1. INTRODUCTION
Nutritional anaemia is defined as any condition in which the red blood cells or the haemoglobin content of the blood is below the level that is normal for a given individual (individual needs vary), resulting from a deficiency of one or more essential hemopoietic nutrients. Lack of these nutrients will produce anaemia, and adequate intake will correct it. Three Nutrients fit this definition - iron, folate, and vitamin B12. By far the most common cause of nutritional anaemia is iron deficiency (Stekel, 1986).

Although the amount of iron contained in even the most inadequate diet is considerably more than man's nutritional requirements, iron deficiency remains the most commonly recognized of the nutritional deficiencies. While it reaches its greatest prevalence and severity in developing countries, it is also frequently encountered in affluent societies. The explanation for this paradox lies in the poor bio-availability of much of the iron in the present day diets. Our digestive systems are well adapted to the absorption of the heme iron in meat, poultry and fish (Cox et al, 1968, Layrisse, et al 1968, and Layrisse, et al 1974) it is the iron in rice, wheat, maize and other vegetable staples which is so poorly absorbed (Layrisse, et al 1968) and much of the iron deficiency in the world can be ascribed to the virtual disappearance of meat from the diet of a large proportion of the world's population. The reason why man can absorb the heme in meat products so well and the non-heme iron in grain products so poorly is not known, but may relate, in part at least to the fact that
it is only comparatively recently in evolutionary terms that he has abandoned his hunter/gatherer lifestyle in favour of a more settled agricultural existence (Cook and Finch, 1975).

In India Iron-deficiency anaemia is a major nutritional problem, despite dietary iron intakes of up to 30mg/day in adults (Venkatachalam, 1968). Impaired absorption of iron resulting from high intakes of various anti-nutrients such as phytate (Hussain and Patwardhan, 1959 and Apte and Venkatachalam, 1962), dietary fibre (Rao, et al, 1981), and tannins (Narasingarao and Prabhavathi, 1982) and low intakes of flesh foods has been proposed as the most likely causes of this inadequate iron status (Narasingarao, 1978). Iron deficiency accounts for almost 85% of all types of anaemias in India and affects all ages and both sexes (Shukla, 1982). The most vulnerable are women and children (Dallman and Reeves, 1984). The incidence of anaemia among women and children has been reported to be as high as 60-70% (Narasingarao, 1975-78). In addition many may have iron deficiency without anaemia.

Mild iron deficiency anaemia generally goes unrecognized because it is not overtly symptomatic. There are usually no profound ill effects. Anaemia may give rise to fatigue, irritability, light headedness, headaches, paresthesias, and shortness of breath. These symptoms are usually relieved
by iron administration. The basis for this symptomatology is thought to be associated with tissue iron deficiency as a consequence of depleted iron stores without a significant reduction in haemoglobin level (Garby, 1973).

The pathogenesis and symptoms of iron deficiency are shown in figure - 1.1

Iron deficient food, reduced iron absorption, and increased blood-loss or iron requirement result first in "Prelatent" iron deficiency, characterised by depleted iron stores and increased intestinal iron absorption with, however, still normal serum iron levels and normal total iron-binding capacity (T.I.B.C.) of blood plasma (Henrich, and Bartels, 1967). "Latent" iron deficiency is a more advanced state of iron depletion with permanently low serum-iron levels and increased unsaturated iron-binding capacity (U.I.B.C.) but without anaemia. Finally, manifest iron deficiency is easily recognised by hypochromic microcytic anaemia (Henrich, 1968).

Anaemia reduces the maximum oxygen transport, which is thought to limit work capacity and decrease productivity. Recent investigations have shown that a relatively small drop in haemoglobin level will impair work performance of brief but intense nature. This impairment is proportional to the degree of anaemia (Dallman, 1982). Because treatment with iron reverses the negative effect on work performance, the findings of several studies have been interpreted as providing evidence that fatigue and weakness can be attributed to iron deficiency anaemia (Viteri and Torun, 1974). Although most occupations do not demand a high level of physical activity, there is some evidence that suggests moderate anaemia may limit work performance. Particularly in developing countries, were intensive
Figure 1.1 - Pathogenesis and Symptoms of Iron Deficiency (Henrich, 1968)

Iron deficiency of food

Reduced iron absorption

Blood Loss

Increased iron requirements (pregnancy growth, blood formation).

Depletion of Iron stores
(Males: 0.8g. to < 0.1g., Females: 0.25g. to < 0.05g.)

Increase of $^{59}$Fe absorption
(Males 19% to > 70%, Females 32% to >70%)

Fall of Serum Iron (µg per 100ml)
(Males: 120 to < 80, Females: 100 to < 60)

Increase of plasma transferrin (µg per 100ml)
(TIBC, 360 to 450, UIBC 240 to 450)

Decrease of Hb in erythrocytes
(32 to < 28 pg per erythrocyte)

Hypochromic microcytic anaemia

612g. Hb per 100ml < 4 X 14

Erythrocytes per c.m.m.

Sideropenic dysphagia (atrophy, ulcers)

Koilonychia

Prelatent Iron Deficiency

Latent Iron Deficiency

Manifest Iron Deficiency
manual labour is common place, decreased work capacity may have serious economic consequences (Stekel, 1986). The reduction in the working capacity in presence of unsatisfactory nutritional status has been recently demonstrated in Indonesia and there is no reason why these findings should not hold true for our Country (Shukla, 1982).

To improve the iron status, iron supplements have been given at prophylactic and therapeutic levels. Various studies done on the efficacy of the supplements given (ferrous sulphate, ferrous fumarate and ferric chloride), rely on the haemoglobin level coming back to the normal range. Very few studies are available about the effect of these supplementations on body iron stores. This study was therefore designed not only to assess the prevalence of iron deficiency anaemia in Indian women but also study how it effects their physical work capacity. The efficacy of different types of iron supplements (type and amount) was also compared to see which forms or amounts are more effective in improving the iron status and body iron stores of anaemic women.

OBJECTIVES :

The main objectives of this study were :

1. To assess the prevalence of iron deficiency anaemia and the stages of iron deficiency in Indian women.

2. To study the association (if any) between nutritional status, iron status and physical work capacity in anaemic and non anaemic women and,

3. To study the effect of different types of iron supplementation on the iron status and physical work capacity of anaemic females.