Chapter 1
INTRODUCTION AND OBJECTIVES

Anaemia is defined as the low level of hemoglobin in red blood cells and is caused by inadequate diet (mostly insufficient iron); impaired absorption; or blood loss resulting from hemorrhage or helminths; or in women, from menstruation, child birth, or repeated pregnancies. Non-nutritional anaemia may also be caused by malaria and genetic disorders such as sickle cell disease and thalassemia.

Normal hemoglobin distributions in the body vary with age, sex, and physiological status, e.g., during pregnancy. According to WHO 2008, following hemoglobin threshold levels have been given to define anaemia in different sub-population, at sea level:

<table>
<thead>
<tr>
<th>AGE GROUP</th>
<th>HEMOGLOBIN CONCENTRATION (g/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children (0.50-4.99 years)</td>
<td>110</td>
</tr>
<tr>
<td>Children (5.00-11.99 years)</td>
<td>115</td>
</tr>
<tr>
<td>Children (12.00-14.99 years)</td>
<td>120</td>
</tr>
<tr>
<td>Non pregnant women (≥15.00 years)</td>
<td>120</td>
</tr>
<tr>
<td>Pregnant women</td>
<td>110</td>
</tr>
<tr>
<td>Men (≥15.00 years)</td>
<td>130</td>
</tr>
</tbody>
</table>

Source: WHO, 2008

According to ‘WHO Global Database on Anaemia (1993-2005)’, anaemia affects 1.62 billion people globally with an overall prevalence of 24.8%. As per the database, 47.4% of preschool children (0-4.99 years), 41.8% of pregnant women, 30.2% of non-pregnant women (15.00-49.99 years) and 25.4% of school-age children (5.00-14.99 years) in the world are anaemic (WHO 2008).
WHO has suggested the following classification to identify anaemia as a problem of public health significance: a prevalence of $\leq 4.9\%$ as “no public health problem”, $5.0\text{-}19.9\%$ as “mild public health problem”, $20.0\text{-}39.9\%$ as “moderate public health problem” and $\geq 40.0\%$ as “severe public health problem” (WHO 2008).

According to World Bank (2004), Iron deficiency anaemia (IDA) is in the “top ten” risk factors contributing to the global burden of disease. The economic costs of IDA at 4.05\% of gross domestic product (GDP)—US$2.32 per capita in lost productivity and US$14.46 per capita in lost cognitive function. Worldwide, $50\text{ billion in GDP}$ is lost annually in low-Estimates of Economic Losses from Iron Deficiency Anaemia (Cognitive & Productive) as % of GDP income of countries due to IDA’s effect on productivity.

The consequences of anaemia includes impaired cognitive performance, significant reduction of physical work capacity and productivity, increased morbidity from infectious diseases, greater risk of death amongst the pregnant women during the perinatal period and negative foetal outcome like intrauterine growth retardation, low birth weight and prematurity.

Anaemia, thus affects all age groups, and its far reaching impact presents a true major hurdle to national development.

In India, the prevalence of anaemia is more than 70\% amongst all age groups, i.e. Children, Adolescent girls, Pregnant and lactating mothers (Toteja and Singh, 2004).

Adolescence has been reported and proven as one of the most vulnerable phase in the path of human life cycle after infancy, characterized by rapid growth and development with a transition from childhood to adulthood. During this period adolescents gain 50\% of their adult weight and skeletal mass and more than 20\% of their adult height, where, nutrition plays a vital role in determining the growth, development and survival of an individual. Adolescents, especially adolescent girls, at this stage needs
protein, iron and other micronutrients to support the adolescent growth spurt to meet the body’s increased demand for iron during menstruation (WHO, 2002). The main nutritional problems identified in adolescents are micronutrient deficiencies in general and iron deficiency anaemia in particular. Thus, adolescent girls require specific and special attention and controlling anaemia in them is very important since they are the future mothers.

According to Mc Lean 2008, the prevalence of anaemia in India amongst non-pregnant women of reproductive age is more then 40% in almost all parts of the country.

**Figure 1.1: Anaemia as a public health problem by country: Non Pregnant women of reproductive age**

(Source: Mc Lean 2008)

In 1970, the Government of India launched the “National Nutritional Anaemia Prophylaxis Programme” as a preventive measure for anaemia. Under the programme, tablet containing 60 mg of elemental iron and 500 mcg of folic acid was given to all pregnant women, nursing mothers and women acceptors of family planning. Children (1-11 years) were given a daily tablet containing 20 mg of elemental iron and 100 mcg of folic acid for a minimum period of 100 days in a year. Infants (6-12 months) and children were given 2ml of liquid syrup containing the same dose as in tablet. In 1991, the
programme was renamed as “National Nutritional Anaemia Control Programme”. The dosage of iron supplementation was revised from 60 mg of elemental iron to 100 mg per tablet for pregnant and lactating women. The beneficiary group was redefined to include children 1 to 5 years of age. The NNACP programme was again revised in 2007 and the programme beneficiaries now also include Adolescent girls, 11-18 years of age and are given the same dose (100 mg elemental Iron + 500 mcg Folic Acid) as for adults.

However, even after iron folic acid supplementation programme being in operation from the last 40 years, there has been no considerable reduction in the prevalence of anaemia in the country. Since, the impact of the programme is not desirable, there is a need to look into newer strategies.

Vitamin B12 (cobalamin) which is an important water-soluble vitamin functions as a methyl donor and works with folic acid in the synthesis of DNA and red blood cells (Watanabe 2007). Studies have shown that Vitamin B12 status has an impact on the optimum Folic Acid metabolism in the body. Orally administered or injected pteroylglutamic acid (PGA) (folic acid) has been reported to disappear rapidly into the tissues of vitamin B12-deficient patients (Spray and Witts, 1952; Cox et al, 1958).

Herbert and Zalusky, 1962 showed that in the vitamin B12-deficient subject, pteroylglutamic acid (PGA) is rapidly converted to an L. casei-active and presumably metabolically useful form (probably N5-methyl-tetrahydrofolic acid) which then "piles up" in the serum because vitamin B12 is required for its normal utilization. This "piled up" folate activity tends to reduce the amount of folic acid available for other 1-carbon unit transfers. The study concluded that vitamin B12 is required for normal folic acid metabolism.

Hence, Vitamin B12 status of an individual can have a potential impact on the effectiveness of Iron Folic acid tablet in anaemic subjects. There is no published literature on the effect of Vitamin B12 supplementation along with Iron and Folic Acid under community settings on Adolescent girls in the
country. Therefore, the present study was a supervised double blind randomized clinical trial to assess the impact of Vitamin B12 supplementation along with Iron and Folic acid on mildly or moderately anaemic adolescent girls aged 11-18 years living in a slum in Delhi. The study has following objectives:

4.1 To assess the prevalence of anaemia in adolescent girls in a slum in Delhi

4.2 To assess the impact of weekly supplementation of Vitamin B12 with Iron and Folic Acid (IFA) on hemoglobin, serum ferritin, folate and vitamin B12 levels in Adolescent girls.

4.3 To assess the impact of weekly supplementation of Iron and Folic Acid on hemoglobin level, serum ferritin, folate and vitamin B12 levels in adolescent girls.

4.4 To compare the effect of IFA Versus IFA and Vitamin B12 supplementation based on hemoglobin, serum ferritin, folate and vitamin B12.

4.5 To assess the dietary adequacy of the adolescent girls.