Chapter I

INTRODUCTION

“Many women come to believe that it’s normal to feel tired, weak, or irritable . . . but iron deficiency anemia is not normal.”

- Dr. Indu Lew

Health is a fundamental human right and central to the concept of quality life (Sundar Lal, 2007). Women’s health is central to the survival of the society. They are the pivot of the family, they nurture the next generation and give care for the elderly. Apart from their family duties, they have the primary responsibility towards their own health and happiness.

Anemia is the most common nutritional deficiency disorder in the world. It is a condition that occurs when the red blood cells do not carry enough oxygen to the tissues of the body. WHO (2008) defines anemia as a condition in which the Haemoglobin (Hb) content of blood is lower than normal as a result of deficiency of one or more essential nutrients. Most of the anemias are due to inadequate supply of nutrients like iron, folic acid and vitamin B12, proteins, amino acids, vitamins A, C, and other vitamins of B-complex group i.e., niacin and pantothenic acid are also involved in the maintenance of haemoglobin level.

Anemia is one of the most widespread nutritional deficiency diseases and a major public health concern all over the world
affecting 1.62 billion people, which corresponds to 24.8% of the population. It is one of the most prevalent health issues among women within reproductive age group, that is, it has affected 41.8% of the pregnant women. Among women, anemia may become the underlying cause of maternal mortality and perinatal mortality. **The National Family Health Survey (2005-06)** reported that more than 55% of the women in India were anemic. WHO estimated that the prevalence of anemia among the reproductive age group of women was 14% in developed countries and 51% in developing countries, while it was 65-75% in India (Mishra, Kalaivani, Barbara, and Rosenwei, 2012).

Iron deficiency anemia is one of the commonest forms of anemia and highly prevalent among the reproductive age group of women, as a result of excessive loss of iron or demand of iron associated with menstruation and child birth. It is a critical health concern as it affects growth, energy levels and also leads to various health problems. It is one of the main causes of morbidity and mortality in reproductive age and a key factor to low birth weight. Inadequate knowledge on anemia, poverty, inadequate diet, pregnancy, lactation, poor educational level and poor access to health services predispose women to get anemia (Bhanushali, Kanani and Poojara, 2011).

The reason for the high morbidity and mortality rates among women can be that the manifestations of anemia among women in reproductive age may not be evidenced easily in the beginning as it
is like an ice berg. But Paleness, fatigue and low blood pressure can be manifested later. In severe cases, there will be shortness of breath and chest pain, which is an evidence of inadequate perfusion and oxygenation of the major organs. These factors can worsen the health conditions of women and lead to various secondary health problems such as lung diseases, cardiovascular diseases and heart attack, ultimately to death. Severe anemia is closely related to the risk of high mortality among reproductive age group of women, and mild anemia carries health risks and reduces capacity to work. (Khatry, et al., 2008).

**Anemia**

Anemia is not a specific disease state, but a sign of an underlying disorder. It is so far a most common hematology condition. It is a condition in which Hemoglobin concentration is lower than normal, reflects presence of fewer than normal RBCs within circulation of oxygen delivered to body tissues (NFHS-3, 2005-06, Park and Umeta, 2009).

According to the Park (2015) anemia is classified as early anemia if Hb level is 10-11g/dl and marked anemia if Hb level below 10 g/dl.

Anemia results from defective red cell production or increased red cell destruction or blood loss. Iron is necessary for synthesis of hemoglobin. Iron deficiency is thought to be the most common cause of anemia globally, but other nutritional deficiencies
(including folate, vitamin B12 and vitamin A), acute and chronic inflammation, parasitic infections, and inherited or acquired disorders that affect Hb synthesis, red blood cell production or red blood cell survival can cause anemia.

The function of the RBCs is to deliver oxygen from the lungs to the tissues and carbon dioxide from the tissues to the lungs. This is accomplished by using hemoglobin (Hb), a tetramer protein composed of haem and globin. Anemia impairs the body’s ability to exchange gas by decreasing the number of RBCs transporting oxygen and carbon dioxide.

**Magnitude of the Problem**

A Systematic Analysis of Global Anemia Burden (1990 to 2010) aimed to produce the first complete account of global anemia burden. Prevalence was higher in most of the regions among females. South Asia and Central, West, and East sub-Saharan Africa had the highest burden, while East, Southeast Asia saw the greatest reductions.

WHO data base (1995-2005) Micronutrient Deficiency Information System (MDIS) estimated the prevalence of iron deficiency anemia among the industrialized and non-industrialized countries. In non-industrialized countries, 30% to 60% of non-pregnant women were anemic with the highest rates in Asia and Africa. Iron deficiency was the main cause of anemia in industrialized countries, whereas in the non-industrialized
countries the other factors such as malaria and parasitic infections (hookworm) played a role. According to the WHO database, in the industrialized countries, the most affected groups were pregnant women (18% anemic), school children (17% anemic), non-pregnant women and the elderly, (both 12% anemic). In the non-industrialized countries, the most affected population groups were pregnant women and school-aged children (both 53% anemic), non-pregnant women (44% anemic), preschool children (42% anemic) and the elderly (51% anemic). The prevalence of anemia was low among the adult males in industrialized countries (4.7% anemic), but in non-industrialized countries, not less than 1/3 of the adult males were anemic.

**National Family Health Survey (NFHS) (2011)** estimated that about 20%-40% of maternal deaths in India are due to anemia. India contributed to about 50% of global maternal deaths due to anemia.

Iron is used for formation of hemoglobin, oxygen transportation, brain development, regulation of body temperature and muscle activity. When the haemoglobin level is decreased in human body, it is called as iron deficiency anemia. Iron deficiency is the most common etiological factor in causing anemia (**Park, 2007**).

Anemia is a serious public health problem, which affects the mental and physical development, as well as health maintenance and work performance. Iron deficiency is by far the most common
cause of anemia worldwide. About 2 billion people suffer from varying degrees of anemia in developing countries. Iron deficiency occurs when insufficient iron is absorbed to meet the body’s needs. This may be due to inadequate iron intake, poor iron absorption, increased iron need or chronic blood loss. Prolonged iron deficiency leads to iron deficiency anemia (IDA).

**Iron Deficiency Anemia**

*WHO (2015)* defined Iron-deficiency anemia (IDA) as the most common type of nutritional anemia which results from long-term negative iron balance and is responsible for approximately 50% of all anemia. It is a severe stage of iron shortage in which hemoglobin falls below the normal range (Hb 12.0 mg/dL or haematocrit below 36%).

Iron deficiency anemia affecting both developing and developed countries with major consequences for human health as well as social and economic development. It occurs at all stages of the life cycle, but is more prevalent in women during the reproductive age and among the young children. In *WHO (2002)*, Iron Deficiency Anemia (IDA) was considered to be among the most important contributing factors to the global burden of anemia.

**Stages of Anemia**

According to *Herbert (1992)* deviations from normal iron status have been summarized as follows:
Stages I negative iron balance (i.e. iron depletion) - In these stages, iron storage are low, and there is no dysfunction. In this stage there is reduced iron absorption and has moderately depleted iron storage.

Stage II negative iron balance is characterized by severely depleted iron storage. When persons in these two stages are treated with iron, they never develop dysfunction or disease.

Stages III & IV negative iron balance (i.e. iron deficiency) Iron deficiency is characterized by inadequate body iron, causing dysfunction and disease. In stage III negative iron balance, dysfunction is not accompanied by Anemia; however, Anemia does occur in stage IV negative iron balance.

Risk Factors for Anemia
Anemia is the most common cause of maternal deaths, accounting at number fifth of all maternal deaths (more than one lakh women in India die of pregnancy-related deaths, out of which 22,000 are related to nutritional anemia). Severe anemia accounts for 20.3% of maternal deaths.

The risk of dying from haemorrhage and infection is five to ten times greater among anemic women compared with non-anemic women.

Anemia among women also contributes to infant health by intra-uterine growth retardation, low birth weight and ultimately
perineal mortality, and a higher risk of irreversible brain damage in infants. Anemia is more likely to occur during:

- Preschool age when growth is rapid.
- Adolescence when there is rapid growth and menstrual loss of iron.
- Pregnancy, when there is rapid growth of foetus and maternal tissues

**Causes of Anemia**

In India, iron deficiency anemia is mostly influenced by poverty, illiteracy, ignorance and lack of knowledge regarding iron deficiency anemia and dietary requirements and nutritive value of different vegetables (Park, 2015).

Iron-deficiency anemia (IDA) is often caused by insufficient iron intake. Iron-deficiency anemia doesn’t develop immediately. Instead, a person progresses through stages of iron deficiency, beginning with iron depletion, in which the amount of iron in the body is reduced while the iron in RBCs remains constant. If iron depletion isn’t corrected, it progresses to iron deficiency, eventually leading to IDA. Not having enough iron in our body causes iron-deficiency anemia. Lack of iron usually is due to blood loss, poor diet, or an inability to absorb enough iron from the foods that we eat.

**Blood loss**

When one loses blood, one loses iron. If enough iron is not stored in one’s body to make up for the iron loss, the person develops iron-deficiency anemia. In women, low iron levels may be
due to blood loss from long or heavy menstrual periods or bleeding fibroids in the uterus. Blood loss that occurs during childbirth is another cause for low iron levels in women. Internal bleeding (bleeding inside the body) also may lead to iron-deficiency anemia. This type of blood loss isn’t always obvious, and it may occur slowly. Some causes of internal bleeding are:

- A bleeding ulcer, colon polyp, or colon cancer
- Regular use of aspirin or other pain medicines, such as non-steroidal anti-inflammatory drugs (for example, ibuprofen and naproxen)
- Urinary tract bleeding.

**Poor diet**

The best sources of iron are meat, poultry, fish, eggs, and iron-fortified foods (foods that have iron added). If a person doesn’t eat these foods regularly, or if he/she doesn’t take an iron supplement, he/she is more likely to get iron-deficiency anemia. Insufficient intake of iron enhancers in the diet (foods rich in vitamin C such as citrus fruits) will lead to iron deficiency anemia. Vegetarian diets can provide enough iron if the right foods are eaten. For example, good non-meat sources of iron include spinach and other dark green leafy vegetables, certain types of beans, dried fruits, and iron-fortified breads and cereals.

**Inability to absorb enough iron**

Even if there’s enough iron in our diet, our body may not be able to absorb it. This may be due to intestinal surgery or diseases
of the intestine, such as Crohn’s disease or celiac disease. Prescribed medicines that reduce acid in the stomach also can interfere with iron absorption.

**Pregnancy**

During some stages of life, such as pregnancy and childhood, it may be hard to get enough iron in diet. This is because the need for iron increases during these times of growth and development. Women of child bearing age are at increased risk for iron-deficiency anemia because of blood loss during their monthly periods. About 1 in 5 women of child bearing age has iron-deficiency anemia. Pregnant women also are at higher risk for the condition because they need twice as much iron as usual. The extra iron is needed for increased blood volume and for the foetus’ growth. About half of all pregnant women develop iron-deficiency anemia which may be the cause for a premature or low-birth-weight baby.

**Infectious disease**

In the developing world common infections which may be both chronic and recurrent are associated with blood loss leading to iron deficiency, and ultimately to IDA. Hemolytic malaria and parasitic infections such as hookworm, amoebiasis, and schistosomiasis are particularly common diseases that contribute to the depletion of iron stores and often result in IDA.

**Interactions with medication**

Several pharmacological agents can interfere with iron uptake and/or transport leading to iron loss or defective absorption,
including non-steroidal anti-inflammatory drugs, H$_2$ blockers, proton pump inhibitors, and aspirin.

**Socioeconomic status**

Iron deficiency and IDA are most prevalent among women of low socioeconomic status for a number of reasons, including malnutrition, poor knowledge regarding prevention of anemia and worm infestation, and presence of concomitant disease when compared to populations of higher socioeconomic status.

**Other risk groups**

People who get kidney dialysis treatment may develop iron deficiency anemia. This is because blood is lost during dialysis. Also the kidneys are no longer able to make enough of a hormone needed to make red blood cells.

Iron absorption refers to the amount of dietary iron that the body obtains. Healthy adults absorb about 10% to 15% of dietary iron, but individual absorption is influenced by several factors.

Storage levels of iron have the greatest influence on iron absorption. Iron absorption increases when body storage is low. When iron storage is high, absorption decreases to help protect against toxic effects of iron overload. Iron absorption is also influenced by the type of dietary iron consumed.

Meat proteins and vitamin C will improve the absorption of nonheme iron. Tannins (found in tea), calcium, polyphenols, and phytates (found in legumes and whole grains) can decrease
absorption of nonheme iron. Some proteins found in soybeans also inhibit nonheme iron absorption. It is most important to include foods that enhance nonheme iron absorption when daily iron intake is less than recommended, when iron losses are high (which may occur with heavy menstrual losses), when iron requirements are high (as in pregnancy), and when only vegetarian nonheme sources of iron are consumed (Rani, 2010).

National consultation on control of nutritional anemia in India (2005-2006) classified anemia as mild anemia when the hemoglobin level is in the range of 10-11.9 g/dl, moderate anemia as hemoglobin level in the range of 7-9.9 g/dl and severe anemia as hemoglobin level less than 7g/dl among females.

American Society of Hematology (2015) revealed that iron-deficiency anemia is diagnosed by blood tests which include a Complete Blood Count (CBC). Additional tests may be ordered to evaluate iron deficiency anemia. This includes the following tests:

- **Serum iron**: This test measures the amount of iron in the blood. The level of iron in the blood may be normal even if the total amount of iron in the body is low. For this reason, other iron tests are also done.

- **Serum ferritin**: A protein that helps store iron in the body. A measure of this protein helps to find out how much of the body’s stored iron has been used.
Total iron-binding capacity and serum transferrin: Transferrin is a protein that carries iron in blood. Total iron-binding capacity measures the amount of the transferrin that the blood doesn’t carry iron. If there is iron-deficiency anemia, then it will have a high level of transferrin that has no iron.

Peripheral smear: In this test, a sample of the blood is examined under a microscope. If a person has iron-deficiency anemia, his/her red blood cells will look smaller and paler than normal.

Cut off points for the diagnosis of Iron deficiency anemia

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<th>Hb gm/Dl venous blood</th>
<th>MCHC Percent</th>
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<tbody>
<tr>
<td>Adult males</td>
<td>13</td>
<td>34</td>
</tr>
<tr>
<td>Adult females, non pregnant</td>
<td>12</td>
<td>34</td>
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<tr>
<td>Adult female, pregnant</td>
<td>11</td>
<td>34</td>
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At all ages the normal MCHC should be 34 values; below that indicates that red cells are hypochromic, which occurs in iron deficiency anemia. Hemoglobin level of 10 to 11 g/dl has been defined as early anemia, a level below 10 g/dl as marked anemia.

Kawaljit Kaur (2014) conducted a study among the rural population of Patiala, one of the major cities of Punjab, and stated that there was a positive correlation that iron deficiency anemia may be due to the result of blood loss caused by parasitic infection.
Hookworm intensity was significantly associated with hemoglobin level; for each 1,000 egg increase, hemoglobin was reduced by 2.4 g/L.

**Park (2015)** enlisted the forms of iron, haem iron and non-haem iron. Haem iron is better absorbed than non-haem iron. Foods rich in haem iron are liver, meat, poultry and fish. They are not only important sources of readily available iron, but also promote the absorption of non-haem iron from vegetarian food eaten at the same time. Non-haem iron is of vegetable origin e.g. cereals, green leafy vegetables, legumes, nuts, oilseeds, jaggery, and dried fruits. In some areas large amount of iron may be derived from cooking in iron vessels.

**Wood and Ronnenberg (2005)** editors of modern nutrition in health and disease, stated that a healthy adult has approximately 3.5-5g of iron in the body. 65-70% of the iron in the body is referred to as ‘transport iron’ that is the iron as part of the hemoglobin (the pigment of the red blood cells), 25% is stored within the liver, spleen, bone-marrow and muscles as storage iron and approximately 4% is used within myoglobin and iron-containing enzymes as functional iron.

**Bermejom and Garcia (2009)** reported that the Iron deficiency anemia is characterized by microcytic, hypochromic erythrocytes and low iron stores. The mean corpuscular volume is the measure of the average red blood cell volume and mean corpuscular hemoglobin concentration is the measure of the
concentration of hemoglobin in a given volume of packed red blood cells. The normal reference range for mean corpuscular volume is 80–100 fL and means corpuscular hemoglobin concentration is 320–360g/l.

**Consequences of Iron Deficiency Anemia**

*Khatry (2008)* reasoned that the cause of high morbidity and mortality rates among women can be that the manifestations of anemia among women in reproductive age may not be noticeable easily in the beginning as it is like an ice berg. But paleness, fatigue and low blood pressure can be manifested later. In severe cases, there will be shortness of breath and chest pain, which is an evidence of inadequate perfusion and oxygenation of the major organs. These factors can worsen the health conditions of women and lead to various secondary health problems such as lung diseases, cardiovascular diseases and heart attack, ultimately death. Severe anemia is closely related to risk of high mortality; even mild anemia carries health risks and reduces capacity to work. To achieve dietary adequacy of iron by using food-based approaches, food preparation and dietary practices must be considered. For iron bioavailability, it is essential to increase the intake of enhancers of absorption and reduce the intake of inhibitors of iron absorption in a given meal. Therefore, the adequacy i.e. bioavailability of iron in usual diets can be improved by altering meal patterns to favor enhancers, lower inhibitors or both.
Prevention and Control of Iron Deficiency Anemia

Iron deficiency anemia will be prevented by adequate dietary intake or iron such as green leafy vegetables such as amaranthus, spinach, coriander leaves, drumstick leaves, cauliflower leaves, radish leaves, vegetables such as beet root, drumstick, cereals like ragi, barley, rice (raw milled), legumes like bengal gram dhal, black gram dhal, soyabean, nuts and oil seeds and fruits such as chickoo, pomegranate and jaggary (Swaminathan, 2008).

Enhancers of iron absorption

Conrad and Umbreit (2005) stated that the following factors enhance iron absorption:

- Haem iron present in meat, poultry, fish, and seafood
- Ascorbic acid or vitamin C, present in fruits, juices, other vegetables like cauliflower and cabbage
- Fermented or germinated food

Inhibitors of iron absorption

Hurrell and Egli (2010) suggested the factors that inhibit iron absorption:

- Phytates present in cereal bran and cereal grains
- Phosphates in egg yolk
- Oxalates in certain vegetables
- Tannin in tea, coffee, cocoa, herbal infusions in certain spices
- Calcium, particularly from milk and milk products
Control of iron deficiency anemia

The control of iron deficiency is an essential part of the overall effort to fight iron deficiency. Actions that promote an increase in the supply, access, consumption and utilization of an adequate quantity, quality and variety of foods for all populations groups should be supported. Among the plant foods, green leafy vegetables are the cheapest and locally available foods, rich in iron.

Iron deficiency is truly a hidden hunger communication for dietary behavior change which is a necessary part of any programme that seeks to combat iron deficiency and anemia in a sustainable manner. Overall an effective communication plan for prevention and control of Iron Deficiency Anemia (IDA) needs to have four major components:

- Advocacy and resource mobilization.
- Effective training for health personnel.
- Counseling services (diet, supplementation, testing)
- Messages and materials development for public education

Need for the Study

Anemia continues to be a major public health problem in developing countries including India. It is the most common cause of malnutrition in the world and is the eighth leading cause of diseases in girls and women in developing counties (WHO, 2010). In India, two third of women of childbearing age were estimated to
suffer from iron deficiency anemia. Report from National Nutrition Monitoring Bureau 2002 indicated that 15% of all maternal deaths were attributed to anemia. The highest prevalence of anemia among women in India was a burden to their families, and for the economic development and productivity of the country.

**Indian Scenario**

Prevalence of anemia in all the groups is higher in India than in other developing countries *(Kalaivani, 2009)*. In India, anemia affects an estimated 50% of the population. The problem becomes more severe as more women are affected with it as compared to men *(Malhotra, et al., 2004)*. It is estimated that about 20%-40% of maternal deaths in India are due to anemia and one in every two Indian women (56%) suffers from some form of anemia *(District Level Household Survey, DLHS (2008)* surveys have shown that prevalence of anemia is very high (ranging between 80->90%) in preschool children, pregnant and lactating women and adolescent girls. Low birth weight infants, young children and women of childbearing age are particularly at risk of anemia. That way Anemia begins in childhood, worsens during adolescence in girls and gets aggravated during pregnancy.

Traditionally, the Indian housewife eats last, after all male members and children have eaten. Even though the food prepared for the family is the same, women are more prone to develop Iron deficiency anemia than other members of the family because of less intake. In recent decades, important changes in lifestyle habits and
dietary patterns occurred among the Inuit population, contributing to the decreased consumption of country foods that are good sources of iron.

Poverty in India is widespread. Among the nations, India is estimated to have one third of the world’s poor people. In 2010, the World Bank reported that 32.7% of the totals Indian people fall below the international poverty line of US$ 1.25 per day (PPP), while 68.7% live on less than US$ 2 per day. Most of them belong to low socio-economic class with lack of proper education, employment and a low quality lifestyle and diet. In such conditions it is very difficult for them to fulfill their daily iron/nutritional requirements.

D’souza and Rangarajan (2007) reported that the occurrence of restless leg syndrome was significantly higher among those who had iron deficiency anemia. The initial symptoms of iron deficiency anemia are unnoticeable. In severe cases there will be inadequate oxygen supply to major organs in the body. This will cause various health problems such as kidney failure, lung diseases, and cardiovascular diseases and ultimately it leads to death.

India falls in the category where use of simple chapatti, rice and tea is very common. These food servings contain phytate and tanin which inhibit absorption of iron. Iron deficiency anemia is frequently observed in women from south-Asia region because of vegetative diet. Studies have also revealed that food rich in proteins
like beef, chicken and fish are very expensive in our country, due to low income and the daily wages of laborers in India and many are unable to afford to purchase non-vegetarian foods frequently and eat.

**Incidence of Anemia in Tamilnadu, Cuddalore District (2005)**

*Meghendra Banerjee and Gop Ngosh (2005)* reported on examples of studies seeking to understand the high incidence of Anemia among the fisher community. Although coastal communities are mainly non-vegetarian and receive a good amount of micro nutrient supplement as part of their diet, the reason for high incidences of anemia among them, could be to low consumption of green and leafy vegetables, poor sanitary conditions, which leads to worm (largely hookworm) infestation, ignorance about anemia, its consequences and prevention strategies, and misconceptions regarding the iron and folic acid supplements, resulting in a high incidence of anemia.

**Prevalence of Anemia in Chidambaram**

*Devi (2014)* did a study on “prevalence of anemia among children age 10 to 15 years in urban at Chidambaram”. A total of 500 children were included in the study to obtain an almost equal sample of pre and post menarcheal girls. The total students in the Government girls higher secondary school were 3078. Out of total (500) students surveyed, 292 students (58.4%) were found to be anemic. Majority were in the age group of 11 years (39.6%) and
14 years (33.6%) and 74.2% were from joint family. Most of them belong to upper lower class (66.6%). None of the girls had any symptom of anemia, except for 5.4% had loss of appetite. 26.8% was found with pale conjunctiva. There was no statistically significant association between anemia and variables such as birth order, socio-economic status of the family, family type and age at onset of menarche and usage of sanitary latrine. There was a statistically significant association between anemia and variables such as age, personal hygiene, body mass index and menarche status.

**Effect of Green Leafy Vegetables**

Green Leafy Vegetables are a good source of minerals such as zinc, iron and potassium. India ranks second in the world in the production of vegetables and third in the production of fruits. There are many varieties of green leafy vegetables, which are the richest source of iron, but they are discarded and not used properly for human consumption.

*Buvaneswari and Ramya (2014)* in their study of overall acceptability of *Brassica oleracea* leaves (cauliflower leaves) incorporated food products and its impact on treating anemic college going girls. The sensory evaluation was done by trained panelists (n = 20) using a five-point hedonic scale. Three recipes were prepared with and without incorporation of the developed *Brassica oleracea* leaves powder. Enriching the common recipes with *Brassica oleracea* leaves will increase the hemoglobin content
of the anemic adolescents. Thus incorporation with *Brassica oleracea* leaves powder can be made more acceptable and if done will be an alternate for the high cost nutrient (or) therapeutic supplements.

**Cauliflower greens** are also considered the waste products which are often neglected. Stalks are always used for human consumption and leaves are discarded and become a part of animal feed. Literature reveals that cauliflower green leaves are rich source of iron and calcium along with the other micro nutrients and belong to the family of Brassicaceae/Cruciferae. It comes from the Latin words caulis, meaning—stalk and floris—flower. It is cultivated mainly in Northeast from April to December. The flowers are attached to the central stalk surrounding green leaves. A *Brassica oleracea* leaf contains several medical properties. It contains folate which helps in making and stimulating the blood and prevents symptoms of anemia. Cauliflower leaves are available for short duration but after dried, can be stored for long time. The cauliflower green leaves are highly nutritious and a good source of β-carotene-43.11mg, Iron-60.38mg, Copper-1.55mg, Manganese-5.86mg, Zinc-5.10mg (values as per 100gm).

Recognizing the value of *Brassica oleracea* leaves the researcher has aimed to incorporate in common recipes for increasing bioavailability of minerals like iron and calcium as it helps in alleviating nutritional deficiency disorder.
The drumstick tree (*Moringa oleifera*) referred to as the “miracle plant” and known as “Zogale” in Hausa, “Okwe Oyiibo” in Ibo, “Ewe Ile” in Yoruba and “JeghelAgede” in Tiv is common throughout the West African region, thus making the seeds easily available. The leaves are an outstanding source of vitamin A, B group and C (when raw), and are among the best plant sources of minerals. They contain more iron than “kontonmire”, seven times the vitamin C in oranges, four times the calcium in milk, four times the vitamin A in carrots, two times the protein in milk and three times the potassium in bananas. They are excellent sources of protein, but poor in carbohydrates and fats. The leaves are beneficial in the treatment of many ailments due to their various medicinal properties and their rich iron content. In Africa, nursing mothers have been shown to produce more milk when Moringa leaves were added to their diets. Severely malnourished children have been shown to make significant weight gains when caregivers add Moringa leaves to their diet (*Price, 2000*).

**Drumstick leaves** (*Moringa oleifera*) are reported to contain alkaloids, flavonoids] anthocyanins, proanthocyanidins and cinnamates, and is highly reputed in folklore and traditional system of medicine as a remedy for a variety of ailments. Drumstick leaves (*Moringa oleifera*) with a beta carotene (a precursor of vitamin A) content of 19690 mcg/100gm are acceptable in traditional Indian diets both in fresh as well as dry forms and have a good bioavailability in fresh and dry forms, thus they are useful in
improving utilization of iron especially from high phytate Indian diets (Nambiar, Daniel and Guin, 2010).

There are numerous nutritional programs existing for children, adolescents as well as for pregnant and lactating mothers to create awareness and to decrease the prevalence of iron deficiency anemia among them. When compared with women in reproductive age, very less effort has been put forward to create an awareness regarding iron deficiency anemia among the women.

The researcher, during her clinical practice in the community observed multiple cases of anemia in reproductive age and discovered lack of appropriate knowledge on anemia and its prevention as one of the main causes for its high prevalence. Also many of the women do not utilize the available health facilities and they were ignorant about their health status. So keeping this background in mind, the researcher felt the need to conduct the present study to assess knowledge, attitude and practice of the women who are in the reproductive age group between (15-45 years). Further the review on the use of drumstick leaves and cauliflower leaves have motivated the investigator to incorporate the use of drumstick and cauliflower leaves in the from common recipes to increase the nutrients and to treat women residing in the selected villages.
**Statement of the Problem**

A Study to Assess the Effectiveness of Structured Teaching Programme and Dietary Supplementation in Prevention of Anemia Among Women of Reproductive Age Group in Selected Community.

**Objectives**

- To assess the effectiveness of structured teaching programme in terms of knowledge, attitude and practice in prevention of anemia among the women of reproductive age group before and after intervention.

- To assess the effectiveness of drumstick (*Moringa oleifera*) leaves supplementation in prevention of anemia among the women of reproductive age group.

- To assess the effectiveness of cauliflower leaves (*Brassica oleracea*) supplementation in prevention of anemia among the women of reproductive age.

- To compare the effectiveness of drumstick leaves and cauliflower leaves supplementation with the control group in prevention of anemia among women of reproductive age.

**Hypotheses**

- There will be a significant difference in the knowledge, attitude, and practice scores of the subjects after structured teaching programme on prevention of anemia between the experimental group-I, experimental group-II and the control group.
There will be a significant difference in the hematological variables of the subjects after three months of dietary supplementation of drumstick leaves and cauliflower leaves in experimental group-I and experimental group-II.

**Operational Definitions**

**Effectiveness**

Effectiveness means the desired changes brought out in a person. It refers to the extent to which the structured teaching programme and intervention have achieved the desired result in improving the knowledge measured using structured interview guide, improvement in the attitude which was measured using 5 Point Likert scale and improving the practice measured through observational check list. Effectiveness also means the effect improvement in haematological variables among the women with anemia 90 days after dietary supplementation evidenced by the improvement in posttest score of the subjects.

**Structured Teaching Programme**

It is a well-prepared teaching programme with systematically developed information, along with visual aids designed to teach women on prevention of anemia. It includes meaning of anemia causes, signs and symptoms, diagnosis, treatment, prevention and complication of iron deficiency anemia using flash card.

**Knowledge**

It refers to the understanding and awareness of the subjects regarding anemia, its causes, signs and symptoms, treatment,
diagnosis, prevention and complication of iron deficiency anemia measured by structured interview guide.

**Attitude**

It refers to the expressed beliefs and feelings of women regarding anemia and prevention of iron deficiency anemia measured by using five point Likert scales.

**Practice**

It refers to the healthy practices and dietary practices followed by the subjects related to cooking and hygienic practice, dietary consumption of source of iron and avoidance of iron inhibitors on prevention of iron deficiency anemia, measured by using a observational check list.

**Prevention**

It refers to measures taken to stop the occurrence of iron deficiency anemia about creating awareness on anemia, causes, signs and symptoms treatment, prevention and complication through structured teaching programme, deworming and dietary supplementation. Deworming is done by giving Tab. Albendazole 400 mg single dose for all subjects.

**Dietary supplementation**

Dietary supplementation means, giving 100 gm of cooked drumstick leaves poriyal for 3 days/week as dietary supplementation for 90 days for 65 subjects in the experimental group–I living in Pichavaram village. Also it includes supplementation of 100gm of
cooked cauliflower leaves poriyal for 3 days / week as dietary supplementation for 90 days for 70 subjects in the experimental group–II living in Kumaramangalam village.

Anemia

Anemia is a condition in which the number of Red Blood Cells (RBCs), and consequently their oxygen carrying capacity is insufficient to meet the body’s physiological needs. According to Park (2007) the cut off point for diagnosis of anemia for adult female is 12gm% and MCHC 34%. Therefore in the present study those who are having iron deficiency anemia with their hemoglobin level ranging from 9 gm/dl to 12 gm/dl with MCHC 34% who fall into the category of mild anemic were included as anemic. As the subjects having moderate and severe anemia need intensive treatment they were not included in the study as advised by the ethical committee.

Reproductive age group of women

In this study it includes all married and unmarried women aged between 15-45 years living in selected villages, who are at risk of developing anemia because of chronic iron depletion due to menstrual periods, inadequate dietary intake of iron sources repeated pregnancy and recurrent worm infestation.

Assumptions

- Anemia is more prevalent among women of reproductive age group.
- Women will have some knowledge about prevention of iron deficiency anemia.

- Dietary supplementation will help in combating iron deficiency anemia.

- Women need education regarding iron deficiency anemia.

- Structured teaching programme will enrich the knowledge of women on iron deficiency anemia and its prevention and helps to seek treatment at the right time.

**Delimitations**

- The sample size was limited to 195.

- The study was delimited to women of 15-45 years and who attained menarche in selected community.

**Conceptual Frame Work**

A conceptual framework can be defined as concepts and assumptions that integrate into a meaningful configuration (Fawcett, 1994).

Conceptual framework provides certain frame of reference for clinical practice, research and education. Conceptual framework is the conceptual underpinning of the study. Conceptual frameworks (theoretical frameworks) are a type of intermediate theory that has the potential to connect to all aspects of inquiry (e.g., problem definition, purpose, literature review, methodology, data collection
and analysis). It acts like maps that give coherence to empirical inquiry. It is a set of coherent ideas or concepts organized in a manner that makes them easy to communicate to others. A model is used to denote symbolic representation of concepts (*Patrizi and Neri, 1996*).

The present study is intended to assess the effectiveness of structured teaching programme and dietary supplementation in prevention of anemia and improving the knowledge, attitude and practice among women of reproductive age group. The conceptual framework for this study was based on *Ludwig Von Bertalanffy, 1968*. General system theory is used with certain modification and is presented in the form of figure (Figure 1).

According to general system theory, a system is a set of interrelated components and units interacting with each other in a boundary. The individual is capable of taking energy and information from the environment and revealing them to the environment. Because of this exchange, individual is an open system. System model consists of three phases: input, throughput, output and feedback.

**Input**

According to theorists, input is the type of information that enters into the system from the environment through its boundaries. In this study, the input included demographic variables such as age, education, occupation, income, type of family, source
of information and dietary pattern, menstrual history, and obstetrical history that contributes to change in clinical signs in hematological variables. It also includes their inadequate knowledge, attitude and practice regarding prevention of anemia assessed during pretest. Further preparation of structured teaching programme and a plan for dietary supplementation of cooked drumstick leaves 100 gm poriyal 3 days per week for 3 months (90 days) for the experimental group-I and cooked cauliflower leaves 100 gm poriyal 3 days per week for 3 months (90 days) for the experimental group-II in order to prevent anemia.

**Throughput**

Throughput is the operational phase. It is the process that allows the input to be transformed to the women of reproductive age group through implementation of structured teaching program as meanings, causes, signs and symptoms, diagnosis, treatment, prevention and complication of anemia and dietary supplementation with 100 gm cooked drumstick leaves (*Moringa oleifera*) in poriyal from on the experimental group-I for 90 days from April 2013 to September 2013. During the intervention the dietary supplementation was given to the subjects 3 days per week for 3 month (90 days), namely Monday, Wednesday and Friday.

For the experimental group-II, the investigator administered a dietary supplementation with 100 gm cooked cauliflower leaves for a period of 90 days from October 2013 to March 2014.
The dietary supplementation for this group was given 3 days per week for 3 months (90 days), namely Monday, Wednesday and Friday. No intervention for the control group deworming was done with Tab. Albendazole 400mg single dose for all the three groups before giving dietary supplementation.

**Output**

After processing the input, the system gives out the output to the environment in an altered state. It is the information that is transferred to the environment. In this study, the output is improvement in knowledge on prevention of anemia, favorable attitude and adequate practice regarding prevention of anemia and improvement in hematological variables of the subjects in the experimental group-I and experimental group-II who received dietary supplementation.

**Feed Back**

Feedback refers to the re-assessment of the entire process in-order to produce desirable results. In this study, the subjects with no improvement in knowledge, attitude and practice and hematological variables will undergo re-assessment process for ensuring improvement.