Summary and Conclusions
Iron deficiency anaemia is a problem of serious public health significance. Prolonged iron deficiency leads to iron deficiency anaemia. Infants, pre-school children, adolescents and women of child bearing age, particularly pregnant women are at the greatest risk of developing iron deficiency anaemia. However, adult males may also be at risk, especially where there is inadequate food intake or frequent parasitic infections. The prevalence of anaemia in elderly is slightly higher than that of adult males. Anaemia are prevalent mostly in rural areas. Among the different communities residing in the rural areas of Andhra Pradesh, the fishing community is one that is poor and neglected.

Iron deficiency anaemia is a rampant problem, aggravated by other nutrient deficiencies especially among the poor. The incidence of cardiovascular diseases is also on the increase in the subcontinent. Diet is shown to be an important factor, both in alleviating anaemia as well as coronary risk (hyperlipidaemia). Fish is a rich source of ω-3 fatty acids and has a favourable effect on the blood lipid levels. As age advances, blood lipid levels and iron stores are also shown to increase. Recent literature revealed that iron status and lipid profiles are positively correlated and may play a part in the epidemiology of CHD. It would be interesting to study these interrelations in such fish consuming communities, who also show high prevalence of iron deficiency anaemia and a different dietary pattern (eg. a rice - fish diet, 2-3 times a day).

In view of this, the present study was taken up on the fishing communities to assess their iron status in relation to their blood lipid profiles, diet and other factors.
The sample of the study comprised of 500 men and women of the fishing community. The subjects were drawn in such a way as to fall into 5 age groups viz. 21-30 years, 31-40 years, 41-50 years, 51-60 years and 61-70 years. In each age group 50 men and 50 women were selected after conducting a preliminary survey in all the 7 hamlets of the Ponnapudi Panchayat using stratified random sampling. General background information of the total sample (n=500) was recorded which included occupation, literacy, economic status, family size, non-nutritional habits and obstetric history of the women subjects etc. In a sub sample (n=300) drawn randomly of 30 males and 30 females in each age group, a three day dietary survey was carried out. Anthropometric data and blood pressure readings were recorded. The assessment of biochemical parameters of iron status and lipid status were included.

Iron status was assessed by estimating haemoglobin levels, packed cell volume, serum iron levels, total iron binding capacity and per cent transferrin saturation (%TS).

Lipid profiles i.e., total cholesterol, high density lipoprotein cholesterol and triglyceride levels in blood were estimated. Low density lipoprotein cholesterol, very low density lipoprotein and TC/HDL-C ratio were calculated. The methods followed to assess the iron status and lipid profiles were as follows.

**Indicators of Iron Status**

- Haemoglobin-Cyanmethaemoglobin method (Dacei & Lewis, 1984)
- Packed cell volume- Wintrobe method (1981)
- Serum Iron- Bathophenanthroline Method
  
  (N. Raghuramulu et. al., 1983, NIN Lab Manual)
- TIBC - Ferric chloride Method
  
  (N. Raghuramulu et. al., 1983, NIN Lab Manual)
% TS - \frac{\text{Serum Iron}}{\text{TIBC}} \times 100

Lipid Profiles

Serum Cholesterol - Parekh & Jung (1970)
Serum Triglycerides - Fletcher Method modified by Foster & Dunn (1971)
HDL-C - Heparin Manganese Precipitation Method
(Warnick and Albers, 1978)
LDL-C - By calculation TC - HDL-C (TG/5)
VLDL - By calculation TC - (LDL + HDL)
TC/HDL-C Ratio - By calculation

After assessing the iron status and lipid profiles of the subjects, in a sub-sample (n=100; 50 males and 50 females) who had higher levels of serum iron and total cholesterol levels were selected and their serum ferritin levels were estimated following Ferritin EIA method (Kit) (White et. al., 1986).

In the three day diet survey, the quantities of foods consumed at each meal were recorded in terms of a steel katori supplied to each subject of the sample. The cup was later standardized in the laboratory and raw weight equivalents of cooked weights of all recipes were determined. The mean nutrient composition of the diets was calculated using tables of food composition (Gopalan et. al., 2000; Ghafoorunissa et. al., 2000; Gopakumar and Nair, 1972 and 1975). The nutrients calculated were total calories, protein, fat, SFA, PUFA, (LA, (n 6), ALNA (EPA, DHA (n-3)) P/S ratio, carbohydrates, fiber, calcium, iron, thiamine, riboflavin, \( \beta \)-carotene, vitamin C and sodium.
Anthropometric measurements like height, weight, waist and hip circumferences were recorded. From this data BMI (Wt. kg/Ht. (m)$^2$) and waist-to-hip ratios were calculated.

Systolic and diastolic blood pressure readings were recorded by using a standard mercury sphygmomanometer, after taking the necessary precautions.

The results of the study were tabulated and subjected to statistical analysis. ANOVA (Analysis of Variance) test, DMRT (Duncan's Multiple Range Test), and 't' test was done to assess the level of significance of difference between any two variables. Correlation coefficient values were calculated to determine the relationships among different variables studied i.e., biochemical, dietary, anthropometric and BP readings.

The results recorded in the present study are given below:

**General Information**

- In the total sample the literacy percentage was 31% among males and 10% in females. In the younger age group of males and females, the per cent literacy was more compared to the old age groups.
- The income of the fishermen subjects ranged from Rs.800/- month to Rs.7500/- month. Majority of the subjects of the younger age groups (21-50 yrs) were found in the income range of Rs.1001-2500/- month. 84 per cent males and 100 per cent females of the elderly age group (51-70 year) had an income of Rs.800/- month. The income of the females was less than that of males.
- The major occupation of the males was fishing, followed by agricultural labour during off season. For females fish marketing and agricultural
labour was the major occupation. Along with these occupations the other activities were cultivation, petty business, vegetable vending, aqua watcher, aqua cooli etc. More than 50 per cent of old people were idle, without doing any work.

- Nuclear families were found in 90 per cent of the fishermen communities. Only widows of the family live with their son's family in a few cases.

- The size of the family ranged between 5 and 10. In younger age groups, the size of the family was less than 5 and in older age groups, it was nearly 10-12 in 10% of the families.

- The work age at entry to work of the men folk ranged from 13 to 17 years. For females it was not specific.

- The mean age at marriage for men folk was 20 years and for women it was 17 years in the younger age groups. However, for older age groups, it was 16 years and 12 years for men and women respectively.

- The age of menarche among women ranged from 11 years to 16 years.

- The number of pregnancies varied from 4 to 12. In younger age groups nearly 66% were having less than 4 children. But in older age groups, it ranged between 4 and 10.

- Deliveries were conducted at home mostly. Few preferred PHCs and very few prefer hospitals.

- Family planning practices were observed mostly in younger age groups but never preferred by older women.

- Non-nutritional habits like consumption of toddy or alcohol, smoking of cigar, cigarette and beedi, chewing of betel leaves, tobacco, ghutka
etc. were observed in major percentage of men folk. In women folk, chewing betel leaves and tobacco was common. Toddy consumption in a few older women was observed.

The daily pattern of food consumption consisted of 3 meals. As breakfast, left over food soaked in water was consumed. At lunch and dinner, rice or ragi with fish or vegetable curry was eaten.

Consumption of cereals and fish, twice or thrice per day was observed. Fish either in fresh or dry form is a regular item in their menu, Consumption of pulses was observed weekly once or fortnightly once and vegetables weekly twice or thrice. Green leafy vegetables, roots and tubers, fruits, milk and jaggery or sugar were consumed occasionally. Eggs and chicken consumption was rare. Sea products such as fish, prawn, crab, snails etc. were regularly consumed.

**Anthropometric Data and B.P. Readings**

The mean heights and weights of men and women of fishermen community were normal. The mean BMI (20.87 kg/m²) and W/H ratio (0.85 cms) indicated the normal statures of this population with the exception of a few who showed higher BMI (>30 kg/m²).

The mean blood pressure readings were in normal range. The mean SBP/DBP of males was 125/81 mmHg and for females it was 121/78 mmHg. Only few males and females of elderly age groups showed hypertension.
Clinical survey data indicated B-complex, iron and vitamin A deficiency symptoms in the subjects of the sample. Along with this deficiency symptoms, joint pains, back pains etc., were also reported.

**Biochemical Parameters**

**Iron Status**

- The mean haemoglobin levels of the total male sample was 9.95g/dl, with a range of 6 to 13.9g/dl. For the female sample the mean was 8.40g/dl, with a range of 5.8 to 11.6g/dl. The difference in values of haemoglobin between males and females was statistically significant (p<0.05). Compared to standard norms, all the subjects showed lower values.

- The mean packed cell volume (PCV) of the male subjects was 34.35% with a range of 22 to 48% and for females the mean was 29.54%, with a range of 21 to 43%. Between males and females the difference in PCV values was statistically significant (p<0.01).

- The mean serum iron values for males was 59.04 μg/dl, with a range of 31 to 96 μg/dl and for females it was 50.98 μg/dl, with a range of 24 to 79 μg/dl. Statistically significant difference (p<0.001) was there between the serum iron values of males and females.

- The mean TIBC levels of the males was 412.14 μg/dl with a range of 307 to 594 μg/dl. For females it was 423.04 μg/dl, with a range of 273 to 581 μg/dl. The higher the TIBC levels, the higher will be the iron deficiency. The difference in values between males and females was significant statistically (<0.05).
The mean per cent transferrin saturation for males was 14.48%, with a range of 7.3 to 23.1%. For females, it was 12.18% with a range of 5.7 to 20.0%. The difference in values between males and females was significant (p<0.001). % TS<16% indicates iron deficiency.

The mean serum ferritin levels for males was 24.62 μg/L, with a range of 12 to 44.6 μg/L. For females the mean was 18.8 μg/L with a range of 9 to 30 μg/L. The mean values indicate iron deficiency state of the individuals but not iron deficiency anemia. It is noted that as age advanced, serum ferritin level also increased in the subjects studied.

Based on these results it can be stated that a good percentage of subjects in the fishing community suffer from iron deficiency anaemia. Female subjects showed a higher deficiency state compared to males.

Lipid Profiles

The mean cholesterol levels of the total male subjects was 142.93 mg/dl, with a range of 74 to 227 mg/dl. For females the mean was 135.90 mg/dl with a range of 88 to 218 mg/dl.

The mean HDL-C of male subjects was 43.0 mg/dl, with a range of 20 to 79 mg/dl and for females, the mean was 43.77 mg/dl with a range of 23 to 70 mg/dl.

The mean TC/HDL-C ratio of male subjects was 3.48, with a range of 0.17 to 8.43 and for females, it was 3.45 with a range of 1.11 to 6.61.

The mean triglyceride levels of the male subjects was 74.86 mg/dl, with a range of 31-137 mg/dl and for females the mean was 75.70 mg/dl with a range of 31 to 141 mg/dl.
The mean LDL-C of male subjects was 84.76 mg/dl, with a range of 24 to 171 mg/dl and for females, the mean was 75.73 mg/dl, with a range of 16 to 161 mg/dl.

The mean VLDL levels of the male subjects was 14.95 mg/dl, with a range of 6 to 27 mg/dl and for females, the mean VLDL was 15.38 mg/dl with a range of 5 to 38 mg/dl.

The difference in the lipid profile values of males and females were not significant.

The normal or lower levels of the lipid profiles observed in this community might be due to the regular fish consumption, which being a rich source of ω-3 fatty acids protects against cardiovascular diseases.

Results of Diet Survey

The mean nutrient composition of the diets consumed by the fishermen subjects was calculated after conducting a diet survey. The results indicated lower intake of all the nutrients by the subjects when compared with RDA.

The grand mean of energy intake of males was 1728 K.cals as compared against 2333 K.cals of RDA and the grand mean intake of energy by females was 1592 K.cals. in comparison with 1867 K.cals of RDA. The RDA's were computed considering age, sex, and activity of the groups.

The mean protein intake was 46.0 g and 36.8g for males and females respectively as compared against the RDA of 60 and 50 g respectively. The dietary protein deficit was about 24% and protein supplied on an average 9-10% of total calories.
The mean fat intake of these groups was also low when compared with RDA. Because of this low total fat intake the SFA, MUFA, PUFA and P/S ratio was also low. Fat supplied 10-11% of total calories in their diets.

The mean per cent of total calories contributed by carbohydrates was above 75% in both the sex groups. Usually about 60-70% of total calories are contributed from carbohydrates.

Against 10g of fiber recommended, the mean consumption of fiber was only 2.3 and 1.8g for males and females respectively.

The mean calcium intake was 348 and 266 mg for males and females respectively against the RDA of 800 and 1000 mg for males and females respectively. There was a 56 and 78% calcium deficit in the diets of men and women respectively.

The mean iron intake was 8.7 mg for males and 6.8 mg for females. The RDA was 28 mg for males and 30 mg for females. There was 60% and 78% dietary iron deficit for males and females respectively.

The mean β-carotene, thiamine, riboflavin and vitamin C intake values for both males and females were deficient by approximately 70% when compared with RDAs.

The diets of the fishermen communities were deficient in all the nutrients when compared with the RDA. This was because of the limited varieties of foods consumed by these people.

The overall iron nutritional status of the fishermen subjects was unsatisfactory. The poor dietary habits i.e. lower intakes of non-haem iron rich foods and iron absorption promoting foods, unhygienic food habits, poor
sanitary conditions, open defecation methods etc., might be the reasons for lower levels of iron stores and iron parameters in the study sample.

Because of the large quantities of fish consumption, the ω-3 PUFAs present in fish seems to help these people by bestowing a few health benefits and protecting them from cardio vascular diseases.

Physical strain or strenuous activities especially when males go to the sea for fishing, emotional stress, and inadequate intake of energy and protein rich foods might have contributed to low and/or normal anthropometric measurements seen in the study sample.

By improving the food habits like promoting the consumption of indigenously grown pulses, fruits and vegetables, green leafy vegetables, and milk and milk products the nutrient intake of these groups could be improved. Better food habits and health consciousness/awareness may be promoted in this community by carrying out appropriate nutrition education/counselling programmes. The people of this community could be taught about low cost or cheaper but nutritious foods which supply most of the micronutrients abundantly. They can be encouraged to grow kitchen gardens and start producing varieties of green leafy vegetables, vegetables like drumstick, and fruits like papaya, mango, citrus fruits etc. Valuable nutrients like vitamin C, β-carotene, iron, calcium and other trace elements and fiber can be ingested by including these foods in the daily diets. Improving the health and nutritional status of people of tribal, fishing communities and of people of remote rural areas should be the goal of any type of nutrition policy or preventive strategy that is planned and implemented by Governmental or any other voluntary organisation, concerned with the welfare of the down trodden and disadvantaged communities.