7        | 5        | 4        |
| III trimester                        | -        | -        | -        |
| No supplements                       | -        | 2        | 5        |
| <b>Type of supplements</b>           |          |          |          |
| Multivitamin                         | 3        | 1        | -        |
| Iron                                 | 2        | -        | 1        |
| Folate                               | 1        | 2        | 1        |
| Folate and iron                      | 1        | 1        | 1        |
| Iron and Multivitamin                | 2        | 4        | 2        |
| Vitamins and zinc                    | 1        | -        | -        |

Group A-folic acid alone; Group B-folic acid and multi-vitamin;  
Group C -folic acid and iron

Two women in group B and 5 women in group C did not take any supplements due to excessive vomiting and lack of awareness. Among the women who had taken supplements, none of them had consumed the supplements preconceptionally. Nearly 7 women in group A and 5 women in group B and 4 women in group C took the supplements only from second trimester onwards. Maternal periconceptional use of folic acid has been found

to reduce the risk of both recurrent and occurrent NTDs (Locksmith and Diff, 1998; Watkins, 1998 and Czeizel *et al* 1996).

Majority of the women in group B (5) and group C (4) reported that they had consumed a combination of iron and multivitamin tablets and 3 women in group A had taken multivitamin tablets alone. The remaining women in the three groups reported to have consumed iron, folate, and iron and folate tablets as supplements during pregnancy.

#### ix) Outcome and cost of pregnancy

Outcome and cost during NTD affected pregnancies are presented in Table LIII.

**TABLE LIII**  
**OUTCOME AND COST OF PREGNANCY AMONG THE**  
**EXPERIMENTAL GROUPS (N=30)**

| Outcome of pregnancy           | Group A  | Group B  | Group C  |
|--------------------------------|----------|----------|----------|
|                                | (N = 10) | (N = 10) | (N = 10) |
| <b>Mode of delivery</b>        |          |          |          |
| Medical termination            | 6        | 6        | 5        |
| Normal                         | 1        | 1        | 1        |
| Caesarean                      | 3        | 3        | 4        |
| <b>Cost of pregnancy (Rs)*</b> |          |          |          |
| < 5000                         | 2        | -        | -        |
| 5001-10,000                    | 4        | 7        | 8        |
| > 10,000                       | 4        | 3        | 2        |

Group A-folic acid alone; Group B-folic acid and multi-vitamin;

Group C -folic acid and iron

Among the selected experimental women majority of them had undergone medical termination of their NTD pregnancy in all the three groups. Three women in group A and group B and 4 subjects in group C had caesarean delivery. However one women in each of the three groups had delivered NTD affected infants normally. Regarding medical expenses incurred by the experimental groups, majority of the women (19) had spent Rs. 5,001-Rs. 10,000 as cost of pregnancy. Some of them (9) spent more than Rs. 10,000 towards pregnancy.

**x) Sex of the NTD affected infants**

Table LIV presents the sex of the NTD affected infants.

**TABLE LIV**  
**SEX OF THE NTD AFFECTED INFANTS OF THE EXPERIMENTAL**  
**GROUPS (N=10)**

| Type of NTD      | Group A  |          | Group B  |          | Group C  |          |
|------------------|----------|----------|----------|----------|----------|----------|
|                  | M        | F        | M        | F        | M        | F        |
| Anencephaly      | 3        | 3        | 1        | 3        | -        | 2        |
| Meningocele      | -        | 1        | -        | 3        | 1        | 3        |
| Meningomyelocele | 2        | 1        | -        | 3        | 1        | 3        |
| Encephalocele    | -        | -        | 1        | -        | 1        | -        |
| <b>Total</b>     | <b>5</b> | <b>5</b> | <b>2</b> | <b>8</b> | <b>3</b> | <b>7</b> |

Group A-folic acid alone; Group B-folic acid and multi-vitamin;

Group C -folic acid and iron

Greater number of female infants were affected by NTDs compared to male infants in experimental groups B and C. This preponderance of females affected with NTDs was more than males as reported by Lary and Paulozzi (2001) and Forrester and Merz (2000).

**xi) Biometrics of the NTD affected fetuses**

The biometrics of the NTD affected fetuses of the experimental group from the sonogram report is presented in Table LV.

**TABLE LV**  
**MEAN BIOMETRICS OF THE NTD AFFECTED FOETUSES OF THE**  
**EXPERIMENTAL GROUPS (N=30)**

| <b>Weeks of Gestation</b>      | <b>Standard (mm) *</b> | <b>N</b> | <b>Group A</b> | <b>N</b> | <b>Group B</b> | <b>N</b> | <b>Group C</b> |
|--------------------------------|------------------------|----------|----------------|----------|----------------|----------|----------------|
| <b>Bi Parietal Diameter</b>    |                        |          |                |          |                |          |                |
| 20-24                          | 56.0                   | 5        | 37.88±4.32     | 4        | 44.6±10.55     | 1        | 54.0±0         |
| 25-29                          | 69.8                   | 1        | 72.3±0         | 2        | 47.6±1.98      | 2        | 44.25±18.17    |
| 30-34                          | 80.8                   | 1        | 83.4±0         | 4        | 78.95±6.34     | 3        | 75.8±3.50      |
| 35-39                          | 88.6                   | 3        | 76.63±17.3     | -        | -              | 4        | 77.97±16.38    |
| <b>Head Circumference</b>      |                        |          |                |          |                |          |                |
| 20-24                          | 202.0                  | 5        | 141.48±7.29    | 4        | 161.5±39.07    | 1        | 210±0          |
| 25-29                          | 251.4                  | 1        | 260.3±0        | 2        | 142.65±16.48   | 2        | 168.05±59.33   |
| 30-34                          | 288.0                  | 1        | 303.2±0        | 4        | 282.45±21.14   | 3        | 269.7±17.94    |
| 35-39                          | 312.8                  | 3        | 273.7±72.4     | -        | -              | 4        | 279.2±59.74    |
| <b>Abdominal Circumference</b> |                        |          |                |          |                |          |                |
| 20-24                          | 183.8                  | 5        | 190.1±21.4     | 4        | 178.5±10.7     | 1        | 187±0          |
| 25-29                          | 233.8                  | 1        | 242.2±0        | 2        | 232.55±1.63    | 2        | 206.9±50.77    |
| 30-34                          | 277.6                  | 1        | 296.0±0        | 4        | 274.72±20.7    | 3        | 232.46±36.26   |
| 35-39                          | 314.4                  | 3        | 306.16±12      | -        | -              | 4        | 300.77±1.97    |
| <b>Femur length</b>            |                        |          |                |          |                |          |                |
| 20-24                          | 39.0                   | 5        | 42.66±3.84     | 4        | 36.47±2.78     | 1        | 45.0±0         |
| 25-29                          | 51.6                   | 1        | 53.6±0         | 2        | 54.85±4.31     | 2        | 49.85±6.01     |
| 30-34                          | 62.0                   | 1        | 66.5±0         | 4        | 62.77±4.03     | 3        | 59.4±1.97      |
| 35-39                          | 85.0                   | 3        | 65.63±22.33    | -        | -              | 4        | 66.13±2.30     |

**\* Mediscan Prenatal Diagnosis and Foetal Therapy Centre, Chennai.**

Group A-folic acid alone; Group B-folic acid and multi-vitamin;

Group C -folic acid and iron

In group A, except one foetus in 25-29 weeks and 30-34 weeks of gestation, the foetal biometrics like Bi Parietal Diameter (BPD), Head Circumference (HC), Abdominal Circumference (AC) and Femur Length (FL) were below the standard. In group B, only two foetuses between 25-29 weeks and four foetuses between 30-34 weeks had FL above the standard. In group C except one foetus between 20-24 weeks of gestation, all the other foetal biometrics were below the standard. It is evident from the table that majority of the foetuses had foetal biometrics below the standard value framed and prescribed by the Mediscan prenatal diagnosis and foetal therapy center, Chennai.

## **2) Information regarding current pregnancy**

Particulars regarding current pregnancy such as consumption pattern, food and nutrient intake, anthropometric measurement and nutritional knowledge of the experimental groups are discussed in the following pages.

### **a) Consumption pattern of folic acid rich foods**

Rice was the main staple food of all the women. Next to rice, wheat was consumed weekly once by a majority of women. Bajra and jowar were included only during summer season. Among pulses, roasted bengal gram dhal, red gram dhal and black gram dhal were consumed twice a week. Curry leaves were used in minimum quantities for various recipes daily and amaranthus and cabbage were consumed weekly once. Folic acid rich spinach and mint were rarely consumed by the women. Among roots and tubers, potato and carrot were consumed only once a week. Most of the women included ladies finger and snake gourd at least once in a week for lunch. Coconut (fresh) and tomato were included in various preparations commonly. The women reported to consume fruits based on the availability and season. Chicken and hen's egg were included once a week by the women compared to fish and mutton. Milk and curds were included daily by all the women.

## **b) Food intake pattern of the experimental groups**

The mean food intake of the experimental groups before and after counseling is presented in Table LVI and Figure 17 and the individual mean food intake and food consumption pattern of the experimental groups are presented in Appendix XIV a, b, c.

The mean intake of all the foods was less than the RDA in the three groups both before and after counseling, except for pulses, fats and oils and sugar and jaggery. In group A after counseling, the intake of all the foods increased. However the increase was statistically significant in the case of fruits. In group B and C the food intake increased but the intake was statistically significant in the case of vegetables. The analysis of the table revealed that counseling increased the consumption of folic acid rich foods like green leafy vegetables and fruits by the experimental groups. This shows that counseling had good impact in improving the food intake of folic acid rich foods by all the three groups.

**TABLE LVI**  
**MEAN FOOD INTAKE OF THE EXPERIMENTAL GROUPS**

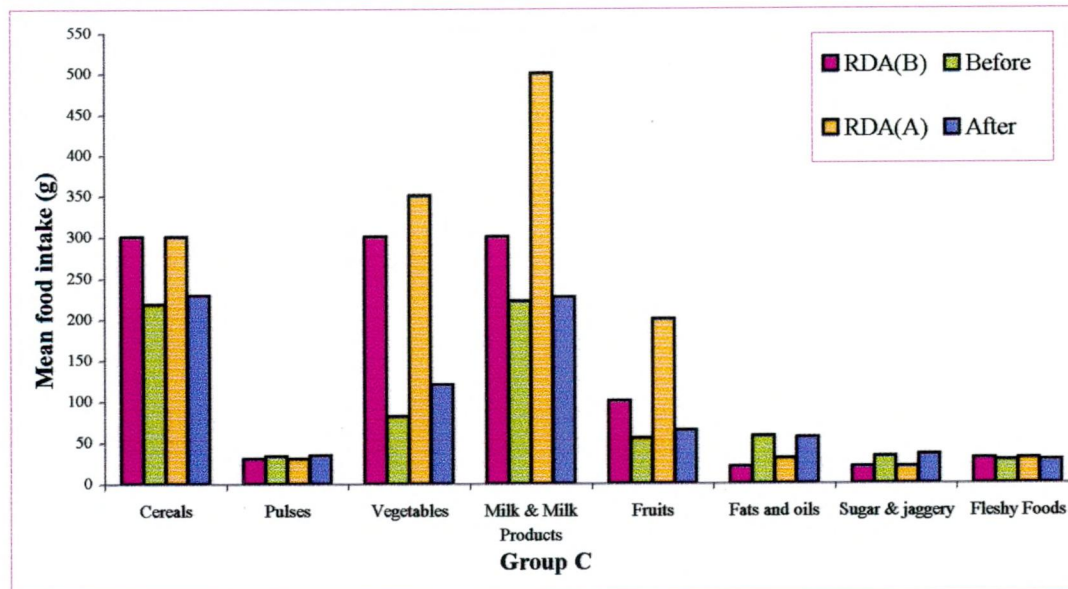
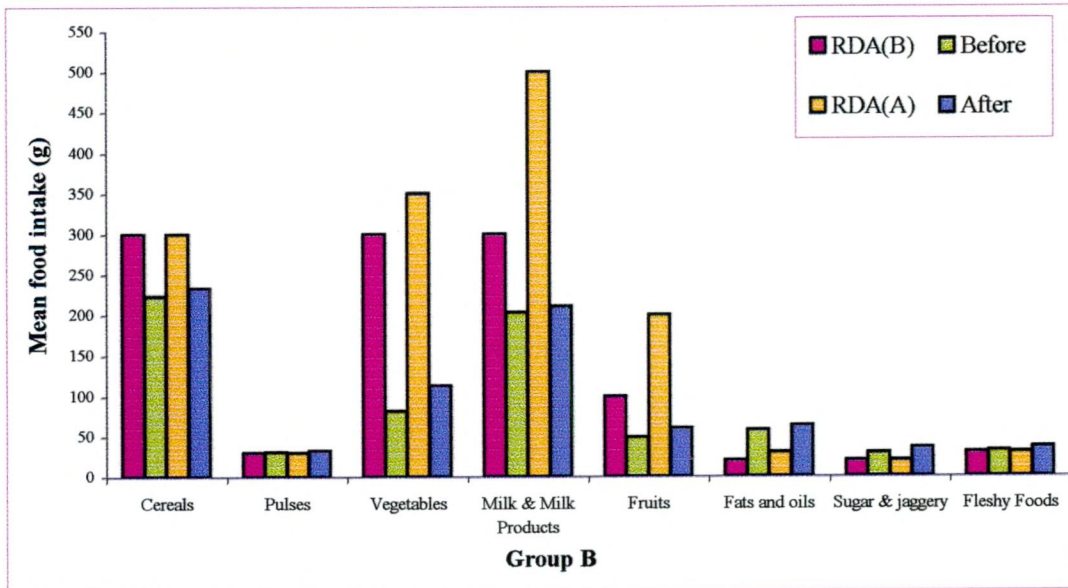
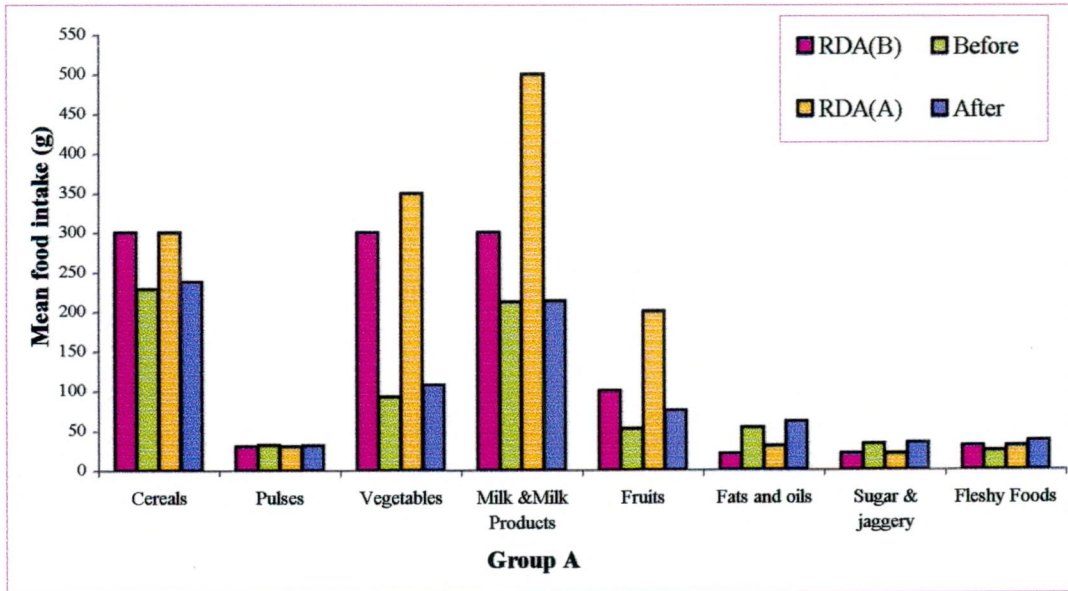
| Groups                   | Foods (g)             | RDA(B) (g) | Before      | RDA(A) (g) | After       | t value            |
|--------------------------|-----------------------|------------|-------------|------------|-------------|--------------------|
| <b>Group A</b><br>(N=10) | Cereals               | 300        | 228.7±45.91 | 300        | 237.8±21.44 | 0.79 <sup>NS</sup> |
|                          | Pulses                | 30         | 31.68±8.62  | 30         | 31.31±9.17  | 0.06 <sup>NS</sup> |
|                          | Vegetables            | 300        | 93.06±24.8  | 350        | 107.6±17.72 | 1.60 <sup>NS</sup> |
|                          | Milk & Milk Products  | 300        | 212.0±28.9  | 500        | 213.3±24.6  | 0.10 <sup>NS</sup> |
|                          | Fruits                | 100        | 52.3±25.9   | 200        | 75.2±16.5   | 2.39*              |
|                          | Fats and oils         | 20         | 53.83±25.54 | 30         | 60.79±8.07  | 0.89 <sup>NS</sup> |
|                          | Sugar & Jaggery       | 20         | 32.7±4.1    | 20         | 34.4±4.7    | 0.95 <sup>NS</sup> |
|                          | Egg/Meat/Chicken/Fish | 30         | 24.78±8.52  | 30         | 36.22±15.25 | 1.72 <sup>NS</sup> |
| <b>Group B</b><br>(N=10) | Cereals               | 300        | 223.3±7.82  | 300        | 233.1±13.09 | 0.79 <sup>NS</sup> |
|                          | Pulses                | 30         | 30.47±12.67 | 30         | 32.37±9.20  | 0.39 <sup>NS</sup> |
|                          | Vegetables            | 300        | 81.28±22.5  | 350        | 112.8±9.69  | 4.04*              |
|                          | Milk & Milk Products  | 300        | 203.3±51.4  | 500        | 210.0±22.5  | 0.48 <sup>NS</sup> |
|                          | Fruits                | 100        | 49.04±17.32 | 200        | 60.3±13.19  | 1.30 <sup>NS</sup> |
|                          | Fats and oils         | 20         | 57.6±9.78   | 30         | 63.1±10.8   | 2.03*              |
|                          | Sugar & Jaggery       | 20         | 29.6±5.14   | 20         | 35.8±5.6    | 2.86*              |
|                          | Egg/Meat/Chicken/Fish | 30         | 31.32±12.38 | 30         | 36.44±16.10 | 1.59 <sup>NS</sup> |
| <b>Group C</b><br>(N=10) | Cereals               | 300        | 218.7±20.5  | 300        | 229.8±4.41  | 1.64 <sup>NS</sup> |
|                          | Pulses                | 30         | 33.78±7.01  | 30         | 34.17±9.98  | 0.12 <sup>NS</sup> |
|                          | Vegetables            | 300        | 81.6±30.69  | 350        | 120.6±17.63 | 3.39*              |
|                          | Milk & Milk Products  | 300        | 222.4±50.2  | 500        | 227.5±29.4  | 0.38 <sup>NS</sup> |
|                          | Fruits                | 100        | 55.5±20.6   | 200        | 64.6±11.0   | 1.72 <sup>NS</sup> |
|                          | Fats and oils         | 20         | 57.6±14.9   | 30         | 55.8±5.67   | 0.39 <sup>NS</sup> |
|                          | Sugar & Jaggery       | 20         | 32.8±5.8    | 20         | 35.3±5.24   | 0.88 <sup>NS</sup> |
|                          | Egg/Meat/Chicken/Fish | 30         | 27.65±12.58 | 30         | 27.89±9.58  | 0.10 <sup>NS</sup> |

ICMR (2003); RDA(B) - for adult women; RDA(A) - for pregnant women

NS – Not Significant; \* - Significant at 5 per cent;

Group A-folic acid alone; Group B-folic acid and multi-vitamin;

Group C -folic acid and iron



**MEAN FOOD INTAKE OF THE EXPERIMENTAL GROUPS  
BEFORE AND AFTER COUNSELING**

**FIGURE 17**

### **c) Mean nutrient intake of the experimental groups**

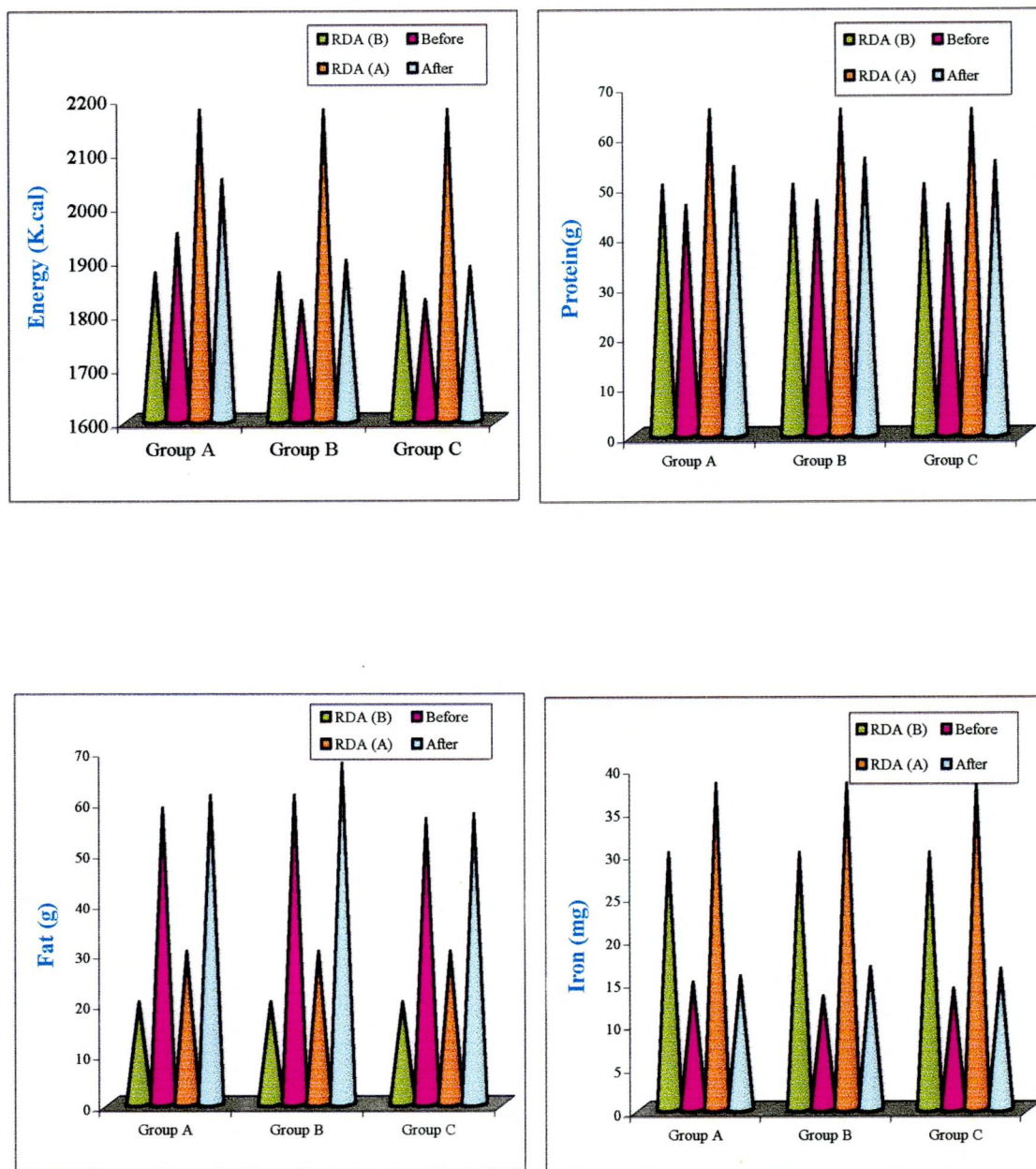
The mean nutrient intake of the experimental groups before and after counseling is presented in Table LVII and Figure 18 and individual mean nutrient intake of the experimental groups are given in Appendix XV a, b, c.

In group A, the intake of energy and fat was greater than the RDA before counseling. However after counseling the mean nutrient intake of all the nutrients increased in all the groups, and statistical analysis revealed significant difference in the case of energy, protein, free folate and vitamin C. In group B the mean nutrient intake of fat was greater than the RDA before counseling, after counseling the increase was found to be statistically significant in all the groups except fat. It is further noted that the vitamin C and fat content were greater than the RDA after counseling. In group C before counseling except fat the mean nutrient intake of all other nutrients was lesser than the RDA. Further, after counseling, the mean intake of all the nutrients increased and statistical analysis showed the significant difference in the case of protein, iron and vitamin C. It is evident from the table that the mean nutrient intake of pulses, fruits and vegetables increased after counseling which improved the nutrients in turn with regard to proteins, iron, folate and vitamin C in the diet of the experimental groups.

**TABLE LVII**  
**MEAN NUTRIENT INTAKE OF THE EXPERIMENTAL GROUPS**

| Groups                   | Nutrients                | RDA(B)         | Before      | RDA(A)     | After       | t value            |
|--------------------------|--------------------------|----------------|-------------|------------|-------------|--------------------|
| <b>Group A</b><br>(N=10) | Energy (K.cal)           | 1875           | 1947±266.7  | 2175       | 2047±241.6  | 1.88*              |
|                          | Protein (g)              | 50             | 45.9±12.9   | 65         | 53.6±10.2   | 3.90*              |
|                          | Fat (g)                  | 20             | 58.45±24.38 | 30         | 60.91±17.67 | 0.87 <sup>NS</sup> |
|                          | Iron(mg)                 | 30             | 14.78±4.0   | 38         | 15.5±2.2    | 0.54 <sup>NS</sup> |
|                          | β-Carotene (mcg)         | 2400           | 795.5±329.1 | 2400       | 879.4±268.2 | 0.78 <sup>NS</sup> |
|                          | Free folate (mcg)        | 100            | 55.9±23.9   | 400        | 67.5±13.6   | 2.13*              |
|                          | Total folate(mcg)        | -              | 129.4±37.56 | -          | 136.2±45.42 | 0.83 <sup>NS</sup> |
|                          | Vitamin C(mg)            | 40             | 37.7±15.6   | 40         | 47.0±11.2   | 1.87*              |
|                          | <b>Group B</b><br>(N=10) | Energy (K.cal) | 1875        | 1822±171.0 | 2175        | 1897±195.3         |
| Protein (g)              |                          | 50             | 46.7±12.5   | 65         | 55.1±11.5   | 2.53*              |
| Fat (g)                  |                          | 20             | 60.9±18.7   | 30         | 67.2±9.13   | 1.12 <sup>NS</sup> |
| Iron(mg)                 |                          | 30             | 13.1±3.2    | 38         | 16.5±3.14   | 4.17*              |
| β-Carotene (mcg)         |                          | 2400           | 725.8±302.4 | 2400       | 863.7±337.9 | 2.34*              |
| Free folate (mcg)        |                          | 100            | 68.1±16.0   | 400        | 79.4±20.1   | 4.22*              |
| Total folate(mcg)        |                          | -              | 114.8±12.2  | -          | 150.7±25.68 | 3.62*              |
| Vitamin C (mg)           |                          | 40             | 40.9±9.04   | 40         | 57.5±13.3   | 5.31*              |
| <b>Group C</b><br>(N=10) |                          | Energy (K.cal) | 1875        | 18.23±249  | 2175        | 1885±169.9         |
|                          | Protein (g)              | 50             | 45.9±8.0    | 65         | 54.5±7.19   | 5.02*              |
|                          | Fat (g)                  | 20             | 56.31±10.85 | 30         | 57.25±10.69 | 0.18 <sup>NS</sup> |
|                          | Iron(mg)                 | 30             | 14.0±3.3    | 38         | 16.3±1.58   | 3.01*              |
|                          | β-Carotene (mcg)         | 2400           | 767.6±401.4 | 2400       | 778.2±118.9 | 0.09 <sup>NS</sup> |
|                          | Free folate(mcg)         | 100            | 78.5±12.5   | 400        | 103.9±66.8  | 1.19 <sup>NS</sup> |
|                          | Total folate(mcg)        | -              | 124.3±21.62 | -          | 134.6±21.73 | 1.22 <sup>NS</sup> |
|                          | Vitamin C (mg)           | 40             | 39.5±16.4   | 40         | 55.3±11.2   | 4.40*              |

Gopalan *et al.* (2004); RDA(B) - for adult women; RDA(A) - for pregnant women  
NS – Not Significant; \* - Significant at 10 per cent;  
Group A-folic acid alone; Group B-folic acid and multi-vitamin;  
Group C -folic acid and iron



**MEAN NUTRIENT INTAKE OF THE EXPERIMENTAL GROUPS BEFORE AND AFTER COUNSELING**

**FIGURE 18**

#### d) Mean weight gain during the current pregnancy

Mean weight gain during the current pregnancy among the three experimental groups is presented in Table LVIII and the individual height, weight and BMI are given in Appendix XVI.

**TABLE LVIII**

**MEAN WEIGHT GAIN AMONG THE EXPERIMENTAL GROUPS (N=30)**

| <b>Parameters</b>           | <b>Group A</b> | <b>Group B</b>     | <b>Group C</b>     |
|-----------------------------|----------------|--------------------|--------------------|
| Preconceptional weight (Kg) | 52.0 ± 4.89    | 47.9 ± 4.2         | 49.1 ± 5.15        |
| Final trimester (Kg)        | 61.3 ± 4.22    | 58.2 ± 3.9         | 58.2 ± 3.99        |
| Weight gain (Kg)            | 9.3 ± 1.40     | 10.3 ± 1.48        | 9.1 ± 1.37         |
| t Value                     | 20.74*         | 34.33*             | 21.0*              |
| Groups compared             | A & B          | B & C              | A & C              |
| t value                     | 2.24*          | 1.72 <sup>NS</sup> | 0.27 <sup>NS</sup> |

\* Significant at 5 per cent level; NS – Not Significant

Group A-folic acid alone; Group B-folic acid and multi-vitamin;

Group C -folic acid and iron

From the Table LVIII, it is found that group B had registered the highest mean weight gain during pregnancy. Group A ranked second and group C registered the lowest gain. On statistical analysis a significant difference in weight gain was noted in all the three groups at five per cent level. Comparison of weight gain between groups, the difference between A and B was statistically significant at five per cent level.

**e) BMI grades of the experimental groups in pre conceptional period**

Maternal weight has been associated with NTD risk. Obesity has been linked to increased NTD rates (Kallen, 1998 and Watkins *et al* 2003). However, another finding failed to show any association between maternal weight and NTD risk (Feldman *et al* 1982). BMI grades of the experimental groups during preconceptional period are presented in Table LIX.

**TABLE LIX**  
**BMI GRADES OF THE EXPERIMENTAL GROUPS**

| Parameters      | BMI*        | Group A            | Group B             | Group C            |
|-----------------|-------------|--------------------|---------------------|--------------------|
|                 |             | (N = 10)           | (N = 10)            | (N = 10)           |
| CED III         | <16.0       | -                  | -                   | -                  |
| CED II          | 16.0 – 17.0 | -                  | -                   | 1                  |
| CED I           | 17.0 – 18.5 | 1                  | 1                   | -                  |
| Low Weight      | 18.5 – 20.0 | -                  | 1                   | -                  |
| Normal          | 20.0 – 25.0 | 9                  | 8                   | 1                  |
| Obesity - I     | 25.0 – 30.0 | -                  | -                   | 8                  |
| Obesity – II    | >30.0       | -                  | -                   | -                  |
| <b>Mean BMI</b> |             | <b>22.56 ± 2.0</b> | <b>20.88 ± 1.65</b> | <b>21.63 ± 2.2</b> |

CED-Chronic Energy Deficiency; \*NNMB(2002)

Group A-folic acid alone; Group B-folic acid and multi-vitamin;

Group C -folic acid and iron

Nine women in group A and 8 women in group B had normal BMI during the preconceptional period. About 8 women in group C were categorized under grade I obesity. One women in group A and B were classified under CED I while one women in group C suffered from CED II. However, the mean BMI of the three experimental groups was within the normal BMI range.

#### **f) Nutritional knowledge of the experimental groups**

The level of knowledge of the experimental groups on importance of folic acid before and after counseling is given in Table LX and the individual knowledge scores of the experimental groups is given in Appendix XVII.

**TABLE LX**  
**KNOWLEDGE SCORES OF THE EXPERIMENTAL GROUPS**  
**BEFORE AND AFTER COUNSELING**

| Knowledge level (%) <sup>*</sup> | Group A (N=10) |       | Group B (N=10) |       | Group C (N=10) |       |
|----------------------------------|----------------|-------|----------------|-------|----------------|-------|
|                                  | Before         | After | Before         | After | Before         | After |
| Low (0-33 Scores)                | 6              | -     | 2              | -     | 3              | -     |
| Moderate (34-66 Scores)          | 4              | -     | 8              | -     | 7              | -     |
| High (67-100 Scores)             | -              | 10    | -              | 10    | -              | 10    |

\* Kumar *et al* (2004)

Group A-folic acid alone; Group B-folic acid and multi-vitamin;  
Group C -folic acid and iron

Among the experimental groups, a majority (6 women) in group A, 2 women in group B and 3 women in group C had least knowledge about folic acid rich foods, recommendations of folic acid during pregnancy, recommendations for mothers with previous incidence of NTD and about the time of intake of supplements before counseling. It was also observed that 4, 8 and 7 women in group A, B and C respectively had moderate knowledge about the importance of folic acid before counseling. However, after counseling, all the women in the three groups gained more knowledge about the recommended intake of folic acid, consequences of folic acid deficiency and importance of folic acid intake.

### 3) Impact of periconceptual supplementation of folate on the serum folate levels of experimental groups

Pregnancy is a period of anabolic activity, when the most rapid rate of growth takes place. Among the nutrients, folic acid assumes a primary role in pregnancy as it is essential for maternal health and performance. The use of folic acid supplements requires a conscious effort on the part of women anticipating pregnancy as adequate folic acid is needed at the time of embryogenesis. Hence in this study an attempt was made to find out the outcome of pregnancy after supplementation with folic acid during the periconceptual period among mothers who had an incidence of NTDs.

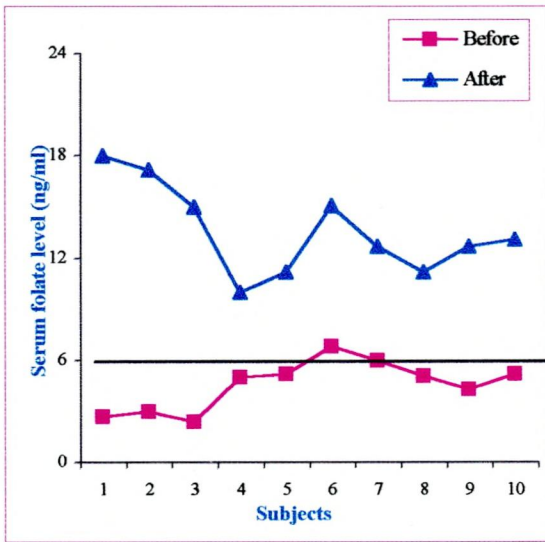
#### a) Mean serum folate levels before and after supplementation

Table LXI and Figure 19 highlight the mean serum folate levels of experimental groups before and after supplementation. The experimental groups are classified based on the serum folate levels as suggested by Bamji (2003). The individual serum folate levels of the experimental groups are given in Appendix XVIII.

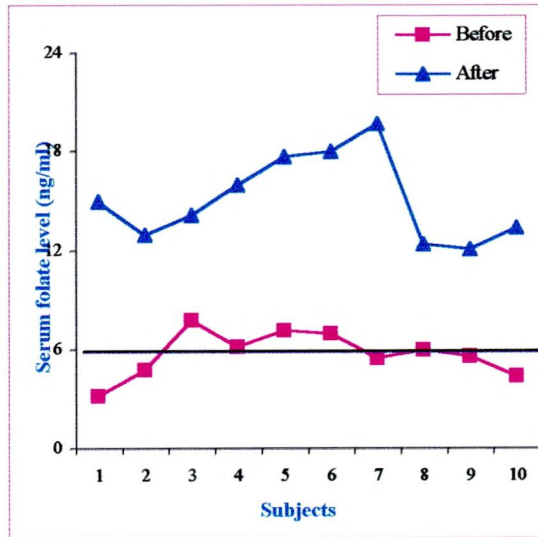
**TABLE LXI**  
**MEAN SERUM FOLATE LEVELS OF THE EXPERIMENTAL**  
**GROUPS BEFORE AND AFTER SUPPLEMENTATION (N=30)**

| Serum folate levels (ng/ml)* | Group A (N=10)   |                   | Group B (N=10)   |                   | Group C (N=10)   |                   |
|------------------------------|------------------|-------------------|------------------|-------------------|------------------|-------------------|
|                              | Before           | After             | Before           | After             | Before           | After             |
| Acceptable (> 6.0)           | 2                | 10                | 5                | 10                | 5                | 10                |
| Medium (3.0-5.9)             | 6                | -                 | 5                | -                 | 5                | -                 |
| High risk (<3.0)             | 2                | -                 | -                | -                 | -                | -                 |
| <b>Mean ± S.D</b>            | <b>4.57±1.45</b> | <b>13.62±2.64</b> | <b>5.77±1.39</b> | <b>15.15±2.62</b> | <b>6.42±1.62</b> | <b>13.18±2.89</b> |
| <b>'t' value</b>             | <b>7.82**</b>    |                   | <b>11.42**</b>   |                   | <b>13.58**</b>   |                   |

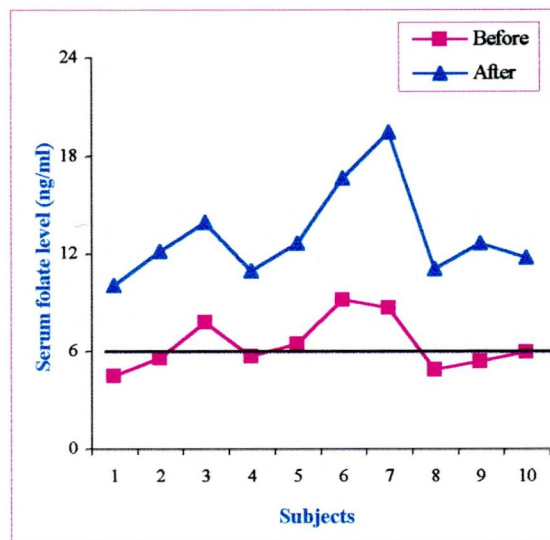
\* Bamji (2003); \*\* Significant at 5 per cent level; Group A-folic acid alone; Group B-folic acid and multi-vitamin; Group C-folic acid and iron



**Group - A**  
**Folic acid alone**



**Group - B**  
**Folic acid and multivitamin**



**Group - C**  
**Folic acid and iron**

**IMPACT OF FOLATE SUPPLEMENTATION ON SERUM FOLATE LEVELS OF EXPERIMENTAL GROUPS**

**FIGURE 19**

Mean serum folate levels of all the three experimental groups improved after supplementation. Women of group B supplemented with folic acid and multivitamin showed greater serum folate levels of  $15.15 \pm 2.62$  ng/ml after supplementation followed by group A supplemented with folic acid alone wherein serum folate levels increased to  $13.62 \pm 2.64$  ng/ml and group C supplemented with folate and iron showed increased values of  $13.18 \pm 2.89$  ng/ml. It is also evident that supplementation of folate and its combinations showed statistically significant difference at five per cent level in all the three groups. Further, the women in the three groups with medium and high risk moved to acceptable serum folate levels after supplementation. This shows the beneficial effect of periconceptual folic acid supplementation in the serum folate level in all the three experimental groups. The results are similar to the findings reported by Venn *et al* (2002).

**b. Mean serum folate levels of the experimental groups after supplementation - A comparison**

Table LXII shows a comparison of mean serum folate levels of experimental groups after supplementation and also a comparison among the groups.

**TABLE LXII**  
**IMPACT OF SUPPLEMENTATION ON MEAN SERUM FOLATE LEVELS**  
**AMONG THE EXPERIMENTAL GROUPS-A COMPARISON ( N=30)**

| Groups | After supplementation ng/ml | Groups compared | 't' value          |
|--------|-----------------------------|-----------------|--------------------|
| A      | $13.62 \pm 2.64$            | A vs B          | 1.22 <sup>NS</sup> |
| B      | $15.15 \pm 2.62$            | B vs C          | 2.88*              |
| C      | $13.18 \pm 2.89$            | C vs A          | 0.35 <sup>NS</sup> |

NS-Not Significant; \* Significant at 5 per cent level; Group A-folic acid alone; Group B-folic acid and multi-vitamin; Group C-folic acid and iron

It is evident from the table that group B had registered a high serum folate level, followed by group A and C. The difference in the serum folate levels between group B and C was found to be statistically significant at five per cent level. However, the differences in the mean serum folate levels of groups A and B and groups A and C were not significant.

**c. Total folate intake and serum folate levels of the experimental groups**

The food consumption pattern and supplementation have a definite role on the improvement of serum folate levels, hence an attempt was made to assess the correlation between total folate intake and serum folate levels of the experimental groups. The correlation coefficient between total folate intake and serum folate levels of the experimental groups is presented in Table LXIII.

**TABLE LXIII**  
**CORRELATION COEFFICIENT VALUES BETWEEN TOTAL FOLATE INTAKE AND SERUM FOLATE LEVELS AMONG THE EXPERIMENTAL GROUPS (N=30)**

| <b>Supplementation</b> | <b>Group A</b>      | <b>Group B</b>      | <b>Group C</b>      |
|------------------------|---------------------|---------------------|---------------------|
| Before                 | 0.456 <sup>NS</sup> | 0.190 <sup>NS</sup> | 0.145 <sup>NS</sup> |
| After                  | 0.256 <sup>NS</sup> | 0.041 <sup>NS</sup> | 0.307 <sup>NS</sup> |

NS – Not Significant

Group A-folic acid alone; Group B-folic acid and multi-vitamin;

Group C-folic acid and iron

A positive correlation was observed between total folate intake and serum folate levels in all the experimental groups before and after supplementation. The findings are similar to the reports of Scholl *et al* (1996).

#### d. Mean haemoglobin levels before and after supplementation

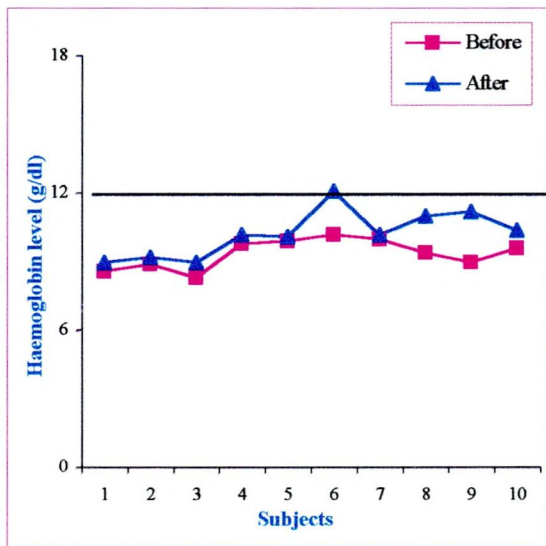
Anemia of pregnancy is one of the major health problems in developing countries with anaemia being directly responsible for at least 20 per cent of maternal deaths. Studies indicating the positive effects of folic acid supplementation along with other haemopoietic substances give ample proof to show the importance of availability of folic acid for healthy blood formation especially in pregnant women. The mean haemoglobin levels before and after supplementation and the distribution of experimental groups based on haemoglobin levels according to WHO (1989) are given in Table LXIV and Figure 20. The individual haemoglobin levels of the experimental groups are given in Appendix XVIII.

**TABLE LXIV**  
**MEAN HAEMOGLOBIN LEVELS OF THE EXPERIMENTAL**  
**GROUPS BEFORE AND AFTER SUPPLEMENTATION (N=30)**

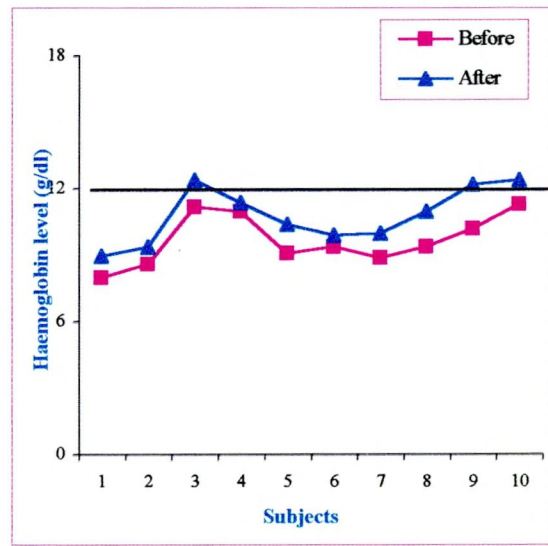
| Anaemia (g/dl)*   | Group A (N=10)   |                   | Group B (N=10)   |                   | Group C (N=10)   |                  |
|-------------------|------------------|-------------------|------------------|-------------------|------------------|------------------|
|                   | Before           | After             | Before           | After             | Before           | After            |
| Normal (>12)      | -                | 1                 | -                | 3                 | -                | 2                |
| Mild (10-12)      | 2                | 6                 | 4                | 4                 | 3                | 7                |
| Moderate (7-10)   | 8                | 3                 | 6                | 3                 | 7                | 1                |
| Severe (<7)       | -                | -                 | -                | -                 | -                | -                |
| <b>Mean ± S.D</b> | <b>9.37±0.64</b> | <b>10.24±1.01</b> | <b>9.71±1.16</b> | <b>10.81±1.26</b> | <b>9.25±1.09</b> | <b>11.7±0.86</b> |
| <b>'t' value</b>  | <b>3.67**</b>    |                   | <b>7.27**</b>    |                   | <b>7.77**</b>    |                  |

\* WHO (1989); \*\* Significant at 5 per cent level; Group A-folic acid alone; Group B-folic acid and multi-vitamin; Group C - folic acid and iron

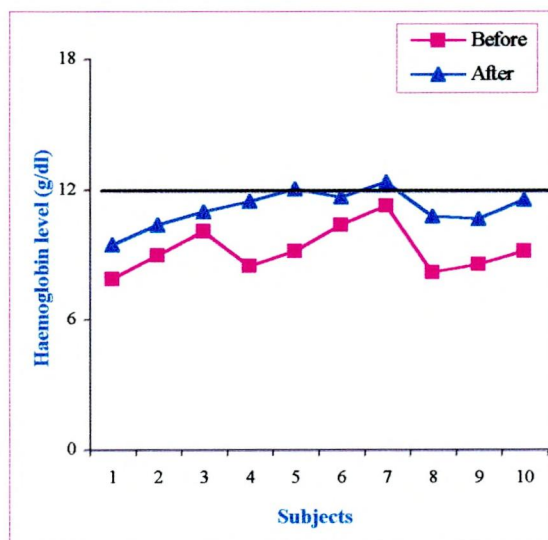
The mean haemoglobin levels of all the three experimental groups increased after supplementation with folic acid and combinations. Among the three experimental groups, group C women supplemented with folic acid and iron registered better haemoglobin values of  $11.7 \pm 0.86$  g/dl after



**Group - A**  
**Folic acid alone**



**Group - B**  
**Folic acid and multivitamin**



**Group - C**  
**Folic acid and iron**

**IMPACT OF FOLATE SUPPLEMENTATION ON  
HAEMOGLOBIN LEVELS OF EXPERIMENTAL GROUPS**

**FIGURE 20**

supplementation followed by group B with  $10.81 \pm 1.26$  g/dl supplemented with folic acid and multi vitamin and group A with  $10.24 \pm 1.01$  g/dl supplemented with folic acid alone. It is also noted that supplementation of folic acid and combinations showed statistically significant improvement in the haemoglobin levels at five per cent level. Further, the findings also reveal that before supplementation 8, 6 and 7 women in groups A, B and C respectively had moderate haemoglobin levels (7-10 g/dl). After supplementation, only 3, 3 and 1 woman in groups A, B and C respectively were in moderate category. This shows the beneficial effect of folic acid supplementation on the haemoglobin levels among all the three groups.

**e. Mean haemoglobin levels of the experimental groups after supplementation - A comparison**

Table LXV shows a comparison of the mean haemoglobin levels of experimental groups after supplementation and also a comparison among the groups.

**TABLE LXV**

**IMPACT OF SUPPLEMENTATION ON MEAN HAEMOGLOBIN LEVELS AMONG THE EXPERIMENTAL GROUPS – A COMPARISON (N=30)**

| <b>Groups</b> | <b>After supplementation g/dl</b> | <b>Groups compared</b> | <b>'t' value</b>   |
|---------------|-----------------------------------|------------------------|--------------------|
| A             | $10.24 \pm 1.01$                  | A vs B                 | 1.22 <sup>NS</sup> |
| B             | $10.81 \pm 1.26$                  | B vs C                 | 0.83 <sup>NS</sup> |
| C             | $11.7 \pm 0.86$                   | C vs A                 | 2.87*              |

NS- Not Significant; \* - Significant at 5 per cent level; Group A-folic acid alone; Group B-folic acid and multi-vitamin; Group C - folic acid and iron

The findings reveal that group C had registered a high mean haemoglobin level, followed by group B and group A after supplementation of folate combinations. The difference in the haemoglobin levels between group C and A was found to be statistically significant at five per cent level. However, the difference between the mean haemoglobin levels of the experimental groups A and B and groups B and C was not significant.

**f. Iron intake and haemoglobin levels of the experimental groups**

The correlation coefficient between iron intake and haemoglobin levels of the experimental groups is presented in Table LXVI.

**TABLE LXVI**  
**CORRELATION COEFFICIENT VALUES BETWEEN IRON INTAKE**  
**AND HAEMOGLOBIN LEVELS AMONG THE EXPERIMENTAL**  
**GROUPS (N=30)**

| <b>Supplementation</b> | <b>Group A</b>      | <b>Group B</b>      | <b>Group C</b>      |
|------------------------|---------------------|---------------------|---------------------|
| Before                 | 0.280 <sup>NS</sup> | 0.099 <sup>NS</sup> | 0.181 <sup>NS</sup> |
| After                  | 0.122 <sup>NS</sup> | 0.180 <sup>NS</sup> | 0.194 <sup>NS</sup> |

NS - Not Significant.

Group A-folic acid alone; Group B-folic acid and multi-vitamin;

Group C-folic acid and iron

A positive correlation was observed from Table LXVI between iron intake and haemoglobin levels in all the three experimental groups before and after supplementation.

### **g. Identification of factors associated with serum folate level by Factor Analysis**

In order to identify the most influencing factors on serum folate level before supplementation of the three experimental groups, Factor Analysis has been conducted and results are presented. The output of Factor Analysis is obtained by requesting principal component analysis and specifying the rotation. The method of principal component analysis was chosen to identify the critical factor. Before proceeding to Factor Analysis, appropriateness of principal component analysis to selected variables was evaluated. In principal component analysis, variables must be correlated to each other for the Factor model to be appropriate.

#### **Group A**

Table LXVII represents a correlation matrix between the variable. It is evident from the table that all the selected variables are correlated to each other. Bartlett's test of sphericity and Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy are used to test the appropriateness of the Factor model. Since approximate chi-square satisfaction is 21.165 which are significant at 10 per cent level and the value of KMO statistics (0.565) which is greater than 0.5, it is considered that the data is appropriate for Factor Analysis.

After testing the adequacy of data and explanatory variables, Factor Analysis was undertaken with those six variables. To decide the number of factors needed to represent serum folate level, EIGEN values were estimated. EIGEN values of the factors represent the total variance explained by that Factor.

**TABLE LXVII**

**FACTOR ANALYSIS IN GROUP A**

| <b>Correlation matrix variables</b>                 | <b>Family type</b> | <b>Family size</b> | <b>Educational status</b> | <b>Age at marriage</b> | <b>Consanguinity</b> | <b>Parity</b> |
|---|--------------------|--------------------|---------------------------|------------------------|----------------------|---------------|
| Family type   | 1.000              |                    |                           |                        |                      |               |
| Family size   | 0.103              | 1.000              |                           |                        |                      |               |
| Educational status                                  | 0.160              | 0.228              | 1.000                     |                        |                      |               |
| Age at marriage                                     | 0.286              | 0.331              | 0.062                     | 1.000                  |                      |               |
| Consanguinity                                       | 0.373              | 0.169              | 0.373                     | 0.461                  | 1.000                |               |
| Parity  | 0.666              | 0.225              | 0.224                     | 0.285                  | 0.403                | 1.000         |
| <b>KMO AND BARTLETT'S TEST</b>                      |                    |                    |                           |                        |                      |               |
| Kaiser-Meyer-Olkin measure of sampling adequacy     |                    |                    |                           |                        |                      | 0.565         |
| Bartlett's test of sphericity (Approx.): Chi-square |                    |                    |                           |                        |                      | 21.165        |
| Degrees of freedom                                  |                    |                    |                           |                        |                      | 15            |
| Significance  |                    |                    |                           |                        |                      | 0.100**       |

**TOTAL VARIANCE**

| <b>Variables</b>   | <b>Initial EIGEN Values</b> |                      |          | <b>Extraction sums of squared loadings</b> |                      |          | <b>Rotation sums of squared loadings</b> |                      |          |
|--------------------|-----------------------------|----------------------|----------|--|----------------------|----------|--|----------------------|----------|
|                    | <b>Total</b>                | <b>% of variance</b> | <b>C</b> | <b>Total</b>                               | <b>% of variance</b> | <b>C</b> | <b>Total</b>                             | <b>% of variance</b> | <b>C</b> |
| Family type        | 2.528                       | 41.075               | 41.075   | 2.528                                      | 41.075               | 41.075   | 2.498                                    | 40.826               | 40.826   |
| Family size        | 1.575                       | 27.293               | 68.368   | 1.575                                      | 27.293               | 68.368   | 1.605                                    | 27.542               | 68.368   |
| Educational status | 0.946                       | 15.772               | 84.139   |  |                      |          |  |                      |          |
| Age at marriage    | 0.608                       | 10.131               | 98.270   |  |                      |          |  |                      |          |
| Consanguinity      | 0.305                       | 5.088                | 99.358   |  |                      |          |  |                      |          |
| Parity             | 0.003                       | 0.642                | 100.000  |  |                      |          |  |                      |          |

C- Cumulative ; Extraction Method : Principal Component Analysis

Variable 1 (Family type) accounts for a variance of 2.528 which is 41 per cent of variance. Likewise the second variable (family size) accounts for 1.575 which is 27 per cent of the total variance and first two variables combined account for 68.37 per cent of total variance. From the EIGEN value, only two components possessing EIGEN values which are greater than one, that is four components are said to be extracted from the total of six factors.

Thus it is concluded that socio economic factors like family type and family size have a close association with the serum folate level of group A before supplementation.

### **Group B**

From the results of Factor analysis of Group B it is inferred that all the variables selected are said to be correlated with each other. The Bartlett's test of sphericity and KMO measure of sampling adequacy (>0.5) indicated that Factor Analysis is considered as the most appropriate technique for analysing the correlation matrix. It is evident from the Table LXVIII that, family type accounts for a variance of 2.377 which is 37.8 per cent of the total variance. Likewise, family size (1.60) which is 26.6 per cent of the total variance. Educational status accounts for 1.325 which is 23.9 per cent of total variance and the first three variables accounted 88.4 per cent.

**TABLE LXVIII**

**FACTOR ANALYSIS IN GROUP B**

| <b>Correlation matrix variables</b>                 | <b>Family type</b> | <b>Family size</b> | <b>Educational status</b> | <b>Age at marriage</b> | <b>Consanguinity</b> | <b>Parity</b> |
|---|--------------------|--------------------|---------------------------|------------------------|----------------------|---------------|
| Family type   | 1.000              |                    |                           |                        |                      |               |
| Family size   | 0.006              | 1.000              |                           |                        |                      |               |
| Educational status                                  | 0.258              | 0.455              | 1.000                     |                        |                      |               |
| Age at marriage                                     | 0.375              | 0.475              | 0.121                     | 1.000                  |                      |               |
| Consanguinity                                       | 0.408              | 0.344              | 0.365                     | 0.369                  | 1.000                |               |
| Parity  | 0.121              | 0.133              | 0.485                     | 0.159                  | 0.066                | 1.000         |
| <b>KMO AND BARTLETT'S TEST</b>                      |                    |                    |                           |                        |                      |               |
| Kaiser-Meyer-Olkin measure of sampling adequacy     |                    |                    |                           |                        |                      | 0.646         |
| Bartlett's test of sphericity (Approx.): Chi-square |                    |                    |                           |                        |                      | 31.756        |
| Degrees of freedom                                  |                    |                    |                           |                        |                      | 15            |
| Significance  |                    |                    |                           |                        |                      | 0.009         |

**TOTAL VARIANCE**

| <b>Variables</b>   | <b>Initial EIGEN Values</b> |                      |          | <b>Extraction sums of squared loadings</b> |                      |          | <b>Rotation sums of squared loadings</b> |                      |          |
|--------------------|-----------------------------|----------------------|----------|--|----------------------|----------|--|----------------------|----------|
|                    | <b>Total</b>                | <b>% of variance</b> | <b>C</b> | <b>Total</b>                               | <b>% of variance</b> | <b>C</b> | <b>Total</b>                             | <b>% of variance</b> | <b>C</b> |
| Family type        | 2.377                       | 37.826               | 37.826   | 2.377                                      | 37.826               | 37.826   | 2.127                                    | 34.849               | 34.849   |
| Family size        | 1.600                       | 26.662               | 64.488   | 1.600                                      | 26.662               | 64.488   | 1.623                                    | 27.051               | 61.900   |
| Educational status | 1.325                       | 23.879               | 88.367   | 1.325                                      | 23.879               | 88.367   | 1.552                                    | 26.467               | 88.367   |
| Age at marriage    | 0.519                       | 8.651                | 97.018   |  |                      |          |  |                      |          |
| Consanguinity      | 0.613                       | 2.721                | 99.739   |  |                      |          |  |                      |          |
| Parity             | 0.015                       | 0.261                | 100.000  |  |                      |          |  |                      |          |

C- Cumulative; Extraction Method : Principal Component Analysis

Since there are three components possessing EIGEN values which are greater than one (i.e.) three components are said to be extracted from the total of six factors. Thus it is concluded that family type, family size and educational status have close association with serum folate level in group B before supplementation.

### **Group C**

In group C, results of Factor Analysis revealed that all the three variables selected correlated with each other. The Bartlett's test of sphericity and KMO measure of sampling adequately ( $>0.5$ ) were considered appropriate for analysing the correlation matrix in Factor Analysis. From the Table LXIX, it is noted that family type accounts for a variance of 2.155 which is 35.9 per cent of total variance, family size accounts for 1.485 of variance which is 24.8 per cent of total variance, educational status accounts for 1.1 which is 18.2 per cent and the first three factors combined account for 78.9 per cent of total variance. It is inferred that these three variables are extracted based on their EIGEN values which are greater than one. Thus the most influencing factors on serum folate level of group C before supplementation are family type, family size and educational status.

**TABLE LXIX**  
**FACTOR ANALYSIS IN GROUP C**

| Correlation matrix variables                        | Family type | Family size | Educational status | Age at marriage | Consanguinity | Parity |
|---|-------------|-------------|--------------------|-----------------|---------------|--------|
| Family type   | 1.000       |             |                    |                 |               |        |
| Family size   | 0.006       | 1.000       |                    |                 |               |        |
| Educational status                                  | 0.206       | 0.265       | 1.000              |                 |               |        |
| Age at marriage                                     | 0.364       | 0.493       | 0.345              | 1.000           |               |        |
| Consanguinity                                       | 0.345       | 0.413       | 0.215              | 0.443           | 1.000         |        |
| Parity  | 0.272       | 0.247       | 0.423              | 0.138           | 0.243         | 1.000  |
| <b>KMO AND BARTLETT'S TEST</b>                      |             |             |                    |                 |               |        |
| Kaiser-Meyer-Olkin measure of sampling adequacy     |             |             |                    |                 |               | 0.557  |
| Bartlett's test of sphericity (Approx.): Chi-square |             |             |                    |                 |               | 12.125 |
| Degrees of freedom                                  |             |             |                    |                 |               | 15     |
| Significance  |             |             |                    |                 |               | 0.075  |

**TOTAL VARIANCE**

| Variables          | Initial EIGEN Values |               |         | Extraction sums of squared loadings |               |        | Rotation sums of squared loadings |               |        |
|--------------------|----------------------|---------------|---------|-------------------------------------|---------------|--------|-----------------------------------|---------------|--------|
|                    | Total                | % of variance | C       | Total                               | % of variance | C      | Total                             | % of variance | C      |
| Family type        | 2.155                | 35.916        | 35.916  | 2.155                               | 35.916        | 35.916 | 1.891                             | 31.509        | 31.509 |
| Family size        | 1.485                | 24.800        | 60.716  | 1.485                               | 24.800        | 60.716 | 1.431                             | 22.753        | 54.262 |
| Educational status | 1.095                | 18.200        | 78.916  | 1.095                               | 18.200        | 78.916 | 1.413                             | 24.654        | 78.916 |
| Age at marriage    | 0.693                | 11.542        | 90.458  |                                     |               |        |                                   |               |        |
| Consanguinity      | 0.401                | 6.685         | 97.143  |                                     |               |        |                                   |               |        |
| Parity             | 0.171                | 2.857         | 100.000 |                                     |               |        |                                   |               |        |

C- Cumulative; Extraction Method : Principal Component Analysis

From the Factor Analysis, it is observed that among the six socio economic and maternal factors chosen, three socio economic factors namely family type, family size and educational status are associated with serum folate levels of the experimental groups before supplementation. Maternal literacy has a much more pronounced positive impact on child's nutritional status in urban than in rural area. (Gillespie, 1996). Maternal education is a strong independent predictor of both awareness and use of folic acid benefits (Berg *et al* 2005). Increased family size may adversely affect the nutritional status of every member of the household because it may be associated with decreased per capita human input (Chaudhury, 2004).

#### **h) Foetal biometrics of the experimental groups**

The mean foetal biometrics of the experimental groups taken during 22<sup>nd</sup> week of gestation through ultra scanning is presented in Table LXX. The mean foetal biometrics of the experimental groups is presented in Appendix XIX.

**TABLE LXX**

**MEAN FOETAL BIOMETRICS OF THE EXPERIMENTAL GROUPS (N=30)**

| <b>Foetal biometrics*</b>    | <b>Standard*</b> | <b>Group A</b> | <b>Group B</b> | <b>Group C</b> |
|------------------------------|------------------|----------------|----------------|----------------|
| BiParietal diameter (mm)     | 56               | 57.62±0.77     | 58.01±0.76     | 57.67±0.73     |
| Head circumference (mm)      | 202              | 208.3±4.39     | 208.2±3.07     | 208.5±3.02     |
| Abdominal circumference (mm) | 184              | 187.8±3.8      | 189.9±2.42     | 187.6±2.31     |
| Femur length (mm)            | 39               | 40.3±1.0       | 40.87±1.02     | 40.44±0.74     |

**\*Mediscan Prenatal Diagnosis and Foetal Therapy Centre, Chennai;**

Group A-folic acid alone; Group B-folic acid and multi-vitamin;

Group C-folic acid and iron

None of the foetuses in the three groups reported to have abnormal foetal biometrics nor did they show any birth defects. The mean values of foetal biometrics such as biparietal diameter, head circumference, abdominal circumference and femur length met the standard values expected for 22<sup>nd</sup> weeks of gestation. Among the experimental groups, except for head circumference, the mean values of the biparietal diameter, abdominal circumference and femur length of group B supplemented with folic acid and multivitamin were greater than group A and group C. The mean head circumference in all the three groups was almost equal. When groups A and C were compared, the mean values of biparietal diameter and abdominal circumference of group A showed slightly higher values than group C and the mean femur length of group C was slightly higher than group A.

**i) Pregnancy outcome of the experimental groups**

The pregnancy outcome of the experimental groups is presented in Table LXXI.

**TABLE LXXI**  
**PREGNANCY OUTCOME**

| <b>Parameters</b>         | <b>Group A (N=10)</b> | <b>Group B (N=10)</b> | <b>Group C (N=10)</b> |
|---------------------------|-----------------------|-----------------------|-----------------------|
| <b>Weeks of gestation</b> |                       |                       |                       |
| 38 weeks                  | 2                     | 1                     | -                     |
| 39 weeks                  | 5                     | 6                     | 8                     |
| 40 weeks                  | 8                     | 3                     | 2                     |
| <b>Type of delivery</b>   |                       |                       |                       |
| Normal                    | 4                     | 5                     | 3                     |
| Caesarean                 | 6                     | 5                     | 7                     |
| <b>Sex of new born</b>    |                       |                       |                       |
| Male                      | 4                     | 3                     | 2                     |
| Female                    | 6                     | 7                     | 8                     |

Group A-folic acid alone; Group B-folic acid and multi-vitamin;  
Group C-folic acid and iron

It is highly gratifying to note that there were no instance of NTDs in three experimental groups. Five, 6 and 8 mothers in groups A, B and C respectively delivered at 39<sup>th</sup> week of gestation and 3 mothers each in group A and B and 2 mothers in group C delivered at 40<sup>th</sup> week of gestation. Only 2 mothers in group A and 1 woman in group B delivered at 38<sup>th</sup> week of gestation. According to Scholl *et al* (1997) women who took multivitamins during pregnancy were less likely to suffer from preterm delivery.

Among the three experimental groups, 4 mothers in group A, 5 in group B and 3 in group C had normal delivery and the remaining mothers of the three groups delivered through caesarean section.

A majority of the new borns in all the three experimental groups were females and only 4, 3 and 2 neonates in group A, B and C respectively were males. According to Czeizel (1993) the number of female births was marginally greater among the folic acid supplemented women.

#### **j) Anthropometric measurements of the new born**

Table LXXII presents the mean anthropometric measurements of the infants in the three experimental groups at birth. The individual anthropometric measurements of the new borns in three experimental groups are presented in Appendix XX.

**TABLE LXXII**  
**MEAN ANTHROPOMETRIC MEASUREMENTS OF**  
**THE NEW BORN**

| Anthropometric measurements      |   | Standard* | Group A    | Group B    | Group C    |
|----------------------------------|---|-----------|------------|------------|------------|
| Birth weight (kg)                | M | 2.98*     | 2.98±0.05  | 3.23±0.23  | 3.0±0.35   |
|                                  | F | 2.76*     | 2.80±0.19  | 2.88±0.17  | 2.92±0.21  |
| Crown heel length (cm)           | M | 47.95*    | 50.27±0.49 | 49.37±2.82 | 46.50±0.71 |
|                                  | F | 48.00*    | 49.65±0.85 | 49.10±1.32 | 47.04±1.79 |
| Head circumference (cm)          | M | 34.10*    | 33.27±0.35 | 34.03±2.63 | 34.80±1.70 |
|                                  | F | 33.50*    | 32.97±0.71 | 33.40±0.58 | 34.07±1.43 |
| Chest circumference (cm)         | M | 31.20*    | 32.22±0.46 | 32.73±2.05 | 30.85±1.20 |
|                                  | F | 30.74*    | 32.28±0.70 | 31.81±0.40 | 31.61±0.65 |
| Mid upper arm circumference (cm) | M | 10.4**    | 10.54±0.04 | 11.0±0.81  | 9.0±1.41   |
|                                  | F | 10.1**    | 10.33±0.50 | 10.84±0.67 | 10.16±0.73 |

\*AIIMS (1993); \*\*Eswaran and Devadas (1981); Group A-folic acid alone; Group B-folic acid and multi-vitamin; Group C-folic acid and iron

Table LXXII reveal that none of the infants had low birth weight (< 2.5 kg) among any of the supplemented groups. This study is also on par with the findings of Tamura *et al* (1997) who suggested a potential beneficial effect of good folate status and improvement in birth weight and gestation. Baumslag *et al* (1970) also reported that the mean birth weight increased by 0.45 kg and the risk of bearing an infant weighing < 2.25 kg was reduced four fold with folic acid supplementation. Male infants had greater birth weight than females in all the experimental groups. The mean birth weight of group B males and group C females was greater than the compared groups.

Infants of group A had higher crown heel length than infants of group B and group C. The head circumference of all the males in the three groups was greater than females, however group C infants had higher head circumference than group A and group B.

The mean chest circumference of group B males was  $32.73 \pm 2.05$  cm and group A females was  $32.28 \pm 0.70$  cm which were slightly higher than the other groups compared. The mean mid upper arm circumference of both the sexes in group B was higher than group A and group C.

The overall anthropometric measurements of infants revealed the successful impact of supplementation of folic acid and combinations on pregnant women and their newborns.