REVIEW OF LITERATURE

CHAPTER 2 REVIEW OF LITERATURE

Iron Deficiency Anaemia (IDA) is one of the most common of the nutritional deficiencies affecting persons of all the ages and socio-economic groups throughout the world.

SECTION I PREVALENCE OF ANAEMIA

Worldwide Prevalence of Anaemia

De Maeyer (1989) reported a prevalence of 51% in pregnant women in the world and as much as 59% in those of the developing countries. As indicated in Table 2.01 the prevalence of anaemia varies between 40-70% in women in places like Burma, Thailand, Bangkok and Indonesia, the average being 65% for the pregnant women of the south-east asian countries.

Prevalence of Anaemia In India

In spite of research regarding anaemia since the 60s all over the world the prevalence of anaemia still continues to be a major public health problem, especially in India, where the prevalence is still between 60 to 80%, the rural and tribal parts having a higher prevalence. The results of various workers are summarised in tabular form in Table 2.01,2.02.

The incidence of anaemia is reported to increase significantly with increasing gestational age. As seen in Table 2.03, the overall incidence of moderate to severe anaemia (Hb <9g %) increased from 14.4% at 16 weeks to 35.8%

Table 2.01 : Prevalence Of Anaemia In India And Abroad

Sr	Author	Year	Place	Subjects	Prevalence*
1	Joshi & Andeigh	1968	Jaipur	Pregnant Women	76%
2	Bonnar et al	1969	Glassgow	Pregnant Women	50%
3	Aung Than Batu et al	1972	Burma	All age groups	42-70%
4	Wasi et al	1973	Thailand	All women Children	45% 45%
5	Sood et al	1975	Delhi & Vellore	Pregnant Women Pregnant Women	80% 87%
6	Christian et al	1978	Chandrapur & Panchmahal	Pregnant Women	90%
7	Shukla et al	1982	Jhansi	Pregnant Women	68%
8	Roy	1984	Chotanagpur	Pregnant Women	65.9%
9	WHO	1987	SE Asian Countries	Pregnant Women	65%
10	Rimdurst	1989	Bangkok Bangkok	All Pregnant Rural Pregnant	30% 40-60%
11	ICMR	1989	India	Pregnant Women	88%
12	NIN	1989	Andhra Pradesh	Pregnant Women	89%
13	Reddiah et al	1989	Delhi	Pregnant Women	46-56%
14	Prasad	1991	Chotanagpur	Pregnant Tribal Pregnant Nontribal	76% 70%
15	Schultink et al	1993	Indonesia	Pregnant Women	42%

* Prevalence = Hb < 11 g/dl

Table 2.02 : Prevalence Of Anaemia In Different Age And Sex Groups (NIN 1983).

Age (Years	Percent Prevalence	
	Male	Female
1-6	71.8	70.4
7-14	47.2	58.2
>=15	30.6	52.7
TOTAL Both Sexes	50.1	

Table 2.03 : Hb Changes And Incidence Of Moderate And Severe Anaemia In Slum Pregnant Women (NIN 1983).

Gestational Age (Weeks)	Overall Incidence Of Anaemia (Hb < 9g%)
< 16 W	14.4%
17-20 W	26.6%
21-24 W	25.7%
25-28 W	29.0%
29-32 W	35.8%
33-36 W	30.3%
> 37 W	25.2%

at 29-32 weeks gestational age, after which, there was a slight reduction in the incidence of anaemia (NIN 1983).

In India there has been no change in the overall picture of prevalence of anaemia especially in pregnant women during the last 20 years. In both hospital and community studies, anaemia has been prevalent any where between 40 to 70% and upto 80% in pregnant women. There are regional and state wise variations and urban and rural differences in the prevalence. However, most of these studies are based on the data collected from under-privileged sections of the community. If the overall population is considered, it is observed that the incidence of anaemia in the upper and middle income group is low and exists only in milder form during pregnancy. Also, maternal deaths have declined from 20-30% in the 60s and early 70s to about 8-10% in the latest maternal mortality surveys of 1986-88 in the hospital and community . The Hb levels of less than 5 gms of 70s are not very frequently seen in the hospital and community surveys of today. So, a definite shift in the Hb levels towards the right is apparent in the population (Raman 1992).

SECTION II IRON DEFICIENCY ANAEMIA

Aetiology of Iron Deficiency Anaemia (IDA)

IDA is a result of insufficient amount of available iron to meet the body's requirement. IDA occurs because of the following reasons :

(1) Dietary inadequacy of protein, iron, folic acid and Vit.B12

(2) Reduced bio-availability of dietary iron.

(3) Iron malabsorption due to chronic diarrhoea, malabsorption syndrome, sprue or gastro-intestinal surgery.

(4) Increased requirements due to

  (a) Acceleration of growth imposing increased requirements for iron, mainly for haemoglobin production.

  (b) Dual stress of growth and conflicting demands of work in and outside the home, for adolescent girls.

  (c) Increased growth needs for pregnancy and lactation.

(5) Chronic blood loss due to

  (a) Intestinal infestation due to hookworm and other parasites or gastro intestinal bleeding.

  (b) Iron losses due to menstruation in women of reproductive age.

(c) Increased blood loss from genital tract due to menorrhagia or abortion.

(Dallman et al 1980, Sjolin 1981, Ramachandran 1985, Fleming et al 1987, Hercberg et al 1987, Lokeshwar et al 1992). IDA is the chief prevalent cause of anaemia, though in pregnant women, there is a concomitant deficiency of folic acid (Yusufji et al 1973, Colman et al 1975, Baker and De Maeyer 1979). These factors are tabulated in Table 2.04.

Body Iron Compartments

An average adult body contains about 3-5 gms of iron while children have 55 mg/kg body weight. As can be seen from Table 2.05, 70% of the iron in the body is in the form of Hb, 26% constitutes the iron stores and 3.9% is incorporated into myoglobin and other iron containing enzymes. Plasma iron forms only 0.1% of the body iron (Bothwell and Charlton 1981, Lokeshwar et al 1992, Ingle 1992).

Iron Cycle in the Body

Iron balance in the body is maintained by controlling absorption of iron rather than its excretion. Most of the body iron is recirculated and only 1 to 1.5 mg is excreted daily. Thus the daily requirement of iron is minimal (Lokeshwar et al 1992). Iron requirements arise due to endogenous losses, requirement for growth and building-up iron stores from infancy to adulthood (Moore and Dubach 1962, Bothwell et al 1979).

Table 2.04 : Eitological Factors In Iron Deficiency Anaemia

Decreased Iron Assimilation	Blood Loss	Increased Physiological Requirement
* Iron Poor Diet	* G.I. Bleeding	* Prematurity
* Iron Malabsorption - Chronic diarrhoea and malabsorption syndrome - sprue - G.I. Surgery	- Hookworm infestation, Peptic ulcer, Diverticulitis, Milk induced enteropathy	* Period of Growth -Infancy -Adolescence
* Pica	* Aspirin and drugs * Feto-maternal transfusion * Early clamping of cord *Bleeding disorders	

c.f. Lokeshwar et al (1992)

Table 2.05 : Iron Containing Compounds In A 55 kg Woman (Approx)

	Compounds	Amount (mg)
Functional Compounds	Haemoglobin	1700
	Myoglobin	222
	Heme enzymes	50
	Non-Heme enzymes	55
	Transferrin	3
		2030
Storage Complexes	Ferritin	200
	Haemosiderin	70
	TOTAL	2300

c.f. Bothwell and Charlton (1981)

External Iron Exchange

Iron balance is maintained by adjusting the iron losses of the body with it's absorption. If adequate iron nutrition is to be maintained, the amount of iron absorbed must meet the daily losses from the body.

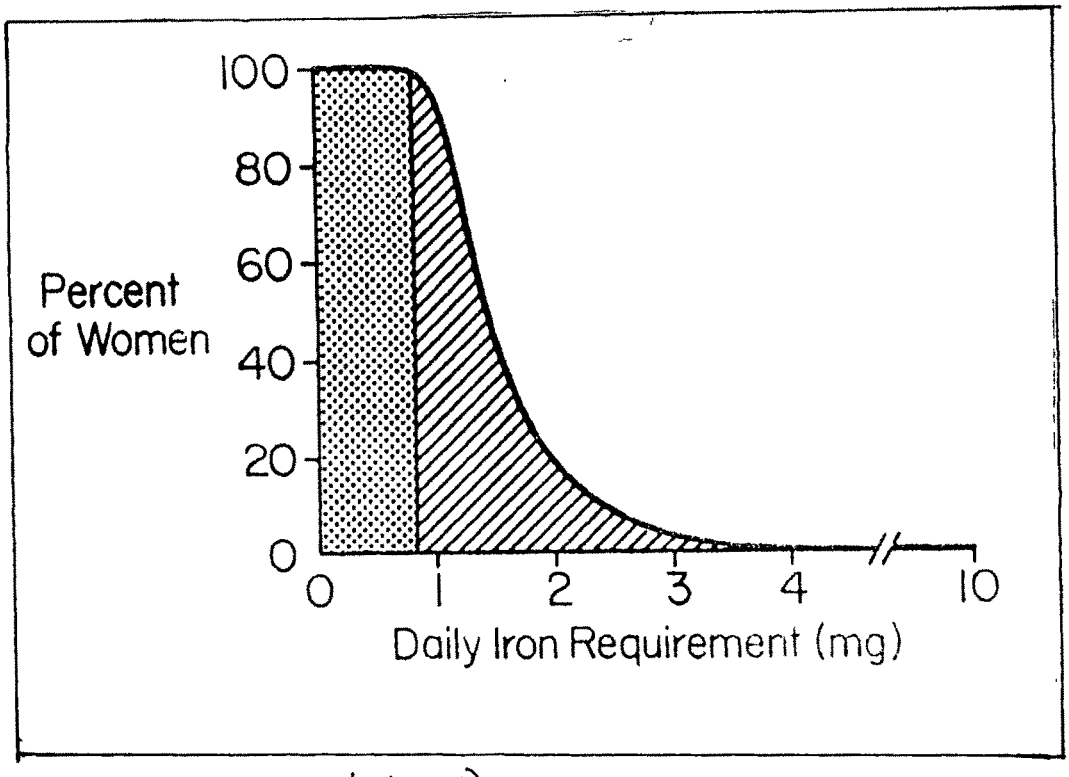
(1) Iron Losses : In women, the daily losses are due to daily basal obligatory iron excretion and extra losses incurred due to menstruation, pregnancy and lactation.

(i) Basal iron losses :- They are due to desquamation of surface cells, with their small amounts of functional and storage iron from skin, gastro-intestinal tract and urinary tract and minimal gastro-intestinal blood loss occurring even in healthy individuals. Small quantities of extra cellular iron is also lost in sweat, bile and urine. In women,iron losses may be between 0.7 to 0.8 mg/day (Bothwell and Charlton 1981).

(ii) Menstruation :- Menstrual losses have been estimated in two large groups of women, Swedish and British. The finding of both the studies indicate median blood loss to be 30 ml and 26.5 ml respectively. It was predicated from the graph constructed on the basis of these findings by Hallberg and co-workers that in order to maintain the iron balance of 90% of the population, 2.2 mg of iron is required daily ie. 0.8 mg basal loss + 1.4 mg for menstrual loss (Hallberg et al 1966). This is explained in Figure 2.01.

(iii)Pregnancy :- Pregnancy is associated with temporary

Figure 2.01: Daily Iron Requirements Of Normal Women



C.f. Bothwell et al (1979).

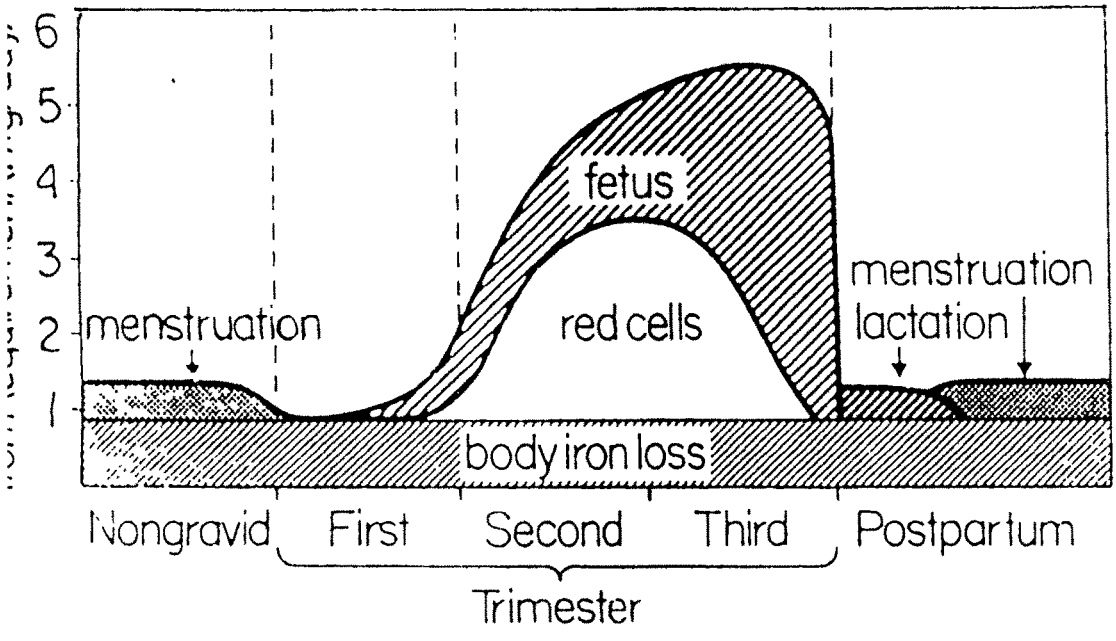
cessation of menstruation. However, the overall cost of iron is greater than in non-pregnant state. The total iron requirement of a 55 Kg woman is more than 1000 mg, but the net cost of pregnancy is less than this, since a large part of the iron requirement is for the expansion of the maternal red cell mass and most of this iron is returned to maternal stores after the delivery. The need for iron varies in the three trimesters. The iron requirement is reduced during the first trimester because menstrual blood losses are none. However, from the beginning of the second trimester there is major expansion in maternal red cells continuing into the third trimester requiring about 450 mg additional iron. However, the haemoglobin concentration tends to fall about 1 g/dl during the second trimester. This "physiologic anaemia" is due to increase in the plasma volume, resulting in haemodilution. During the last half of the pregnancy, the iron requirements for the growing foetus, umbilical cord and placenta are especially higher, since more than three quarters of the growth occurs during this period. This is evident from Figure 2.02. The total iron losses during pregnancy are indicated in Table 2.06. Thus, the average daily amounts needed in each trimester are :

First trimester:

±1 mg daily [Basallosses 0.8mg/day + minimal foetal and red cells needs ±30-40mg]

Second trimester:

Fig 2·02 Daily Iron Requirements During Pregnancy



adapted from
Bothwell et al (1979)

Table 2.06 : Iron Losses During Pregnancy in a 55 kg Iron Replete Woman

Gross Losses	Amount Of Iron (mg)
Foetus	280
Umbilical Cord and Placenta	90
Maternal Blood Loss	150
Obligatory Loss From Gut etc During Gestation	230
Expansion of Maternal Red Cell Mass	450
Gross Total	1200
Net Losses	
Contraction of Maternal Red Cell Mass After Delivery	450
Net Total	750

c.f. Bothwell and Charlton (1981)

±5 mg daily [Basal losses 0.8 mg/day + red cell needs 300 mg + conceptus needs 115 mg]

Third trimester :

±5 mg daily [Basal losses 0.8 mg/day + red cell needs 150 mg + conceptus needs 223 mg]

(Bothwell and Charlton 1981)

(iv) Lactation :- The iron losses of menstruation are also saved during lactation due to the post partum amenorrhoea. However, some iron is required during lactation. The iron loss of lactation is estimated to be 0.1 mg, 0.28 mg and 0.27 mg/day at 1,2 and 3 months respectively (Bothwell and Charlton 1981).

(v) Pathological blood losses :- Pathological blood losses can affect basal losses in women, the most important ones are those involving increased blood loss from the gastro-intestinal tract due to infestations. The prevalence of this can be very high in some communities to significantly affect the overall iron balance. The pathological losses also occur from the genito-urinary tract (Bothwell and Charlton 1981).

Stages of Changes in the Body Iron Content

Iron deficiency develops in three stages

(1) **Iron Depletion :** At this stage there is a simple decrease in iron stores without any effect on the essential body iron.

It is characterised by a fall in plasma ferritin levels and reduced iron concentration in liver and marrow tissues. Iron absorption increases at this stage. Hb, serum iron, transferrin concentration and saturation are within normal limits (Cook 1982, Lokeshwar et al 1992).

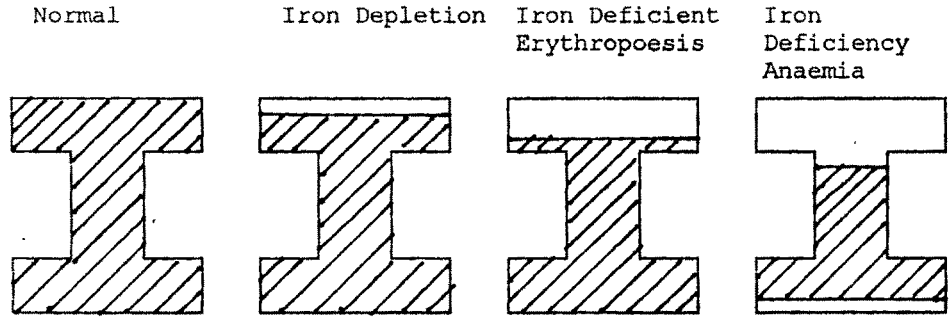
(2) Iron Deficient Erythropoiesis : Due to insufficient iron intake, there is curtailed iron supply to the erythropoietic cells of the marrow resulting in insufficient erythropoiesis. A decrease in serum iron and an elevation of total iron binding capacity as well as erythrocyte protoporphyrin (EP) may be noticed. Due to restricted iron supply to the red cells, EP rises, indicating a fall in Hb. The Hb concentration may fall slightly at this stage but it will still be within normal range (England et al 1976).

(3) Iron Deficiency Anaemia : At this stage, there is a sufficient fall in haemoglobin due to an impaired flow of iron to erythroid marrow. This is recognized as anaemia (INACG 1981). Most of the circulating red cells are replaced by microcytic and hypochromic red cells. At this stage, depletion of functional iron-containing compounds in the extra erythroid tissues viz. myoglobin, cytochromes & other iron containing enzymes may also occur. These changes are explained in Figure 2.03. The changes in the parameters to define the iron status as the iron deficiency progresses are depicted in Figure 2.04.

Criteria for Assessing Anaemia

When the Hb concentration falls below the level

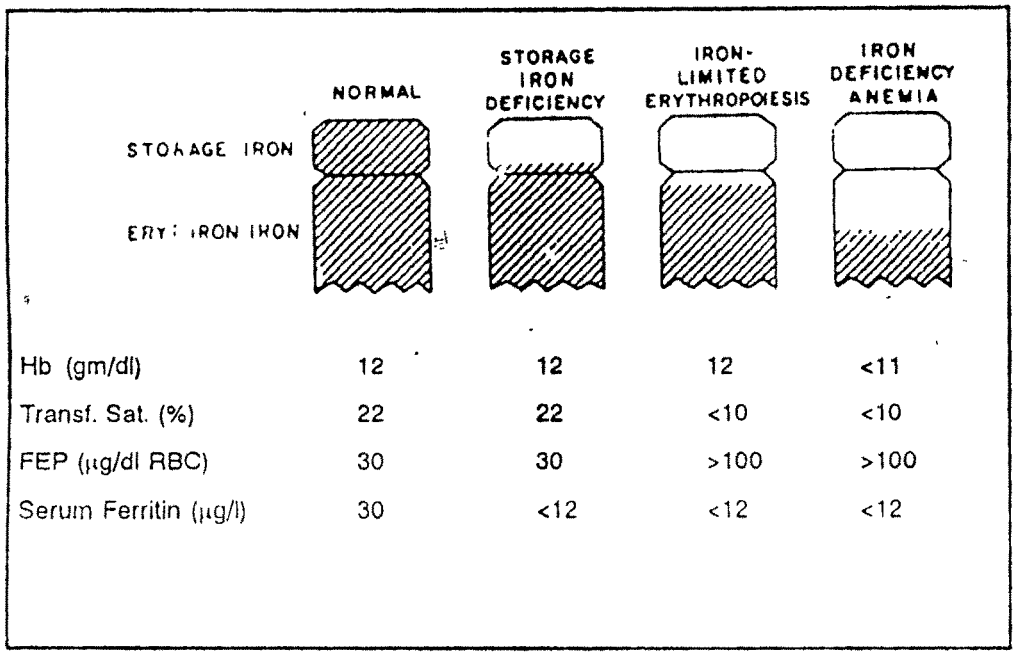
Fig 2.03: Sequence Of Changes Induced By A Depletion Of Iron Content In The Body.



RE Marrow Iron [0-6]	2-3	0-1	0	0
Transferrin IBC[mcg/dl]	330 + 30	360	390	410
Plasma Ferritin [mcg/l]	100 + 60	20	10	< 10
Fe Absorption	Normal	↑	↑	↑
Plasma Fe [mcg/dl]	115 + 50	115	< 60	< 40
Transferrin Saturation%	35 + 15	30	< 15	< 10
Sideroblast [%]	40 - 60	40-60	< 10	< 10
RBC Protoporphyrin [mcg/dl RBC]	30	30	100	200
Erythrocytes	Normal	Normal	Normal	Microcytic + Hypochromic

[Cf : Bothwell etal,1979.]

FIG 2.04 STAGES OF IRON DEFICIENCY



Hb (gm/dl)	12	12	12	<11
Transf. Sat. (%)	22	22	<10	<10
FEP (μg/dl RBC)	30	30	>100	>100
Serum Ferritin (μg/l)	30	<12	<12	<12

Fig. 3. Stages of iron deficiency. Numbers in lightface type are approximate median values for normal children 1 to 12 years old. Those in bold type identify the abnormal values that define the stage of iron deficiency. Hb: Hemoglobin; transf sat.: transferrin iron saturation; FEP: Free erythrocyte porphyrin.

considered normal for the particular age or sex group, anaemia is diagnosed to exist.

Though anaemia has been accepted as a major health problem since 5 decades, the development of acceptable cut-off points to define anaemia in various groups of population has not been uniform (Raman 1992).

Several cutoff levels have been used by various researchers. However, the generally accepted cutoff levels below which anaemia is considered to exist are given by WHO (1989) as follows :-

Age/Sex group	Hb Levels (g/dl)
Children 6 months - 5 years	< 11
Children 6 - 14 years	< 12
Adult males	< 13
Adult females (non-pregnant)	< 12
Adult females (pregnant)	< 11

Various degrees of anaemia have been classified by WHO (1991) as given below :-

Hb	Severity
7 - 10.9 g/dl	Moderate Anaemia
4 - 6.99 g/dl	Severe Anaemia
<4 g/dl	Very Severe Anaemia

Consequences of Anaemia

Since anaemia is most easily recognizable manifestation of iron deficiency (ID), it is thought to be the sole consequence of lack of iron. However, while the major portion

of body iron exists in haemoglobin, it is also an important constituent of myoglobin in muscles and heme and non-heme iron dependent enzymes in cells, playing an important role in cellular respiration and other biochemical reactions (Bothwell and Charlton 1981, Mehta 1988).

The long known deleterious consequences of anaemia on psychological, cognitive and physical development, behaviour and work performance, as well as poor obsteteric outcome, make it a matter of serious concern. Several studies have reported the adverse consequences of anaemia on health which are reviewed below.

Iron Deficiency and Work Performance : Myoglobin accounts for only 4% of the total iron. Myoglobin is involved in oxygen transport across the muscles cells and is stored in the muscles. Hence, iron deficiency results in impaired work performance and affects behaviour (Mehta 1992). Even the mildest degree of iron deficiency may have significant functional consequences (Gardner et al 1977, Seshadri et al 1982, Scrimshaw 1984, Seshadri and Malhotra 1984, NIN 1986, Bhatia and Seshdri 1987, ICMR 1989, Satyanarayana et al 1990) and supplementation has a beneficial effect on physical work capacity (Scrimshaw 1984, Bharadwaj 1986).

Cognitive Performance and Behaviour : Psychological and behavioral changes in terms of decreased attention span, fatigue and insecurity have been reported by Scrimshaw (1984), Fleming (1987), ICMR (1989), WHO (1989) and Mehta (1992). In children, impairment in cognitive function is also reported by

Seshadri et al (1982), Pollitt et al (1985), Bharadwaj (1986) and Seshadri and Gopaldas (1989). This is manifested in terms of poor concentration, poor scholastic performance and absenteeism from school.

Pollitt et al (1981) reported that the alterations in cognitive functions of children with mild iron deficiency without anaemia were reversible. Pollitt et al (1985) reported an improvement in scholistic performance of 10 year old children measured by standard achievement tests after iron supplementation.

Oski and Honig (1978), Lonzoff et al (1982) and Scrimshaw (1983) reported significantly improved reactivity and coordination in iron deficient infants tested on Bayley Scales of Infant Development after treatment with iron.

Iron Deficiency and Immunity : Anaemia is also known to produce impaired immune response, decreased phagocytic function and defects in cell mediated immunity, as has been reported by Chandra and Saraya (1975), Scrimshaw (1983), WHO (1989).

Studies by Basta et al (1979) on rubber plantation in Indonesia showed a decrease in frequency of infectious disease especially diarrhoeal and respiratory infections in anaemic workers after iron supplementation.

Iron Deficiency and Pregnancy Outcome : IDA during pregnancy is a major contributor to high maternal and perinatal mortality and morbidity (Tasker 1958, NIN 1983 and Reddiah et al 1989).

Increased risk of maternal morbidity and mortality, increased foetal morbidity and mortality and increased risk of LBW among anaemic women were also reported by WHO (1989).

Increased frequency of infection, less reserves of iron to stand the stress of haemorrhage at delivery and risk of heart failure in severe anaemia during pregnancy have been reported by Fleming (1987). In India, anaemia is a cause of as many as 23.3% of maternal deaths during pregnancy and child birth (Government of India Health Statistics report 1987). However, WHO (1993) had attributed 16% of all maternal deaths in India to anaemia. The total death per 100,000 live births attributable to anaemia were 38 in India, the corresponding figures for Pakistan and Senegal being 194 and 35. These deaths were mainly due to increase in post partum haemorrhages and blood loss.

Anaemia also contributed to increased incidence of still births, premature births and reduction of infant birth weights (Gopalan 1972, Yusufji et al 1973, Vijayalakshmi and Usha 1981, Scholl et al 1992 And Nutrition Reviews 1993).

Increased risk of premature delivery due to anaemia is also indicated by Prema et al (1981b) in urban women belonging to low socio-economic group in India and by Garn et al (1981) for pregnant women in USA. Bhargava et al (1973) reported that, of the anaemic mothers,28.2% had LBW babies. Tyagi et al(1984) reported LBW babies among almost all preterm babies born to mothers with Hb<11 g/dl. The authors also reported that with similar mother's weight, women with low Hb levels

had greater number of LBW children.

Prema et al (1981b) reported a progressive increase in birth weight with increase in maternal Hb,the incidence of LBW infants increasing from 23% for women with Hb >11g/dl to 62% in those born to women with Hb <5g/dl.

Higher incidence of foetal deaths, decreased gestational duration, LBW infants and medical abnormalities have been reported to significantly occur at both ends of the haematological distributions viz. Hb < 10 g/dl and Hb >= 13 g/dl (Garn et al 1981, Murphy et al 1986).

Cardiovascular Changes : Cardiovascular effects of anaemia are decrease in oxygen carrying capacity of blood, decrease in blood viscosity and increase in heart rate (Finch and Lenfant 1972, Roy et al 1963 and Davis et al 1973).

Mehta (1992) reported electro physiological abnormalities of heart in patients with IDA and its correction by iron therapy. He also reported impaired peripheral nerve function and secondary malabsorption from small bowel due to decreased respiratory enzymes in the intestinal mucosa

Poor temperature regulation, impaired motor development and co-ordination (ICMR 1989) and impaired growth in children (Garn and Smith 1983) are some other consequences of anaemia.

SECTION III STRATEGIES TO PREVENT AND CONTROL ANAEMIA

A number of strategies have been suggested for the prevention and control of anaemia : dietary modification, control of viral, bacterial and parasitic infestations, food fortification and supplementation with medicinal iron being the important ones, are discussed hereunder in detail.

(1) Dietary Modification : In poor communities iron intake can be increased by two means :

(i) Increase in total energy intake without changing the availability of iron. The amount of increase in iron intake depends on the extent to which the existing energy gap is bridged. This implies, increase in the purchasing power of the families, which is out of the means of health sector.

(ii) Improving the quality of diet. This implies the bioavailability of iron. However, addition of meat and Vitamin C rich foods is not a practical solution due to religious objections and high cost, especially among the poor in whom anaemia is most prevalant. Also, since change in dietary habits is difficult to make, it is not a reliable measure of decreasing the prevalence of anaemia in the community (WHO 1989, Lokeshwar et al 1992, Dodd 1992).

(2) Control of Viral, Bacterial and Parasitic Infections : The adverse nutritional consequences of viral and bacterial disease could be decreased by timely preventive and curative measures (Lokeshwar et al 1992).

However, to control these, good environmental sanitation and hygiene is a good preventive public health measure, which can be made possible by improving the living conditions of the poor by improving the economic status, which is not possible for the health sector to undertake.

Also, though parasites are undesirable from nutritional as well as health point of view, without eradication of the parasites from the environment, reinfestation is bound to occur after deworming. The provision of additional iron through food fortification or medicinal iron results in greater increase in the Hb levels without deworming and hence is a more practical solution (De Maeyer 1989).

(3) Food Fortification : "Fortification" means "the process whereby nutrients are added to foods to maintain or improve the quality of diet of a group, a community or a population". It can be applied to large population groups at low cost and has the advantage that the cooperation of the individuals is not a prerequisite as it is with supplementation (INACG 1981). However, the major difficulty is to identify suitable widely consumed food to be fortified and the form of iron that is adequately absorbed without alternating the form, texture and taste of food. Fortification with iron is more difficult, since bioavailable forms of iron produce undesirable changes in odours, flavour and discolouration of foods by chemical reaction. Also, in the developing countries the infrastructure for centralized production and distribution of foods is lacking, which makes fortification more difficult.

(4) Supplementation with Medicinal Iron : Supplementation involves giving iron in medicinal form. This is the only feasible approach when the iron requirement is large and a relatively short time span, as during pregnancy is available (INACG 1981). Dodd (1992) also reported that supplementation with medicinal iron is advantageous, since rapid improvements in the iron status are achieved and can be targeted to specific vulnerable groups. Various compounds of iron, that can be used for supplementation are known, their extent of absorption, the cost and optimum dose required have already been established. In comparison to the other alternatives, oral supplementation with medicinal iron is the strategy of choice for the prevention and control of iron deficiency anaemia, in the community, until the improvement in the economic status of the community is achieved (WHO 1989).

Apart from these, Raman (1992) has suggested certain strategies to improve the iron status in the community : (a) Improvement in the sanitation and hygiene of the community to prevent the communicable diseases responsible for draining the body iron. (b) Health education to the health functionaries and the community regarding anaemia and its consequences, importance of consuming iron rich foods and tablets and cleanliness. (c) Creating awareness regarding the magnitude of anaemia and its deleterious effects on health among the administrators, industrialists, village officers, panchayats, doctors and grass-root level functionaries (d)Deworming and malaria eradication in endemic areas. (e)Social marketing

strategy to make the messages acceptable, leading to change in behaviour and ultimately nutritional status.

Programs to Combat Anaemia In the World

In order to reduce the high prevalence of anaemia various programmes have been launched in different parts of the world. The Indonesian government started implementing iron supplementation programme to reduce the high rate of anaemia. Health staff were instructed to distribute iron and folic acid tablets to each woman throughout third trimester of pregnancy free of charge in the form of 3 platic begs, each containing of ferrous sulphate (equivalent to 60 mg of elemental iron). Pregnant women were told to take 1 tablet per day by the health-care staff and return to the health centre after finishing the tablets.

The evaluation of the Indonesian supplementation programme was done after about 10 years of its inception to assess the compliance of programme participants and effectiveness of the ongoing iron supplementation programme in Jakarta, Indonesia. The women were questioned about compliance and stool samples were checked for iron content. Prevalence of anaemia was 42% at the beginning of the study period, which decreased during the study period. After the dropouts, 64% women claimed to have taken all iron tablets but this was confirmed by positive stool tests in 12 women only. Compliance was low. The most important reason for not taking the tablets was that they just forgot without any further explanation. It

was concluded that iron dose needed to be increased and that supplementation programmes need a reliable monitoring and evaluation system (Schultink et al 1993). Thus the anaemia control programme in Jakarta, Indonesia did not show very encouraging results at the time of evaluation.

Anaemia Prophylaxis in India

In India, the National Nutritional Anaemia prophylaxis programme was started in 1970 with the objective of decreasing the prevalence of anaemia. The beneficiaries of the programme are pregnant and lactating women, family planning acceptors and children below 6 years of age.

Existing Delivery System of Iron Folate Distribution : As already mentioned earlier, the NNAPP programme was floated in 1970 during the fourth five-year plan by the Government Of India. It was started with the objective of reducing the prevalence of anaemia in pregnant and lactating women, family planning acceptors and children 1 to 12 years of age.

Distribution of Supplements : Iron and folic acid were provided in the form of red sugar coated tablets. Each tablet contains 60 mg of elemental iron in the form of ferrous sulphate and 0.5 mg folic acid to be given for 100 consecutive days to all the beneficiaries each year of their beneficiary status. Children received 20 mg of iron and 0.1 mg folic acid per tablet for 100 consecutive days each year. Tablets were given for 15 days or for a month for the sake of convenience. The programme was expected to be implemented through all

institutions rendering family planning and MCH services like the primary health centres (PHCs), their subcentres, maternity homes, urban family welfare programme (FWP) and anganwadi centres (AWCs). Therefore the ANMs, female health assistants (FHAs), lady health visitors (LHVs), the community volunteers and anganwadi workers were the grass-root level workers involved in the distribution of the tablets.

The dose level of iron for pregnant and lactating women has recently been raised to 100 mg per day. The programme has also been renamed as Nutritional Anaemia Control Programme (Ministry of Health and Family Welfare, Government of India and UNICEF 1989).

Estimation of Requirements and Cost Consideration : The number of tablets are supposed to be ordered on the basis of the requirements estimated from the population. However, the number of tablets ordered by the government is fixed by the budget and not by the requirements. The family planning department procures tablets for 13 million mothers and 13 million children annually. Orders are placed with the instructions that the cost should not exceed Rs.8 per thousand tablets. At the time of the inception of NNAPP, provision was made for a million women per year. For the estimated 12 million pregnant women (70% of the pregnant population) in whom the prevalence of anaemia was expected to be higher, the cost was Rs.13.2 million per year which was out of reach at that time (Seshadri 1985).

Storage and Distribution : These tablets are stored in the medical store depots in Delhi, Hydrabad, Madras, Calcutta and Bombay. The district health centres (DHCs) in each state make a requisition to the state family planning officer who sends these to the department of family planning, who in turn instructs the medical store depots to supply the drugs to the district health officers. From here the supply is delivered to the PHC medical officer who in turn supplies the tablets to the ANMs. The CHVs and the AWWs collect the tablets from the ANMs. The ANMs and the AWWs distribute these tablets to the beneficiaries in the AWCs run under the ICDS scheme. Since private gynaecologists and government or trust run hospitals also provide MCH services, they are also expected to distribute free iron tablets to their beneficiaries (Seshadri 1985).

About 2 decades after its inception, the NNAPP was evaluated at the national level (ICMR 1989). The results of NNAPP evaluation were not very encouraging. It indicated that the prevalence of anaemia has not decreased significantly during the last two decades and the program itself had not made any significant impact on the prevalence of anaemia. The results revealed that only 19% of the pregnant women received more than 90 tablets (considered to be effectively complete supplementation). A vast majority of beneficiaries received less than two-third of the recommended supplement dose. Only 4% of the subjects reported gastro-intestinal upsets/ constipation, nausea/vomiting or a combination of more than

one side effects and so it cannot be considered a major factor affecting compliance. Sixteen percent of the pregnant women who received the tablets reported to discontinue consumption for reasons other than irregular supply. Poor coverage of pregnant women through NNAPP, viz 1.6% in Bihar and 16% in Uttar Pradesh has also been reported by NIN (1989). Thus, the programme need to be implemented more efficiently.

Reasons for Less Effectiveness of Programme : In the NNAPP programme the evaluation revealed that as few as 12% of the beneficiaries including pregnant women had received complete dose of tablets (more or equal to 90 tablets). Since the supply of the tablets was not regular and the tablets did not even reach the women, the question of consumption or decrease in prevalence of anaemia did not arise. Irregular supply and logistics of the current system, inadequate training of the staff with respect to their knowledge regarding anaemia and awareness of the importance of controlling anaemia and distribution of iron tablets, lack of motivation to work more efficiently and inadequate monitoring and follow up of tablet distribution are some of the main reasons for improper functioning of the present system of iron folate distribution (ICMR 1989, NIN 1989, Raman 1992).

SECTION IV PERCEPTION OF WOMEN AND GRASS-ROOT LEVEL FUNCTIONARIES REGARDING ANAEMIA.

In the present delivery system of iron folate distribution the ANMs, AWWs, FWCs and LMOs are responsible for distributing iron tablets to the beneficiaries. Therefore, it is essential that the functionaries are aware regarding iron deficiency anaemia, its causes, symptoms and treatment, benefits of taking iron tablets and the dose of iron to be taken. It is also necessary that the beneficiaries themselves are aware about the causes and consequence of anaemia so that they perceive the need to take iron tablets. Very few studies are available in literature which report the knowledge of the ICDS functionaries regarding anaemia.

Knowledge of the Functionaries

In a study conducted by Nutrition Research and Training Centre (NRTC 1990) on the situational analysis of NNAPP and NVAP, it was reported that in most of the FWCs, ANMs, ICDS ANMs and supervisors were aware of the women as beneficiaries of NNAPP. Seventy percent of the AWWs were aware about the pregnant women as beneficiaries. Majority of the ANMs, supervisors and AWWs perceived the beneficial effect of iron folic acid supplement to be for the prevention of anaemia. Majority of the functionaries stated pallor as a symptom and more than half of the supervisors and ANMs mentioned fatigue

as a symptom.

The total dosage of 90 to 100 iron folic acid tablets was known to over 90% of the functionaries but some were confused regarding the dose of tablet per day (NRTC 1990).

Seshadri (1987), studied knowledge regarding anaemia of both the supervisors and AWWS. The urban supervisors were much more knowledgeable than those in tribal areas.

As many as 60-63% of AWWs could recognize anaemia and stated pallor as a symptom. Only 10% of the AWWs perceived iron tablets should be taken for the prevention of anaemia. The awareness regarding causes, symptoms, prevention and treatment of anaemia specially with respect to iron tablets was very low among the AWWs. Similar results of low knowledge of AWWs regarding anaemia were reported by Sharma (1986) in the evaluation of ICDS services in three blocks of Rajasthan, NIN (1989) in the evluation of NNAPP in Andra Pradesh and Walia et al (1978) in Nurpur Bedi block of Roper District in Punjab.

Women's Knowledge

(i) Women's Awareness Regarding ICDS Services : Mother's awareness regarding ICDS services was low. As reported by Seshadri (1987), most women perceived the programme as a supplementary programme with few other inputs like immunization.

(ii) Awareness Regarding Anaemia : As many as 50% of the subjects in the family welfare centres and ICDS had no

knowledge regarding the benefits of iron tablets. The other half thought that it gave "Shakti" (energy) to the body. Although all the beneficiaries were supposed to take a single tablet each day, many pregnant and lactating women reported taking two tablets (NRTC 1990). Seshadri (1987) reported that mothers were not familiar with "Pandurog" (anaemia) though they were aware of some disease related to a deficiency of blood. Most women were not able to recognize anaemia; didnot know its cause, symptoms and prevention. Similarly none of the women in tribal areas and only 3% in urban areas could perceive iron tablets as a cure for anaemia and seeking medical help was not thought of. Similar results were reported by Sharma (1986) in evaluation of ICDS in Rajasthan.

These studies report inadequate knowledge regarding anaemia, its prevention and treatment among the AWWs and not surprisingly, among the women in the community. Due to lack of awareness, the women are not likely to demand the tablets or utilize the available services. In order to ensure that the women receive and consume their iron tablets regularly it is essential that they are made aware regarding the available services.

Although studies have shown that it is difficult to change the behaviour of the subjects (Chavez 1972 and Mathews 1980), with the experience of the past years and the present communication and marketing strategies, an education programme should be prepared to convince the women regarding the consumption of iron tablets.

SECTION V COMPLIANCE WITH THE PRESCRIBED DRUGS

Christensen (1978) defines drug taking compliance as "a response by the patient to a sequence of testing and illness-redefinition stages during the course of an illness". He assumes the patient as a person constantly assessing the decision to comply with the prescribed instructions as he or she seeks medical help and recovers.

Many researchers have indicated poor compliance with the prescribed treatment regimen especially with iron folate tablets. Bonnar et al (1969) in their study on pregnant women judged compliance with stool test and reported that at the end of the first month of treatment as many as 25% women were not regularly taking oral iron and by the second month 35% of women stopped taking their iron tablets. The women who were anaemic at the start of pregnancy were least likely to take their iron. Therefore, detection of non co-operative patient becomes important in the treatment of anaemia.

Factors Affecting Compliance

Studies on the compliance have explored factors responsible for the non-compliance which can be summarized as under :

1. Factors Related To The Patient

(1.1) **Social Desirability** : Socially, pregnant women are expected to continue their routine tasks and bear the

discomforts associated with pregnancy without complaining. Women who complain about symptoms associated with pregnancy are looked down upon. Hence symptoms associated with anaemia like tiredness, breathlessness, listlessness, decreased physical work capacity and so on are considered a part of the pregnant situation per se, and are to be tolerated. Therefore they are not considered important enough to seek health care. Due to this attitude of the women they tend to just forget taking the prescribed iron tablets (More et al 1991, Raman 1992, Kanani 1994). Schultink et al (1993) in their study in Jakarta also reported that the most important reason given by pregnant women for not consuming iron tablets was that they just forgot to take them without further explanation.

(1.2) Women's Beliefs and Attitude Towards Taking Medicines During Pregnancy : The utilization of health care services and the compliance to the prescribed drugs depend on the patients' beliefs regarding the illness, the cause of the disease, symptoms and the expectation from the prescriptions of the doctor or the health care provider (Bledsoe and Gouboud 1985). According to Dudley (1979), a patient seeks health care from a health authority when he or she perceives himself or herself to be "ill". In that case, the patient seeks health care from any one whom she "feels" appropriate for giving advice. Also the placebo effect can give relief of worry to 30-70% of the patients and relief from disease to about 30% of any group of patients treated. Therefore, a patient's experience tells her that she can get cured even without treatment and therefore

she continues with her life without treatment.

Since pharmacheuticals are becoming a part of the patient's strategies in the third world countries, allopathic medicines were perceived and used within their traditional frame work with very different assumptions as to the properties of the drug, the body and the cause of the disease. Therefore in accordance with the traditional system of treatment, the form in which the drug is administered (injection, tablet or liquid), the colour and the taste of the pill and even the time of the year influences the patients willingness to take the drug offered (Essential Drugs Programme 1985). Since iron supplements are considered as medicine, the factors affecting the use of drugs also influence the acceptance of iron treatment and hence, studies on drug therapy compliance are also included here.

Maxican women believed that iron was absorbed only during the first trimester of pregnancy and hence compliance was low if the tablets were offered later (Galloway and Mc Guire 1994).

Prema et al (1982) and Nichter (1980) observed that in India the women of low socio-economic group consider injections to be more effective and hence readily accept them but they do not take tablets regularly. Similar observations were made for Maxican women (Galloway and Mc Guire 1994).

Nichter (1980) reported that for the villagers in south Kanara, the colour and taste of the tablets indicated the property of the medicines. Tablets were also considered to be

difficult to digest and therefore cause ill effects to the foetus, whereas injections were considered to be too powerful and having "hot" effect. So they were perceived to cause miscarriage. Hence pregnant women prefer liquid medicines for all ailments.

The Mende in Sierra Leone chose red foods and medicinal substances since these were traditionally used to purify or replace blood. Hence all western medicines red in colour like iron tablets, diuretics, pile tablets and folic acid tablets were considered suitable for blood. Similary Maxican women were reported to prefer red iron pills compared to white or brown ones since red colour was thought to strengthen and purify the blood (Galloway and Mc Guire 1994).

Women in South India rejected ferrous sulphate, tetanus toxoid and multi vitamin tablets offered to them free of cost (Nichter And Nichter 1983). These tablets were considered to be inappropriate since pregnant women thought that they caused "big babies" which were not necessarily healthy but were thought to cause more difficult delivery. The fact that pregnant women perceived that iron tablets caused big babies and hence difficult delivery was also reported by Valyasevi (1988) in Thailand and Moore et al (1991) in Java.

In many societies, people believe in humoral theories. Health and ill health are based on a system of defining health as a balance between opposing elements in the body. An imbalance between these elements, deficiency or excess leads to ill health (Manderson And Mathews 1981, Laderman 1987).

Malay believed that coolness is essential for the developing embryo. It can be expelled by making the womb uncomfortably hot by ingesting substances having "hot" effect or by massage (Laderman 1987).

Similarly, for women in South India "over heating" during pregnancy was considered to be dangerous. Ferrous Sulphate distributed to them free of cost was rejected due to the fact that it was considered to be a powerful "heating medicine", producing large but not necessarily healthy babies (Nichter and Nichter 1983).

(1.3) Patients' Psychological Characteristics : According to Dudley (1979), the patient's beliefs about the illness and its treatment can influence compliance independently from the knowledge about illness and treatment characteristics. Hence, the patient who (i) feels susceptible to the disease or its complications (ii) believes that the disease can have severe consequences on the life. (iii) feels that the treatment will be very effective (iv) doesn't see major obstacle to treatment are more likely to be compliant than those not holding the beliefs.

Also some patients have authority problem. They may be so insecure that they are overawed by people in power. In such case the patients do not comply to the prescribed regimen. He tries to take regular medicines for serious illness but stops medicines if it represents more symptoms.

(1.4) Patients' Relationship with Doctor and Clarity of Instructions : The patients' relationship with the doctor is

an important determinant of compliance. According to Dudley (1979), when the doctor is brusque, does not take time to listen to patient and neglects to explain, the patient feels that he is busy and under pressure. Also, his prognosis may be discouraging, therapy unpleasant, and fees a lot more. So patients are frightened away from treatment of doctors who have less rapport with the patients. Positive impact on drug intake due to patient's satisfaction with the treatment and follow-up by doctors has also been reported by Galloway and Mc Guire (1994). Ugalde et al (1986) also reported poor knowledge of patients regarding dosage and frequency of medication due to a poor rapport of the doctor with the patients and his negligence to explain.

The duration of the treatment, complexity of the medical regimen or clarity of instructions given to the patients, seriousness of illness and physician to patient relationship were reported to play an important role in predicting compliance by Christensen (1978), Nyazema (1984), Mamdani and Walker (1986), Galloway and Mc Guire (1994).

(1.5) Success Belief - Patient And Physician Psycho Social Characteristics : According to Dudley (1979), the patient needs to experience success with their disease in order to believe that the treatment will work. Success in treatment of the patient is mediated by ability, effort, task difficulty, luck, expectation of the physician and social support. The patients will complete the prescribed tablets only if their past experience with the illness has been positive.

2. Factors Related To Disease

(2.1) Disease Characteristics : Sometimes the patients' the concept of disease is different from that of a doctor. For most patients diseases means having symptoms, feeling sick and being unable to work. Therefore for asymptomatic disease non-compliance is high. Also, for psychiatric or chronic diseases compliance is low. This is because an individual can have severe disease but may not feel sick and so does not feel the "need" to take medication (Dudley 1979). Christensen (1978) and Mamdani and Walker (1986) also mentioned the type and severity of disease as one of the determinants of patients' complinace.

According to Raman (1992), anaemia, if not severe, does not create perceivable problems to which women or community members are sensitive. Fatigue, lack of concentration and poor work capacity are considered to be due to other health problems or general malnutrition. Therefore women do not feel the need to take iron tablets. The fact that the women did not perceive the need to seek health care for "weakness" is supported by Seshadri (1987) and Kanani et al (1994).

(2.2) Side Effects : Side effects of the prescribed medicines also affect compliance. Many studies suggest side effects as a possible cause of dropouts or non-compliance for iron tablets (Christensen 1978, Dudley 1979, Kuizon et al 1983, De Maeyer 1981 & 1989, Charoenlarp et al 1988 and Raman 1992).

Lokeshwar et al (1992), mentioned two major constraints

against effectiveness of supplementation : the side effects of oral iron, and the length of the treatment to be followed by people who do not perceive themselves to be "ill".

Dodd (1992), also reported gastrointestinal tract side effects to be the main limiting factor in oral iron therapy, the percentage side effects ranging from 11-49 in pregnant and non- pregnant women with different levels of supplementation. However, no correlation was found between the side effects and the dose of the tablets, whereas Reddiah et al (1989) observed nausea, vomiting, abdominal pain and burning of abdomen as side effects and noted that the subjects experiencing side effects increased proportionately with the increase in dose. The dropout rate also increased with increase in dosage of iron, attributed to the side effects experienced.

3. Logistical Factors

Logistical problems have been faced by investigators implementing iron supplementation trials which resulted in inadequate intake of iron tablets by the subjects.

The multicentric evaluation carried out by ICMR in 1986-88 of the present anaemia prophylaxis programme reveals similar reasons for the inadequate success of anaemia prophylaxis, viz :

(a) Short supply of the tablets and poor coverage (5.15%) of the target population.

(b) Poor perceptions of the health functionaries.

(c) Low consumption pattern by the target population.

(d) Failure to replenish stocks regularly, and

(e) Lack of effective health education for both beneficiaries and functionaries (Raman 1992).

Shah et al (1984) reported that in India, the distribution of iron folic acid supplements were not very effective due to the lack of health service personnel. Lack of supply as one of the reasons for poor compliance for iron supplementation programmes was reported by Galloway and Mc Guire (1994) in India, Thailand and other developing countries and Schultink et al (1993) in Indonesia.

In Thailand the dropout of the participants from iron supplementation programme was due to the inability of the field workers to motivate the subjects (Charoenlarp et al 1988).

A study conducted by Taylor and Mutambu (1987) in Zimbabwe to determine compliance with malaria chaemo prophylaxis reported only 51.6% coverage which was attributed to poor logistics like the absence of health workers on drug distribution days, outdated or improper registration of people, inadequate supervision of drug distribution and inadequate health education causing low compliance among the subjects.

4. Knowledge Regarding The Disease And Education

A lack of knowledge regarding the disease and its treatment may create reluctance among the patients to follow the prescribed treatment especially when they do not feel it

necessary to take medicines (Raman 1992). Therefore, especially in case of anaemia for which medication is not considered necessary, educating the patients regarding the causes, symptoms and importance of the treatment of the diseases, help in improving compliance.

SECTION VI IMPACT OF IRON SUPPLEMENTS DURING PREGNANCY ON MATERNAL-INFANT OUTCOME PARAMETERS

Maternal Parameters

(1) Weight Gain : Weight gain during pregnancy is an important determinant of the outcome of pregnancy. It is used as an indicator for identifying the women who are at the risk of unfavourable pregnancy outcomes (Naeye 1979, WHO 1986). Abrams (1989) reported that women with a low rate of weight gain i.e. <0.27 kg/wk had a 60% greater chances of spontaneous preterm birth to those with average rate of 0.27 - 0.52 kg/wk. Hediger et al (1989) reported that early inadequate weight gain of <4.3 kg by 24 weeks of gestation increases the risk of having small-for-gestational-age babies significantly, even when later gains bring total weight to within adult standards. Similarly late inadequate weight gain of <400 gm/wk was associated significantly with preterm delivery irrespective of total adequate gain for the gestation. Therefore, maintaining balanced weight gain throughout pregnancy is very important.

Iron deficiency is known to affect weight gain during pregnancy. A positive impact of iron supplementation on weight gain during pregnancy was reported by Vijayalakshmi and Usha (1981) and Vijayalakshmi and Shobana (1982).

Scholl et al (1992) reported that inadequate pregnancy weight gain was more prevalent among those with iron deficiency anaemia than those having anaemia with other

etiologies.

(2) Haemoglobin Levels : The impact of iron supplementation on Hb levels during pregnancy has been well-documented. Various studies throughout the world have reported a rise in haemoglobin and serum ferritin levels and a prevention of fall in haemoglobin levels below normal in case of non-anaemic subjects by iron supplementation.

Sood et al (1975) conducted collaborative studies on iron supplementation to pregnant women in India. The results indicated that the groups not receiving any iron showed a fall in mean Hb concentration. Majority of women in groups receiving iron showed a rise in Hb, the best results in group receiving 120 and 240 mg of iron with B12 and folate. However even in these groups a high prevalence of iron deficiency anaemia remained at the end of the trial period (26- 36 or 38 weeks of gestation). In each group receiving iron, the rise in haemoglobin tended to be highest in those with the lowest initial Hb concentrations. Similar results were reported by Vijayalakshmi and Usha (1981) Charoenlarp et al (1988) and Reddiah et al (1989).

Wallenburg and Van Eijk (1984) in their study on iron supplementation to pregnant women, reported that iron supplementation appeared to prevent a physiologic fall in Hb concentration. It prevented the decrease in serum iron concentration observed in non-supplemented women.

Vijayalakshmi and Devadas (1987) in study on pregnant women reported highest mean Hb levels of 10.89 g/dl and 11.5

g/dl for women supplemented with 120 mg FeSO4 per day for 90 days and iron tablets and two lakh IU Vitamin A respectively. The Hb levels of groups receiving only Vitamin A or placebo were less than 10 g/dl indicating a positive impact of iron and Vitamin A on Hb levels.

However, in study on the evaluation of iron supplementation programme for pregnant women in Jakarta, Schultink et al (1993) did not observe a change in prevalence of anaemia even after two months of supplementation with 300 mg of FeSO4 per day. Though 64% women claimed to have taken all the iron tablets, only 36% of the subjects showed positive stool tests. A significant rise in serum ferritin and PCV was observed in women with positive stool test after supplementation. It was concluded that a lack of impact was due to low compliance and inadequate iron dose.

Reece et al (1987) studied iron supplementation in two groups of pregnant women, the first one received prescription for 900 mg FeSO4 containing 180 mg iron in addition to the 60 mg contained in the prenatal vitamin tablets. The next group received prescription for only the prenatal vitamin tablets containing 60 mg iron. Additional FeSO4 was not prescribed unless Hb fell to 10.5 g/dl or lower. The results indicated that the two groups were not significantly different with respect to the Hb values in all the three trimesters and hence 60 mg of iron was considered adequate for women having Hb greater than 10.5 g/dl.

(3) Effect of Iron Deficiency on Morbidity : The effect on resistance to infection in human subjects is one of the most important functional consequences of iron deficiency. The studies on iron deficiency and morbidity mainly focus on either the cell-mediated immunity and related mechanisms or the study of frequency and episodes of infectious morbidities in groups of population.

Iron deficiency and humoral immunity :- Nalder and Coworkers (1972) found a decrease in antibody production to Tetanus toxoid proportional to the severity of dietary iron restriction in rats.

Iron deficiency and leucocytes :- Iron deficiency consistently interferes with the function of the leucocytes through cellular mechanisms that require iron-containing enzymes. Chandra et al (1977) reported that in human subjects, iron deficiency causes a defect in microbicidal capacity and impaired formation of hydroxy radicals due to decreased iron saturation of lactoferrin in neutrophils. These effects are promptly reversed by iron therapy.

Cell-mediated immunity :- Bhaskaram and Reddy (1975) and Srikantia and coworkers (1976) reported a significant reduction in cell-mediated immunity due to iron deficiency.

Iron-deficient children, having a decreased percentage of T-lymphocytes could be corrected by 4-weeks of iron supplementation (Chandra and Saraya 1975, Chandra et al 1977). Studies by NIN (1983) and NIN (1980) on pregnant women indicated that percent of T and B cells decrease with a fall

in maternal Hb during pregnancy. The reduction was highly significant when maternal Hb levels fell below 8g/dl.

Delayed cutaneous hypersensitivity :- Delayed cutaneous hypersensitivity to a number of ubiquitous antigens has been reported in iron-deficient children in India by Bhaskaram and Reddy (1975).

Prevalence of morbidity :- A number of studies have indicated a positive impact of iron supplementation on the prevalence of morbidities.

Mackay (1928), reported that infants from poor families in London had a modest decrease in bronchitis and gastroenteritis when they received iron supplementation. It was also observed that iron deficiency with or without anaemia increased the frequency of chronic mucocutaneous candiditis (Higgs and Wells 1973) and recurrent herpes infection (Chandra et al 1977).

Basta and Coworkers (1979) reported that after iron supplementation, a decrease in frequency of infectious disease, principally diarrhoeal and respiratory infections in anaemic workers of an Indonesian rubber plantation was observed.

A fall in Hb levels below 11 g/dl with a trend towards significant increase in prevalence of morbidity due to infections was observed in rural pregnant women in Hyderabad. The prevalence of infectious morbidities was doubled in pregnant women having Hb < 8 g/dl (NIN 1983).

The impact of iron deficiency on immunity function and increase in prevalence of infectious morbidities among anaemics provide a rationale for iron supplementation. However, a few studies indicate the contrary. Since microorganisms require iron for their growth, severe iron deficiency is believed to protect against certain infections and therefore, it is feared that providing iron would facilitate the growth of the organisms and increase morbidities (Stockman 1981).

In a study by Mc Farlane et al (1970) it was observed that administration of iron to children with Kwashiorkor before the immune mechanism was restored by protein repletion, resulted in increased mortality due to bacterial sepsis.

An increase in prevalence of malaria after iron therapy to patients with iron deficiency anaemia has been noted in Nigeria (Murray et al 1978a) and Somalia (Murray et al 1978b). Parasitism increased from 5% to 50%, and the onset of severe clinical malaria was observed in starved Sahelian drought patients whose iron concentrations rose rapidly after a few days of re-feeding.

Oppenheimer et al (1986), in a double-blind placebo controlled iron-supplementation trial in infants reported that the percentage of infants who were admitted to the hospital with malaria was higher in those treated with a single dose of iron dextran (50 mg elemental iron) as compared to the placebo group. The increased susceptibility of infection was attributed to the route of administration; the parenteral

route showing an increase in morbidities, especially malaria.

However, Prema et al (1982) in a study on low socioeconomic group of anaemic pregnant women in India found no difference in the rate of infective morbidity between the study group and the non-anaemic women after intramuscular iron therapy. The morbidity consisted mainly of diarrhoea and respiratory infection. The findings suggest that parenteral therapy may be used to combat severe anaemia in otherwise normal LSE group pregnant women.

Though most of the studies substantiate the fact that iron deficiency decreases immunity and hence, increases morbidity in the iron deficient host, researchers also report increased susceptibility to infection on iron supplementation. These are however, mostly in starved or malnourished subjects or in subjects with parenteral iron therapy.

No report showing an increase in morbidity due to iron supplementation per se is available. Therefore, Scrimshaw (1984) has aptly pointed out that

> "It would be a serious error to assume that, because the multiplication of infectious agents is impaired by severe deficiencies induced in experimental animals, malnutrition of any kind in human population is desirable. In general, resistance to infection is reduced by the common degrees of human malnutrition without being severe enough to affect the infectious agent".

The impact of iron on the morbidity profile, thus, is worthwhile to study.

(4) Pregnancy Outcome : Studies have indicated poor pregnancy outcome for women who have low Hb or haematocrit values during pregnancy.

Association between iron deficiency anaemia and poor pregnancy outcome is difficult to interpret because factors that may affect pregnancy outcome independently of anaemia like other health problems, parity, multiple gestation, ethnicity, low socio-economic status, smoking and education level may confound the interpretation.

Scholl et al (1992) studied 826 women aged 12 to 29 years excluding gravidas with a history of serious non-obstetric problems. When anaemia specific to iron deficiency was used as an independent variable, and after confounding variables were controlled 2.5% increase in risk of preterm delivery was observed. The AOR for LBW was tripled in women with iron deficiency anaemia but the risk of "small-for-gestational-age" (SGA) was not increased. Risk of preterm delivery, SGA and LBW were not significantly increased in anaemic women who were not iron deficient. Exclusion of preterm births who were also SGA did not alter the AOR for SGA births and maternal anaemia. However the risk of inadequate weight gain for pregnancy was increased in both iron deficient and iron non deficient anaemic women. This fact was also reported by Nutrition Reviews (1993).

Researchers at NIN (1981) have reported that a fall in maternal Hb levels below 8 g/dl is associated with a rise in perinatal mortality. They further reported that a correction

of anaemia before 28 weeks is associated with a maximum improvement in birth weight. Therefore optimal time for screening women for intervention programmes was considered to be 20 +/- 4 weeks of gestation.

Tyagi et al (1984) in a study on LBW in relation to nutritional status in primipara reported impact of anaemia on LBW. The incidence of LBW babies was almost 75% if light or short mothers had Hb levels < 9 g/dl, compared to the incidence of 15.2% if maternal Hb levels were >= 11 g/dl. The incidence of LBW decreased to only 7.6% and 8.4% in women having weight > 50 Kg and in mothers with height >= 155 cms respectively with Hb levels >= 11 g/dl .

Prema et al (1981a) observed that the incidence of LBW (BW <2500 g) was three times higher when maternal Hb levels fell below 5 g/dl as compared to non-anaemics with Hb levels > 11 g/dl (62.3% vs 23.1%).

An association between birth weight and Hb levels have also been reported in several studies from other countries (Sagen et al 1984, Kuizon et al 1985, Mitchell and Lerner 1992).

Objectives

Therefore the present study was planned with the following general objectives :

(1) To assess the perceptions of the women and functionaries regarding anaemia, health seeking behaviour and consumption of iron tablets.

(2) To study the feasiblity of linking iron folate delivery to pregnant women to assess its efficacy on coverage and compliance.

(3) To study the impact of iron supplements on maternal and infant outcome parameters.