UGC 12th PLAN

MINOR RESEARCH PROJECT

AN EFFECTIVE NUTRITIONAL KNOWLEDGE INTERVENTION PROGRAMME FOR ANAEMIC COLLEGE GIRLS OF MEHSANA TALUKA

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By

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CERTIFICATE

This is to certify that Dr. Prafulla Udayan Shah, Principal investigator has completed the 12th plan minor research project funded by UGC (University Grant Commission) on **"AN EFFECTIVE NUTRITIONAL KNOWLEDGE INTERVENTION PROGRAMME FOR ANAEMIC COLLEGE GIRLS OF MEHSANA TALUKA "** under the subject and faculty of Home Science.

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ABSTRACT

India is currently in the state of socioeconomic, demographic, nutritional, epidemiological and political transition. Malnutrition i.e. under nutrition and over nutrition are prevalent among communities. Under nutrition among children and anaemia among adolescent girls and women continue to affect the large segment of the population and leads to a poor health status. Anaemia is a major global problem affecting worldwide population. There are multiple causes of anaemia but the most important causes are poor dietary intake, poor access to medical facilities, low absorption, infestations, infections, lack of nutritional as well as health knowledge. Therefore the present investigation was planned for the study of nutritional status in relation with anaemic condition and nutritional knowledge level and impact of knowledge intervention programme among college girls of urban and rural Mehsana. For the study, total 405 (Urban -201 and Rural- 204) college girls were selected with purposive random sampling method from five colleges of Mehsana city. Urban girls were selected from Mehsana city and girls enrolled in the college who came from nearby villages were selected as rural group girls. The age group of girls were of 18-23 years. In the pre test study, anthropometric measurements, clinical signs and symptoms observation and filter paper method was aplied for the study of anaemia prevalence. In the post test procedure, blood haemoglobin and measurements of nutritional knowledge level was undertaken. Blood haemoglobin was estimated with cyanamathaemoglobin method, nutritional anthropometry was conducted for the BMI and clinical signs and symptoms were also observed. The girls who showed fair and poor nutritional knowledge were selected for the knowledge intervention programme.

Nutritonal knowledge intervention was carried out by lectures, power point presentation and recipe demonstration for creating awareness regarding nutrition and to address the myths and facts related to anaemic condition. Dietary information was collected through detailed questionnaire. The mean age of menarche was 14 years. Majority of girls belonged to other backward class and family's monthly income was 10,000 to 20,001 rupees. The results found showed that 63.45 % of girls were suffering from anaemic condition. 37.78 % of girls

were underweight. There was no significant difference found between urban and rural girls in the blood haemoglobin level.The mean body weight of girls was 46.86 kg., their BMI was 19.82 and the mean blood haemoglobin was 10.66 g/dl which is an indicator of moderate anaemic condition. All the college girls were sedentary workers and consumed vegetarian diet. The most observed clinical signs and symptoms were hair fall, paleness of skin, bleeding gums and dental carries. The clinical signs and symptoms related to anaemia that were observed during the study were decreased work performance, fatigue, flat and brittle nails etc. 50 % of the selected girls had four menstrual bleeding days. Overall, 17.28 %, girls had poor nutritional knowledge, 28.89 % had fair knowledge level and 54.57 % had good nutritional knowledge level. The girls from different faculties showed poor and fair knowledge level, girls from Arts and B. Ed. faculty showed poor nutritional knowledge and girls from Science, Home science, Homeopathy and Computer science faculty showed good nutritional knowledge level. Study showed that wheat was consumed daily and overall, 24.44%, 26.93% and 49.69 % girls had poor, fair and good intake of iron rich foods respectively. Overall, 22.72%, 25.19% and 52.10% girls had poor, fair and good intake of vitamin C rich foods. There was 19.08 % increase in nutritional knowledge level after nutritional knowledge intervention programme and 21.85% increase in anaemia awareness level after nutritional knowledge intervention programme. Study for relational analysis, BMI, clinical signs and symptoms, nutritional knowledge level and haemoglobin level showed positive and significant correlation with age, age at menarche, morbidities present, pica, heavy menstrual bleeding, frequency of iron and vitamin C rich foods intake and sources of information used. There was no significant difference found between urban and rural college girls in blood haemoglobin and nutritional knowledge level. Income and age at menarche was not associated significantly with blood haemoglobin levels. There was a strong positive impact of nutritional knowledge intervention on improving the knowledge level of the selected college girls.

Anaemia is manifested by deficiency of many nutrients and is an escalating problem worldwide. Chronic or recurrent infections also play an important role in promoting deficiency. It is not simply a consequence of the lack of affluence of a population, but rather the result of interactions among social, demographic, genetic, infectious and societal conditions. It is likely always to be a public health problem, since the etiology is so complex. The role of the public health nutritionist involves combined vigilance in wisely monitoring populations and situations. Effective interventions will be needed and particular attention should be paid to applying advances in knowledge with a global perspective, and building partnerships between groups of professionals.

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Dr. Prafulla U. Shah
Principal Investigator

CONTENTS

INDEX

List of Tables

LIST OF FIGURES

LISTS OF PLATES

ABBREVIATIONS

- BMI - Body Mass Index
- CBC - Complete Blood Count
- CDC - Child Development Centre
- cm - Centimeter
- cmm - Cubic millimeter
- dl - Deciliter
- DFS - Double Fortified Salt
- DNA - Deoxyribo Nucleic Acid
- EDTA - Ethylene Di amino Tetra Acetate
- Fl - Femo liter
- g - Gram
- GCS - Garden Cress Seeds
- GLVs - Green Leafy Vegetables
- Hb - Haemoglobin
- H.S. - Highly Significant
- IDA - Iron Deficiency Anaemia
- IFA - Iron Folic Acid
- kg - Kilogram
- LC - Leaf Concentrate
- LLC - Lotus Leaf Concentrate
- MAC - Mid Arm Circumference
- MCH - Mean Cell Haemoglobin
- MCHC - Mean Cell Haemoglobin Concentration
- MCV - Mean Cell Volume
- MDM - Mid Day Meal
- ml - milliliter
- MMR - Maternal Mortality Rate
- NCHS - National Community Health Survey
- OBC - Other Backward Class
- PCV - Packed Cell Volume
- pg - Picogram
- QL - Qualitative
- QN - Quantitative
- RBC - Red Blood Cells
- RDA - Recommended Dietary Allowances
- RNA - Ribo Nucleic Acid
- SC - Schedule Caste
- ST - Schedule Tribes
- TIBC - Total Iron Binding Capacity
- TRBC - Total Red Blood Cell
- UGC - University Grants Commission
- UN - United Nations
- UNICEF - United Nations International Children's Emergency Fund
- US - United States
- WHO - World Health Organization

INTRODUCTION

Anaemia is a broad term applied to the condition in which there is inadequate or defective formation of haemoglobin and defective maturation and formation of red blood cells. Nutritional anaemia may be defined as the condition that results from the inability of the erythropoetic tissue to maintain a normal haemoglobin concentration on account of inadequate supply of one or more nutrients leading to reduction in the total circulating haemoglobin. Nutritional anaemia is caused by the absence of any dietary essential that is involved in haemoglobin formation or by poor absorption of these dietary essentials. Some anaemias are caused by lack of either dietary iron or lack of high quality protein, pyridoxine (vitamin B_6) which catalyses the synthesis of the heme portion of the haemoglobin molecule, by lack of vitamin E which affects the stability of the red blood cell membrane. Copper is not part of haemoglobin molecule but aids in its synthesis by influencing the absorption of iron, its release from the liver or its incorporation into haemoglobin molecule. Iron deficiency anaemia (IDA) is the most common nutritional disorder in the world. The numbers are staggering as many as 4 – 5 billion people, 66 – 80 % of the world population may be iron deficient; 2 billion people, over 30 % of the world's population, are anemic, mainly as a result of iron deficiency, and in developing countries, frequently exacerbated by malaria and worm infections. It constitutes a public health condition of epidemic proportions. It particularly affects women in reproductive age group and young children in tropical and sub tropical regions. The world bank estimates that the direct contribution of IDA to global burden of disease is 14 disability adjusted life years per 1000 population. It has the greatest overall effect in terms of ill – health, premature death and lost earning. IDA occurs at all stages of life, but is more prevalent in pregnant women, young children , adolescent girls are vulnerable to iron deficiency. The functional consequences are known to occur prior to onset of clinical stage of iron deficiency. Iron deficiency and iron deficiency anaemia in adolescence is a major public health problem. Studies indicate that the incidence of anaemia in adolescents tends to increase with age and corresponds with the highest acceleration of growth during adolescence **(WHO-1993-2005).**

Iron is a vital component of hemoglobin, which transport oxygen to the various tissues of the body. Life and iron are inseparable with the sole exception of lactic acid bacteria, all living organisms require iron as an essential element for growth and multiplication. Iron deficiency is the most common nutritional problem in the world. It is known as anaemia.

1.1 Definition of anaemia

Anaemia occurs when the total volume of red blood cells (and/ or the amount of hemoglobin in the cells) is reduced below normal values, as defined by healthy populations. Anaemia results from one or more of the following processes: defective red cell production, increased red cell destruction, or blood loss. Hemoglobin transports oxygen around the body, when red blood cells and consequently hemoglobin are low, the body's tissues are not supplied with adequate amounts of oxygen. Women with a hemoglobin level of less than 11 gm/dl are considered to be anemic. There are multiple causes for anaemia. People suffer both nutritional anaemia (impaired red cell production) and from parasitic diseases such as malaria(red cell destruction) and intestinal worms(blood loss). Although iron deficiency is the most common cause of anaemia, especially among younger children and women of child bearing age, other nutrient deficiencies, such as folate and vitamin B_{12}, can also contribute to anaemia.

Adolescence is a transitional period from childhood to adulthood. It is a crucial period in women's life. Health and nutritional status during this phase is critical for the physical maturity, which in turn influences the health of offspring. It is seen that the rate of low birth weight, pre maturity and neonatal and infant mortality is high among children born to malnourished adolescent girls **(Diane Papalia-1984).** The early adulthood growth mounts pressure on the overall nutrition requirements of female and micronutrients too are, therefore required in higher proportion. The increase in height and the related skeletal growth and increase in blood volume and menarche raises the requirements for dietary calcium and iron among adolescent girls. The major micronutrients of concern in adolescent girl's growth and development are iron, calcium and iodine. Thus, the consumption of foods rich in calcium and iron in larger quantities becomes essential for normal growth and development of adolescent girls. Poor nutritional status during adolescence and early adulthood period of female is an important determinant of health

outcomes. Short stature in adolescents resulting from chronic under nutrition is associated with reduced lean body mass and deficiency in muscular strength and working capacity. In adolescent girls, short stature that persists into adulthood is associated with increased risk of adverse reproductive outcomes **(An Analytical Review-2008).**

Adolescents constitute 21.2 % of the total population of India, where malnutrition is an important public health problem among children and adolescents. Adequacy of dietary intake in terms of calorie and protein are important in order to improve the chances of child survival and safe motherhood. In India total projected population aged 18-23 years and their share in the total population is 24.1 % in the period of 2001-2012 and total population was 144,287 thousand including male and female contribute 12 % of total population of India and female population was 68,588 thousand in 2012. According to report of UGC on higher education, more than 252 lakhs of college girls were enrolled in different colleges of India including distance education and in Gujarat total projected college population was 7,590 thousand and projected enrolment was 12,20,537 are a significant human resource that needs to be given ample opportunity for holistic development towards achieving their full potential **(UGC report- 11th plan-2008).** Adult females have their own developmental needs, which are peculiar to them and need to be addressed separately.

1.2 Prevalence of anaemia

Poor density and bioavailability of dietary iron from staple foods are the major etiological factors for wide spread prevalence of iron deficiency in India. Iron deficiency anaemia affects over 2 billion people in the world. In the developing countries alone, 370 million women suffer from iron deficiency anaemia. The average prevalence is higher in pregnant women (51%) than in the non pregnant women (41 %). The prevalence among pregnant women varies from 31 % in South America to 64 % in South Asia. South and South – East Asia contribute to 58 % of total anaemic people in the developing world. In the developing countries, the problem of iron deficiency is high. In India, about 88 % pregnant women are anaemic, in China, however, the prevalence does not exceed 40 %. It is an important public health problem affecting people from all walks of life. Anaemia is very widespread, more among females than males and higher among infants and children than adults. Severe anaemia (with blood haemoglobin levels < 8 g/dl) is more frequently

seen in severely undernourished children who also exhibit signs associated with deficiencies of calories, proteins, vitamin, and minerals **(Anaemia Detection-1996).**

Table: 1.1 Classification of anaemia as a problem of public health significance.

Prevalence of Anaemia	Category of public health significance
≤ 4.9	No public health problem
5.2 – 19.9	Mild public health problem
20.0 -39.9	Moderate public health problem
≥ 40.0	Severe public health problem

Source: WORLD WIDE PREVALENCE OF ANAEMIA 1993-2005

1.3 Causes of anaemia

Causes of anaemia may be broadly divided in to three groups as following.

1. **Anaemias caused by dietary deficiencies.**
   a. Anaemias due to inadequate production of erythropoietin
   b. Anaemias due to deficiencies of folic acid and vitamin B_{12} (Megaloblastic anaemia)
   c. Iron Deficiency Anaemia (IDA)
   d. Anaemias due to deficiency of copper, vitamin C, and certain hormones.
2. **Anaemias due to genetic defects (Hemolytic anaemias)**
   a. Defective formation of heme.
   b. Defective formation of globins (Haemoglobinopathies and Thalassemias)
   c. Defective formation of red blood cells.
   d. Defects due to deficiency of some enzymes in red blood cells.
3. **Anaemias due to other causes.**
   a. Drugs, toxic chemicals, infections.
   b. Antibodies.
   c. Non – availability of iron that is stored in tissues (Sideroblastic anaemia)
   d. Non nutritional anaemia- Sports anaemia and pregnancy anaemia

Reference: Dr. M. Swaminathan-1974

1. Anaemias caused by dietary deficiencies

a. Anaemias due to inadequate production of erythropoietin

Erythropoiesis - Development of RBC in bone marrow: The term erythropoiesis is used for the normal development and formation of RBC in the bone marrow. The entire process takes about 120 hours (5days) to be completed. The stages in the development are as follows: Proerythroblast, basophilic or early normoblast, polychromatophilic or intermediate normoblast, orthochromatic or late normoblast, reticulocyte, erythrocyte.

Figure: 1.1 Normal Red Blood Cells

b. Anaemias due to deficiencies of folic acid and vitamin B_{12} (Megaloblastic anaemias)

Both vitamin B_{12} and folic acid are required for the maturation of pronormoblast (Stage – 1) to late normoblast (Stage – 4). Both these vitamins form coenzymes which are required for the synthesis of DNA. In the deficiency of vitamin B_{12} and folic acid, DNA synthesis in pronormoblast is affected and hence the maturation of pronormoblast to late normoblast is affected and hence the maturation of pronormoblast to late normoblast is affected, resulting in an anaemia called '*Megaloblastic Anaemia*'. This anaemia is characterized by the presence in the RBC of the intermediate stage cells (pronormoblast, intermediate normoblasts and late normoblast) in large numbers. The total RBC count is reduced. Two types of megaloblastic anaemias i.e., *pernicious anaemia* and *megaloblastic anaemia* are caused by the deficiency of vitamin B_{12} and folic acid respectively.

c. Iron deficiency anaemia

In Iron deficiency anaemia, adequate amounts of haemoglobin is not formed. For the formation of heme from protoporphyrin, ferrous iron is necessary. Adequate amounts of heme are not available to combine with globin to form haemoglobin. This anaemia is characterized by a marked reduction (5-7 gm %) of haemoglobin from the normal levels of 11 – 13 gm %. This is most common form of anaemia throughout the world affecting mainly women's reproductive years, infants and children. In both rural and urban areas in the tropics, this type of anaemia is extremely common **(Dr. M. Swaminathan-1974).**

Etiology of iron deficiency

Deficiency of iron may occur as a result of the following:

Poor iron stores: The iron stores of Asians are negligible as evidenced by low bone marrow hemosiderin levels and low liver stores. When the infants are born with poor iron a store, iron deficiency is aggravated in infants who are solely breast – fed for prolonged periods.

Inadequate iron intake: A few foods like greens and processed foods like rice flakes and dates are rich sources of iron. People who do not include these foods in the diet may suffer from anaemia. Availability of iron from plant sources is not as good as heme iron. Heme iron is present in foods of animal origin which are expensive. The average cereal – legume based diets as consumed in most developing countries would appear adequate in iron content (20 – 22 mg) for an adult. But the availability of iron from such diet is very poor. Only 3-5 % of dietary iron is absorbed in normal apparently healthy individual.

Inadequate utilization of iron: This can take place secondary to chronic gastrointestinal disturbances, defective release of iron from iron stores into plasma and defective iron utilization owing to a chronic inflammation or other chronic disorder.

Blood losses: This can occur in accidental hemorrhage, in chronic diseases such as tuberculosis, ulcers or intestinal disorders, or excessive blood donation or due to hookworm infestation. Excessive loss of blood during menstruation and childbirth can cause anaemia. Perinatal bleeding may result from obstetric complication such as placental abruption. In rural areas, post partum hemorrhage on account of poor obstetric spaced pregnancies and prolonged periods of lactation deplete iron stores with each successive pregnancy. This is reflected in the high incidence of anaemia with higher parity. In women

using intrauterine contraceptive device, menorrhagia (increased blood loss) may result in further depletion of already poor stores of iron.

Increased requirements: During period of accelerated demand like in infancy (rapidly expanding blood volume), adolescence (rapid growth and onset of menses in girls) and pregnancy and lactation can result in anaemia. Losses of iron may also occur due to excessive sweating in tropical climate.

Inadequate absorption of iron: This can occur in diarrhea (Sprue and pellagra) or when there is lack of acid secretion by the stomach or in chronic renal diseases when antacid therapy is given. Gastroctomy impairs iron absorption by decreasing hydrochloric acid and transit time through the duodenum. Excessive amounts of phytates and phosphates in the diet and excess consumption of tea can decrease the absorption of iron **(B. Srilakshmi-2005).**

Stages of iron deficiency anaemia

One's iron status can range from iron overload to iron deficiency anaemia. Routine measurement of iron status is necessary because about most of the people have a negative iron balance, about 10% have a gene for positive balance, and about 1% have iron overload. Deviations from normal iron status are summarized as stages viz. Stages I and II negative iron balance (i.e., iron depletion) and Stages III and IV negative iron balance (i.e., iron deficiency) and also Stages I and II positive iron balance.

Iron status has a variety of indicators. Serum (whole blood without coagulation factors) ferritin levels are in equilibrium with body iron stores. Very early (Stage I) positive iron balance may best be recognized by measuring total iron-binding capacity (TIBC). Conversely, measurement of serum or plasma (whole blood that includes coagulation factors) ferritin levels may best reveal early (Stages I and II) negative iron balance, although serum (TIBC) may be as good an indicator **(L. Kathleen Mahan, Sylvia Escott-Stump , 2008).**

Clinical features of iron deficiency anaemia (IDA)

Anaemia is like the tip of an iceberg, major part of iron deficiency is hidden as most adolescents with anaemia are asymptomatic. The symptoms of IDA depend on the rate at which anaemia develops in an individual. Symptoms may relate to rate of fall in haemoglobin. Since lowering of haemoglobin affects oxygen carrying capacity, in IDA,

any physical exertion leads to shortness of breath. Initially, most patients complain of increasing lethargy and fatigue. Most unusual symptoms are headache, tinnitus and disturbance in taste. There is often a poor correlation between haemoglobin level and symptoms. As the severity of deficiency increases, the patients develop pallor of the conjunctiva, tongue, nail beds and soft palate. In IDA of longer duration, there may be papillary atrophy of the tongue and, the nails may become spoon shaped (koilnychia). There may be enlargement of the spleen (splenomegaly). In children, chronic IDA may lead to behavioral changes; they have impairment of cognitive function and short attention spans and appear withdrawn **(Gibney *et al.*, 2013).**

Clinical Findings

Because anaemia is the last manifestation of chronic, long term iron deficiency, the symptoms reflect a malfunction of a variety of body systems. Inadequate muscle function is reflected in decreased work performance and exercise tolerance. Neurologic involvement is manifested by behavioral changes such as fatigue, anorexia, and pica, especially pagophagia (ice eating). **Nokes and colleagues**, in their report of the international nutritional anaemia consultative group **(1998),** supported earlier work by **Pollitt and colleagues (1986)** that abnormal cognitive development in children suggests the presence of iron deficiency before it has developed into overt anaemia. Growth abnormalities, epithelial disorders, and a reduction in gastric acidity are common. A possible sign of early iron deficiency is reduced immune competence, particularly defects in cell-mediated immunity and the phagocytic activity of neutrophils, which may lead to an increased propensity for infection.

Iron

The total iron content of the normal adult man (70 kg wt) is estimated to be about 4-5 gm. A greater part of the iron in the body is present as haemoglobin. Most of the body iron exists in complex forms bound to protein either as porphyrin or heme compounds or as ferritin and transferrin. Free inorganic iron occurs in the body only in very small amounts. The hemo-protein and flavo-protein enzymes also contain iron.

It is evident that (i) over 75% of total iron is present in haemoglobin as ferrous iron, (ii)About 20 % of the total iron is present as storage iron in ferritin (as ferric iron) in

intestines, liver and other tissues and (iii) the quantity of iron present in blood as transport iron (Transferrin) is about 3 mg as ferric iron.

Iron metabolism

The human body requires iron for the synthesis of the oxygen transport proteins, haemoglobin and myoglobin in the body, and other iron- containing enzymes that participate in electron transfer and oxidation –reduction reactions. An active process in the duodenum absorbs iron. The iron thus absorbed is mobilized across the mucosal and serosal membranes into the blood where the plasma transport protein (transferrin) transports it to the cells or the bone marrow for erythropoiesis. Transferrin delivers iron to the tissues by transferring- specific cell membrane receptors. The cell receptors bind the transferrin - iron complex at the cell surface and carry it into the cell to release iron. In the human body, iron is distributed in six compartments. Total body iron in men is about 3.8 g, while in women it is 2.3 g. In men, about one third of the total body iron is storage iron, whereas in women it forms only about one-eighth. Approximately two thirds of the total iron is functional, serving either a metabolic or an enzymatic function. Almost all of this is in the form of haemoglobin circulating within the RBC. Myoglobin and other iron- containing enzymes constitute about 15 % of functional iron.

The factors influencing iron balance are intake of iron, iron stores and iron loss. Adult males require about 1 mg of absorbed iron daily to replace the losses in gut secretions, epithelial cells, urine and skin. In menstruating females this can increases upto 1.4 mg. The body can excrete iron in a limited capacity and excess is stored either as ferritin or as hemosiderin in the liver, spleen and bone marrow.

Inadequate iron intake will:

1. Enhance absorption of dietary iron
2. Mobilize the body's iron stores
3. Reduce the transport of iron to the bone marrow
4. Lower the haemoglobin levels, leading finally to IDA

Iron absorption

The primary regulatory mechanism of iron balance is iron absorption through the gastrointestinal tract. Since humans have no physiological pathway for the excretion of iron, the regulation of the intestinal absorption of iron is crucial. As duodenal crypt cells

mature into absorptive enterocytes, their capacity for iron absorption reflects the iron status prevailing at the time of maturation. The low pH of gastric juice helps in dissolving the ingested iron and facilitates enzymic reduction of ferric iron into the ferrous form by a brush- border ferrireductase. However, the mechanism by which the iron absorption is regulated is still not very clear. Body iron stores and the haemoglobin status of individuals determine the percentage of iron absorption. Since women and children have lower iron stores, they absorb a higher proportion of dietary iron. In pregnancy, as iron stores decline with gestation, iron absorption gradually and steadily becomes more efficient. Conversely, the higher iron stores in males reduce the percentage of iron absorbed, thereby protecting against iron overload. About two-thirds of the total body iron is contained in RBC. Destruction or production of RBC accounts for most of iron turnover. Most of the iron of destroyed RBC is recaptured for the synthesis of haemoglobin.

Iron is widely distributed in meat, eggs, vegetables and cereals, but the concentrations in milk, fruit and vegetables are low. The iron content per se of individual foods has little meaning as iron absorption varies considerably. There are two types of food iron: nonheme iron, which is present in both plant foods and animal tissues, and heme iron, coming from the haemoglobin and myoglobin in animal products. Heme iron represents 30-70 % of the total iron in lean meat and is always well absorbed. Nonheme iron from meat and vegetable foods enters a common nonheme iron pool in gastric juice, from which the amount of iron absorbed depend to a large extent on the presence of enhancing and inhibiting substances in the meal and on the iron status of the individual. Heme iron is obtained mostly from meat, poultry and fish, and is at least two to three times better absorbed than nonheme iron. Nonheme iron is derived mostly from plant and dairy products and accounts for more than 85 % of dietary iron. Several factors are known to enhance or inhibit iron absorption. The absorption of nonheme iron is strongly influenced by the presence of iron absorption inhibitors and enhancers of iron solubility in the upper part of the small intestine.

Iron absorption enhancers

The best known enhancer of iron absorption is ascorbic acid (vitamin C), which can increase nonheme iron absorption significantly. Thus, amla, guava and citrus fruits increase iron absorption from plant foods. Factors present in meat also enhance nonheme iron

absorption. Lactoferrin, a milk glycoprotein present in breast milk, binds iron, enabling the optimal use of iron by delivering iron during deficiency and preventing its availability for intestinal bacteria. Although the iron content of breast milk is same as that of cow's milk, in view of better absorption, breast milk is a better source of iron than either cow's milk or non fortified milk substitutes.

Iron absorption inhibitors

The inhibitors of iron absorption include calcium phosphate, bran, phytic acid and polyphenols. Phytic acid, which is extensively present in cereals and legumes, is the major factor responsible for the poor bioavailability of iron in these foods. Since fiber per se does not inhibit iron absorption, the inhibitory effect of bran is solely due to the presence of phytic acid. Soaking, fermentation and germination of these food grains improve absorption by activating phytases to degrade phytic acid. Polyphenols (phenolic acids, flavonoids and their polymerization products) are present in tea, coffee, cocoa and red wine. Tannins present in black tea are the most potent of all inhibitors. Calcium consumed in dairy products such as milk, cheese can inhibit the iron absorption.

Iron storage

Iron is stored as ferritin or hemosiderin primarily in the liver, reticuloendothelial cells and bone marrow. In the liver it is stored in parenchymal cells or hepatocytes, while in the bone marrow and spleen it is stored in reticuloendothelial cells.The stored iron is mainly a reservoir of iron to supply cellular needs for haemoglobin production. It is important to note that the iron bound to ferritin is more readily mobilized than that bound to hemosiderin. The total amount of storage iron varies considerably without any apparent impairment of body functions. Storage iron may be totally depleted before the appearance of IDA. Under conditions of long – term negative iron balance, the stores are depleted before the onset of iron deficiency in the tissues. When there is positive balance, iron stores increase slowly even when the absorption of iron is lower, as in postmenopausal women.

Iron losses

Iron losses in healthy individuals occur primarily in feces (0.6 mg/ day), bile and desquamated mucosal cells, and in minute quantities of blood. Urinary losses are small. Women of reproductive age, in addition to the basal losses, lose iron in menstruation. The median menstrual blood loss is about 30 ml/ day, which is equivalent to an additional

requirement of 0.5 mg of iron per day. This daily blood loss is computed from the iron content of blood lost during the menstrual period over a month. About 10 % of women lose as much as 80 ml of blood, corresponding to a loss of 1 mg of iron per day. Adopting the higher value (1 mg/day), the total (basal plus menstrual) loss of iron in women would be 30 microgram/ kg per day(> 1.5 mg /day). Such women cannot maintain positive iron balance if iron requirements are based on median menstrual loss of 30 ml. In the tropical countries, hookworm infestation is a major cause of gastrointestinal blood loss contributing to iron deficiency in older children and adults. In the developed world, among adults, chronic use of drugs such as aspirin, bleeding tumors and ulcers contribute to iron losses.

Reference intakes for iron

Table : 1.2 RDA values of iron for different age groups.

Age group	Age and gender	Iron (mg / day)
Infants	First 6 months	0.27
	7 – 12 months	11
Children	1-3 years	7
	4-8 years	10
Teenage boys	9-13 years	8
	14-18 years	11
Teenage girls	9-13 years	8
	14-18 years	15
Adult men	Above 19 years	8
Adult women	19- 50 years	18
Adults	Above 51 years	8
Pregnant women	-	27
Lactating women	Below 18 years	10
Lactating women	19-50 years	9

***Recommended by the US Food and Nutrition Board in 2001.Reproduced with permission from the WHO.**

Daily (absorbed or physiological) iron requirements are calculated from the amount of dietary iron necessary to cover basal losses, menstrual losses and growth needs. They vary according to age and gender, and in relation to body weight they are highest for the young infant. Current RDA values for iron are summarized in Table 1.2. An important

aspect that requires consideration while computing requirements for iron is the percentage of iron absorbed from the diet. While a value of 5 % is assumed for cereal-legume-based diets, about 10-15 % is used for diets containing meat and animal products **(Gibney *et al.* - 2013).**

Factors affecting absorption of iron present in foods.

Heme and Nonheme Iron.

Food iron may be broadly separated into two separate pools, i.e., heme iron and nonheme inorganic iron. Heme iron is present, mainly in haemoglobin and myoglobin present in meat, fish and other animal foods. Heme iron derived from animal foods is absorbed directly in the human gut to the extent of 60 to 70%. It is taken up by the mucosal cells of the intestines with iron still attached to the porphyrin ring. Its absorption is independent of the presence of inorganic iron, and ascorbic acid. **(Dr. M.Swaminathan, 1974).**

Role of Stomach

Since iron is absorbed in the ionic state, it is reasonable to suppose that gastric digestion may help in solubilizing dietary iron. Absorption of iron is impossible in hypoacidity. The presence of anaemia and the nature of the food that accompanies the iron are complicating factors. The assimilation of iron may be impaired by rapid emptying of the food from the stomach. It has been demonstrated that much more iron can be extracted from food materials by acid peptic digestion than by saline extraction **(Dr.M. Swaminathan, 1974).**

Ferrous versus Ferric Iron

There is good evidence that iron is absorbed in the ferrous state. **Venkatachalam *et al.* 1968** showed in rats that radioactive ferric iron was absorbed to about one-fifth the extent of ferrous iron, but that when each was administered with α– α dipyridyl there was no difference in their absorption. **Moore *et al.* 1963** showed in human subjects that increments to the plasma iron were greater after the ingestion of ferrous than of ferric iron, but that there was no difference if a reducing substance was given with the ferric iron **(Dr. M. Swaminathan, 1974).**

Ascorbic Acid

Considerable attention has been given to a role of vitamin C in this process, and it has been demonstrated that the absorption of iron is enhanced by the simultaneous administration of ascorbic acid. It is reasonable to suppose that the effect is related to the reducing action of ascorbic acid. It has been demonstrated in normal and anemic human subjects that vitamin C increases the absorption of iron, but the effective amounts were very large, 500 to 1000 mg. Infants on a normal diet did not absorb iron better if they were given an extra 100 mg of ascorbic acid per day. It does not seem likely that amounts of vitamin C ordinarily ingested would affect the absorption of iron **(Dr. M. Swaminathan, 1974).**

Phytic Acid and Oxalic Acid

Phytic acid, the hexaphosphoric acid of inositol, is a common constituent of the parts of plants that are used for food. It is conspicuous as a constituent of the bran of cereals. Many of the salts of phytic acid have a low solubility and phytates has been implicated as a deterrent to the absorption of metals, principally of calcium and iron. It has been shown that the response of serum iron to large amounts of dietary iron taken with bread and jam was less if sodium phytate had been added to the bread. In a similar experiment it was demonstrated that sodium phytate given with test meals decreased the absorption of iron. The absorption of iron from ferric phytate is very low (2 to 5%). It has been demonstrated that anemic patients can utilize some of the iron from very large doses of iron phytate. Oxalic acid present in certain vegetables forms insoluble iron oxalate and prevents the absorption of dietary iron **(Dr. M.Swaminathan, 1974).**

Haemoglobin

Haemoglobin plays a crucial role in the transport of oxygen. With moderate IDA, there is a compensatory mechanism by biochemical changes to compensate for the reduced oxygen carrying capacity of blood. In contrast, in sever IDA, the markedly reduced haemoglobin content decreases the oxygen carrying capacity, leading to chronic tissue hypoxia.

Packed within each red blood cell are an estimated 200 to 300 million molecules of haemoglobin which make up about 95% of the dry weight of each cell. Each haemoglobin molecule is composed of four protein chains. Each chain, called a globin is bound to a red pigment, identified in Figure 1.2 as a heme molecule. Each heme molecule contains one

iron atom. Therefore, one haemoglobin molecule contains four iron atoms. This structural fact enables one haemoglobin molecule to unite with four oxygen molecules to form oxyhaemoglobin (a reversible reaction). Haemoglobin can also combine with carbon dioxide to form carbamino haemoglobin (also reversible), but in this reaction the structure of the globin part of the haemoglobin molecule, rather than of its heme part, makes the combining possible.

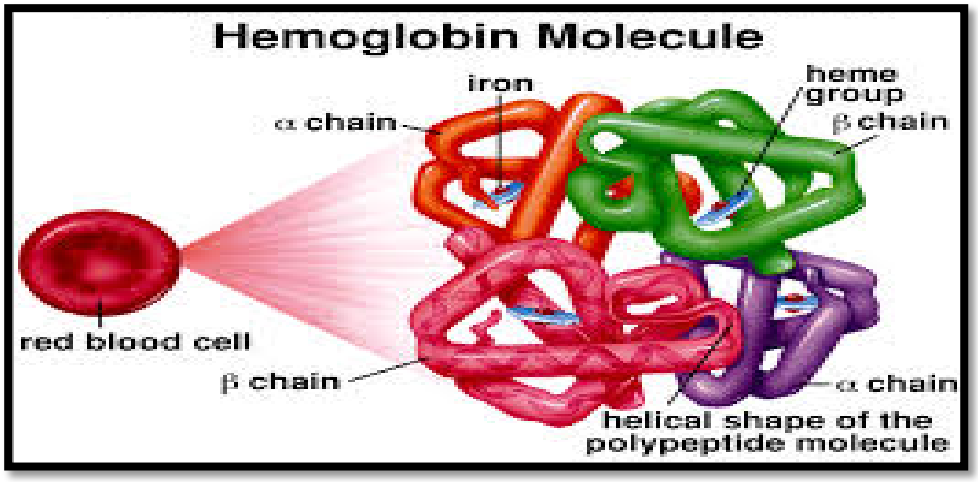


Figure: 1.2 Structure of haemoglobin

A man's blood usually contains more haemoglobin than a woman's in most normal men 100 ml of blood contains 14 to 16 gm of haemoglobin. The normal haemoglobin content of a woman's blood is a little less – specifically in the range of 12 to 14 gm per 100 ml. An adult who has a haemoglobin content of less than 10 gm per 100 ml of blood is diagnosed as having anaemia (from the Greek a-,"not", and haima, "blood"). In addition, the term may be used to describe a reduction in the number or volume of functional red blood cells in a given unit of whole blood. Anaemias are classified according to the size and haemoglobin content of red blood cells.

Diagnosis

Progressive stages of iron deficiency can be evaluated by six different measurements:

1. Quantity of serum or plasma ferritin.
2. Quantity of serum or plasma iron.
3. Quantity of total circulating transferrin.

4. Percent saturation of circulating transferrin, which measures the iron supply to the tissues; it is calculated by dividing serum iron by the TIBC; levels less than 16% are considered inadequate for erythropoiesis.

5. Percent saturation of ferritin with iron.

6. Quantity of *soluble serum transferrin receptors (SFTR)*: Transferrin molecules are generated on the surface of red blood cells in response to the need for iron. With iron deficiency, so many transferrin receptors are on the cell surface looking for iron that some of them break off and float in the blood (serum). Their presence is an early measurement of developing iron deficiency, with a higher quantity meaning greater deficiency of iron.

A definitive diagnosis of iron deficiency anaemia requires more than one method of iron evaluation and preferably includes the first three of the measurements listed above. The evaluation should also include an assessment of cell morphology. The serum or plasma *ferritin* level is the most sensitive parameter of negative iron balance because it decreases only in the presence of true iron deficiency, as with transferrin saturation. Protoporphyrin, the iron-containing portion of the respiratory pigments that combine with protein to form haemoglobin or myoglobin, can be used to assess iron deficiency. The zinc protoporphyrin (ZnPP)/heme ratio is measured. However, this (ZnPP)/heme ratio and haemoglobin levels are affected by chronic infection and other factors that can produce a condition that mimics iron deficiency anaemia when, in fact, iron is adequate **(Herbert *et al.*, 1997).**

The TIBC declines and serum ferritin levels rise in chronic disease unrelated to iron metabolism. By itself, haemoglobin concentration is unsuitable as a diagnostic tool in cases of suspected iron deficiency anaemia for three reasons (1) it is affected only late in the disease; (2) it cannot distinguish iron deficiency form other anaemias (3) haemoglobin values in normal individuals vary widely.

d.Anaemias due to deficiency of copper, ascorbic acid, pyridoxine and of certain hormones.

Copper deficiency

Copper containing enzymes Ferro oxidases I and II are essential in the transport of iron from the intestines to the bone marrow. In copper deficiency, orally administered ferrous iron is not effective in curing iron deficiency anaemia. Copper is essential along with iron for curing iron deficiency anaemia.

Anaemia due to deficiencies of ascorbic acid and pyridoxine

Anaemia due to deficiency of ascorbic acid has been observed in scurvy. This anaemia is cured by ascorbic acid. The exact role of ascorbic acid in curing anaemia of scurvy is not known. Ptridoxine deficiency has been reported to cause anaemia. This may be due to the fact that pyridoxine is essential in the biosynthesis of heme.

Anaemia due to deficiencies of certain hormones

In thyroid deficiency (Myxoedema and cretinism) owing to depressed bone marrow activity, anaemia commonly occurs. This responds to thyroid medication. Thyroxine probably acts as a general metabolic stimulant on the bone marrow. In disorders of pituitary, anaemia occurs. Thus in Simmond's disease, anaemia is common. Polycythemia may occur in Cushing's syndrome. The blood changes are due to general stimulant action of these hormones on the bone marrow.

2. Anaemia due to genetic defects

The anaemia due to genetic defects can be discussed under the following heads

(i) Defective formation of haemoglobin (ii) Defective formation of red blood cells; (iii) Defects in the metabolism of iron and (iv) Defects in the metabolism of red blood cells.

(i) Defective formation of haemoglobin

The different hereditary conditions affecting haemoglobin formations are

(1) Defective heme formation and (2) Defective globin formation.

Defective heme formation: Heme formation is affected in (1) Porphyria: This is a hereditary disorder in which the formation of protoporphyrin present in heme is affected resulting in anaemias of various types. (2) Congenital transferrinanaemia: Transferrin carries the iron in plasma to the bone marrow. In the absence of transferrin, iron is not transported for incorporation in heme.

Defective globin formation: Two groups of hereditary disorders in the synthesis of globin are known (a) involving mutations affecting the structural genes and (b) involving mutations affecting the regulatory genes.

(ii) Defective formations of Red Blood Cells

In some hereditary disorders, the RBC membrane is defective. This changes the shape of the RBC. For example in hereditary spherocytosis, the RBC is spheroidal in shape

and hence easily destroyed while passing through the spleen. Another disorder is hereditary elliptocytosis in which the RBC is elliptical shaped. Hence these cells undergo rapid destruction while passing through the spleen.

(iii) Defect in the metabolism of RBC

The mature RBC in adults contains different enzymes of the glycolytic and hexo monophosphate pathways. The pathways are essential for the survival of RBC. Deficiency of any one of the enzymes will lead to a shortening of the life of the RBC and more rapid hemolysis of the cells. Hereditary disorders due to the deficiency of glucose – 6 phosphate dehydrogenase and pyruvate kinase have been reported to occur among human beings in some countries.

3. Anaemia's due to other causes

The stability of RBC can be adversely affected by (a) Toxic chemicals and drugs (b) Infections (c) Antibodies (d) Sidiroblastic anaemia.

Toxic chemicals and drugs: Some drugs affect the stability of RBC and causes hemolytic anaemia. Poisoning with lead interferes with synthesis of heme and this brings about a reduction in the synthesis of haemoglobin. Medication can alter nutrient metabolism, influence erythropoiesis and blood coagulation and sometimes lead to increased red cell destruction.

Infections: Malaria is a common cause of hemolytic anaemia. Many viral diseases affect adversely the stability of RBC. Anaemia can occur in patients who have chronic infections, inflammatory conditions, autoimmune disorders or cancer. As a result of the inflammatory response macrophages in the liver, spleen and bone marrow sequester iron, making unavailable for erythropoiesis and hence slowing the rate of production of new blood cells. In addition, RBC is destroyed more rapidly than usual and reduced production of RBC can't keep pace. Iron absorption is impaired, possibly intestinal cells inhibit release of iron into blood. Eventually outright iron deficiency may result from inadequate iron absorption.

Antibodies: In recent years, hemolytic, anaemias caused by anti-red cell antibodies are receiving increasing attention. Two such conditions, viz, autoimmune hemolytic anaemia-hemolysis of RBC is produced by activation of complement system. Fragmentation and alterations of the shape of RBC to a rigid spherocyte makes them vulnerable to hemolysis. and isoimmune hemolytic anaemia - This disease is seen mainly in the new born. Foetal

RBC enter maternal circulation at the time of birth. This causes reaction in infants. The isoantibodies formed react with the RBC of infants and cause hemolysis. The new born infants become markedly anemic in a short time.

Sideroblastic anaemia: The Sideroblastic anaemias are a heterogeneous group of disorders that are characterized by the presence of excessive iron deposits within the mitochondria of normoblast in the bone marrow. The deposition of excess iron appears to be due to defect in heme synthesis. Consequently the iron brought to the bone marrow is deposited in the mitochondria of normoblasts. In sideroblastic anaemia, serum iron and tissue stores of iron are also increased. Excessive amounts of iron are deposited in the reticuloendothelial system and in the parenchymal cells of various organs. In some instances, the excess iron deposition interferes with the function of the organs like liver, pancreas and heart.

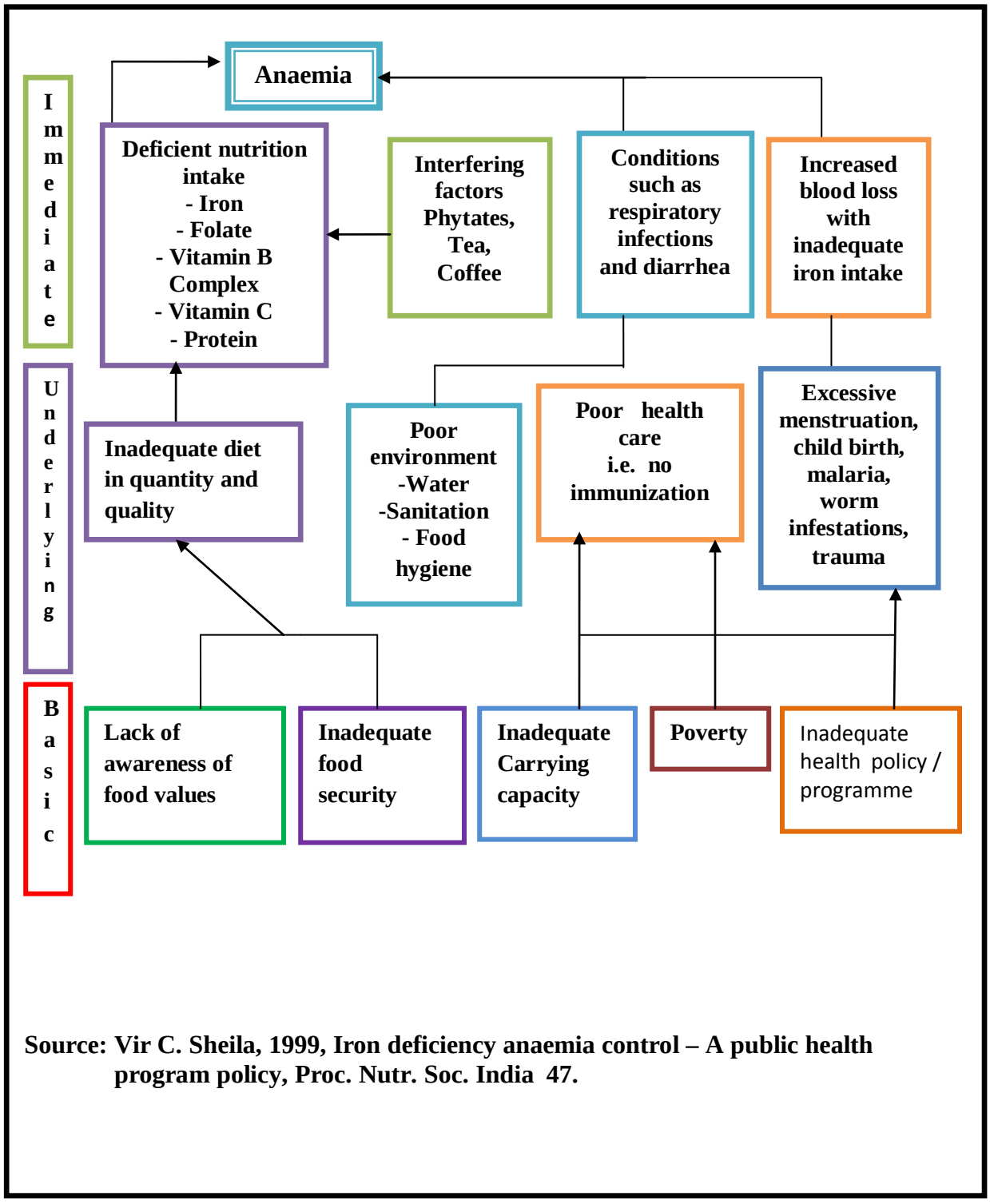
1.4 Morphological classification or types of anaemia

Hypochromic and Microcytic anaemia: If there is an insufficiency of iron for the formation of haemoglobin , the red blood cells are pale and small and the anaemia is said to be hypochromic and microcytic.

Megaloblastic (Orthochromic macrocytic anaemia): Vitamin B_{12} and folic acid are co-enzymes in the DNA synthetic pathway. A deficiency of the vitamins or impairment in their utilization results in damaged or inadequate synthesis of DNA. The synthesis of RNA and protein is unaffected so there is cytoplasmic enlargement, not matched by DNA synthesis which appears to delay or block mitotic division. Thus there appears to be asynchronism between cytoplsmic maturation and nuclear maturation. If the maturation of the red blood corpuscles in the bone marrow is impaired by lack of folate or vitamin B_{12}, the cells which enter the blood stream are irregular in size and shape, but usually larger than normal, and contain their full complement of haemoglobin. This is also known as orthochromic macrocytic anaemia.

Dimorphic anaemia : If both iron and either folate or vitamin B_{12} are deficient it gives rise to hypochromic macrocytic or dimorphic anaemia **(B. Srilakshmi- 2005).**

Figure: 1.3 Multi – factorial causes of anaemia.



Source: Vir C. Sheila, 1999, Iron deficiency anaemia control – A public health program policy, Proc. Nutr. Soc. India 47.

1.5 Prevention and control of iron deficiency anaemia

The basic principles in the prevention of IDA is to ensure regular consumption of iron to meet the requirements of the body and to increase the content and bioavailability of iron in the diet, there are four main approaches.

- Provision of iron supplements
- Fortification of commonly consumed foods with iron
- Nutrition education
- Horticulture-based approaches to improve the iron bioavailability of common foods

Iron supplementation

The essential principle of management of IDA is iron replacement therapy and treatment of the underlying cause, such as parasitic infections or gastrointestinal bleeding. Oral iron therapy is the preferred form of treatment. Ferrous sulfate is the most inexpensive and widely used oral iron preparation. Other preparations such as ferrous gluconate or ferrous fumerate may also be given. A total dose equivalent to 60 mg of elemental iron (300 mg of ferrous sulfate) per day is adequate for adults, and should be given between meals either in the morning or at bed time. In the case of infants and young children, 30 mg/ day of elemental iron would be adequate. In general, over a period of 4 weeks a haemoglobin rise of about 2g/dl would be expected. It is important to remember to continue iron therapy for about 3 months, even after the haemoglobin level becomes normal. The common side effects of iron supplementation are nausea, constipation, black stools and even diarrhea. The risk of side effects is proportional to the iron dose. Poor compliance is the major reason for failure to respond to iron therapy, so simultaneous and appropriate counseling of the individuals may be required. Oral iron is the treatment of choice for prevention of IDA. In general, daily supplements providing about 100 mg of elemental iron are recommended for a period of about 100 days to the most vulnerable groups of population, such as pregnant women. The dosage is fixed, taking into consideration the biological effectiveness and the side effects.

Fortification

Fortification of some commonly consumed foods with iron is an attractive option to tackle the problem of inadequate dietary intakes in the community. The food fortification and food vehicles should be safe and effective. Foods successfully used as vehicles for food

fortification are wheat, bread, milk powder, salt, infant formula and sugar. In India, multi centric field trials indicate that iron-fortified common salt has been effective in reducing the prevalence of IDA in rural communities.

Nutrition education

Extensive and persuasive efforts are required to bring about behavioral changes in the community for people to adopt dietary diversification. Ultimately, the only sustainable solution to IDA is to help the communities to consume regularly the foods that are rich in iron, to encourage intake of promoters of iron absorption such as vitamin C and to discourage high consumption of inhibitory factors.

The following approaches are considered as important in preventing and controlling nutritional anaemias in general:

- Promotion of the consumption of iron-rich foods, e.g. pulses, green leafy vegetables, other vegetables and meat products.
- Encouraging regular consumption of foods that are rich in vitamin C, e.g. citrus fruits, guava and amla.
- Promotion of the addition of iron-rich foods to weaning foods.
- Discouraging consumption of food that inhibits iron absorption, particularly by women and children.

Agriculture and horticulture approaches

Horticulture strategies to encourage production of iron-rich vegetables and fruits are an important component of long-term approach to control and prevent IDA in the developing countries. It is paradoxical that IDA is widely prevalent in countries where a wide variety of iron-rich foods and iron absorption promoters are already available. At the government level, there is a need to add nutrition components to all horticulture and social forestry programs, while at the household level, efforts should be made to encourage production of vegetables. Home gardening is one of the sustainable approaches to control IDA in poor rural communities. It is rather paradoxical that communities involved in agriculture require extension and education to raise nutritious food in their backyards. An advantage of home gardening is that it facilitates consumption of multiple nutrients. In the case of IDA, in addition to providing iron-rich foods, it facilitates inclusion of iron absorption promoters in the diet **(Gibney *et al.*, 2013).**

1.6 Significance of the study

Anaemia is a worldwide problem in persons of all ages; it is not a diagnosis but rather a sign or symptoms of an underlying disorder. The rate of prevalence is higher in the developing countries. In India the prevalence of anaemia among adolescent and college girls, non pregnant and pregnant women, and children under 6 years of age is seen in higher percentage. Iron deficiency and anaemia reduce work capacity of individuals and entire population, and obstacles to national development. Conversely, treatment can raise national productivity levels by 20 %.

In developing countries, where IDA is widely prevalent, universal iron supplementation to people of vulnerable groups would be appropriate. In segments of the population of higher socio- economic groups, selective provision of iron supplements only to anemic individual would be preferable. This approach, however, requires screening of individuals for IDA, requiring suitable skilled staff and laboratory facilities. The success of such a program depends on the distribution of adequate quantities of iron supplements and adherence to treatment.

Unfortunately, under the present socioeconomic conditions in which the current dietary intakes are not adequate, people in developing countries will continue to require iron supplementation to meet their iron needs. For this reason, there is a need for alternative approaches to supplementation such as the use of small – dose iron supplementation and slow release iron preparations. Slow release iron preparations can achieve the same benefit as the lower dose iron with very few side- effects. Weekly iron supplementation in place of daily iron distribution has also been suggested which may result in greater absorption of the iron dose, but may only be effective under supervised conditions.

Person-to-person communication still remains an effective method of communication in most of the developing countries. Group talks, slide shows, folk plays, street plays, television and radio are the other methods of nutrition education. Social marketing which applies marketing principles to improve nutrition awareness by involving communication experts may be one of the strategies to be adopted.

There is a need to provide scientific information to college girls regarding health and nutrition and anaemia, as they are the major portion of Indian population. So there is a need to create overall awareness regarding anaemia and its prevention. This will help in

attaining good health, providing good information and decrease the myths about anaemia, as it is necessary for healthy living and good economy of the country. The measurement of knowledge of selected communities towards anaemia and nutrition is useful to health workers for researching and designing approaches in right direction. This study will also be helpful to students, researchers, people of NGO's and government and all those engaged in the field of health and nutrition to implement and create awareness through education programs.

1.7 Research aim

General objective

- An effective nutritional knowledge intervention for anaemic college girls of Mehsana city and taluka.

Specific objective.

- To study the prevalence of anaemia among selected college girls.
- To study nutritional status by anthropometric measurement.
- To study about level of nutritional knowledge among selected college girls.
- To study the effect of knowledge intervention programme.

REVIEW OF LITERATURE

The comprehensive review of literature is an essential part of any scientific investigation. The review of literature leads the researcher to conclude the findings with references to past studies. The review gives a clear perspective of the overall field of research and allows comparing the results of the past studies in the particular field with the present research. It also provides the investigator with an opportunity to gain insight into the methods and approaches employed by other researchers and helping in formulating the research design. Further literature having direct bearing on different aspect of the present study is limited. Hence, references having indirect bearing are also reviewed. A brief account of such literature reviewed has been presented under the following head.

2.1 Prevalence of anaemia

- 2.1.1 Global prevalence of anaemia.
- 2.1.2 National prevalence of anaemia.
- 2.1.3 Prevalence of anaemia in Gujarat.

2.2 Etiology of anaemia.

2.3 Pica i.e. eating disorder of non nutritional substances.

2.4 Nutritional status.

2.5 Intervention strategies for eliminating anaemia.

- 2.5.1 Supplementation
- 2.5.2 Fortification
- 2.5.3 Bio availability of dietary iron
- 2.5.4 Improving bio availability of dietary iron
- 2.5.5 Nutrition education
- 2.5.6 Beneficial effects of Garden cress seeds

2.1 Prevalence of anaemia

2.1.1 Global prevalence of anaemia

Table:2.1 Population coverage (%) by anaemia prevalence surveys (national or sub national) conducted between 1993 and 2005, by UN region (WHO – 2005)

UN Region[b]	PreSAC[a]	PW	NPW	SAC	Men	Elderly	All
Africa (53)	76.7 (30)[c]	65.3 (25)	63.6 (26)	18.6 (10)	32.0 (14)	1.8 (1)	40.7
Asia(47)	82.1 (30)	80.9 (21)	88.8 (34)	37.0 (11)	47.6 (13)	54.1 (7)	58.0
Europe(41)	19.2 (5)	0.9 (1)	23.9 (5)	12.9 (3)	15.9 (2)	8.7 (2)	14.9
Lam and the Caribbean (33)	70.5 (15)	38.4 (14)	37.5 (12)	28.9 (8)	0.1 (1)	0.0 (0)	22.9
North America(2)	92.4 (1)	92.8 (1)	89.9 (1)	91.3 (1)	89.9 (1)	89.6 (1)	84.3
Oceania(16)	5.1 (3)	4.7 (2)	16.5 (4)	15.1 (3)	15.6 (3)	15.1 (2)	13.8
Global (192)	76.1 (84)	69.0 (64)	73.5 (82)	33.0 (36)	40.2 (34)	39.1 (13)	48.8

[a] Population groups: PreSAC, preschool-age children (0.00-4.99 yrs); PW, pregnant women (no age range defined); NPW, non-pregnant women (15.00 – 49.99 yrs), SAC, school-age children (5.00-14.99yrs), Men (15.00-59.99 yrs); Elderly (≥ 60.00 yrs).[b] Number of countries in each grouping.

[c] Total number of countries with data, No Figure is provided for 'All' since each country may be partially covered by some population groups, but few countries have data on all 6 population groups and no countries have data for women 50-59 years of age.

Table: 2.2 Anaemia prevalence and number of individuals affected in school-age children, pregnant women, and non-pregnant women in each UN region

UN Region[a]	Preschool-age children [b]		Pregnant Women		Non-Pregnant Women	
	Pre. (%)	# affected (mill.)	Pre. (%)	# affected (mill.)	Pre. (%)	# affected (mill.)
Africa	64.6 (61.7-67.5)[c]	93.2 (89.1-97.4)	55.8 (51.9-59.6)	19.3 (18.0-20.7)	44.4 (40.9-47.8)	82.9 (76.5-89.4)
Asia	47.7 (45.2-50.3)	170.0 (161.0-178.9)	41.6 (39.0-44.2)	31.7 (29.7-33.6)	33.0 (31.3-34.7)	318.3 (302.0-334.6)
Europe	16.7 (10.5-23.0)	6.1 (3.8-8.4)	18.7 (12.3-25.1)	1.4 (0.9-1.8)	15.2 (10.5-19.9)	26.6 (18.4-34.9)
LAC	39.5 (36.0-43.0)	22.3 (20.3-24.3)	31.1 (21.8-40.4)	3.6 (2.5-4.7)	23.5 (15.9-31.0)	33.0 (22.4-43.6)
NA	3.4 (2.0-4.9)	0.8 (0.4-1.1)	6.1 (3.4-8.8)	0.3 (0.2-0.4)	7.6 (5.9-9.4)	6.0 (4.6-7.3)
Oceania	28.0 (15.8-40.2)	0.7 (0.4-1.0)	30.4 (17.0-43.9)	0.2 (0.1-0.2)	20.2 (9.5-30.9)	1.5 (0.7-2.4)
Global	47.4 (45.7-49.1)	293.1 (282.8-303.5)	41.8 (39.9-43.8)	56.4 (53.8-59.1)	30.2 (28.7-31.6)	468.4 (446.2-490.6)

[a] UN regions: Africa, Asia, Europe, Latin America and the Caribbean (LAC), Northern America (NA), and Oceania.

[b] Population groups: PreSAC, preschool-age children(0.00-4.99 yrs); PW, pregnant women (no age range defined); NPW, non-pregnant women (15.00-49.99 yrs).

[c] 95% Confidence intervals.

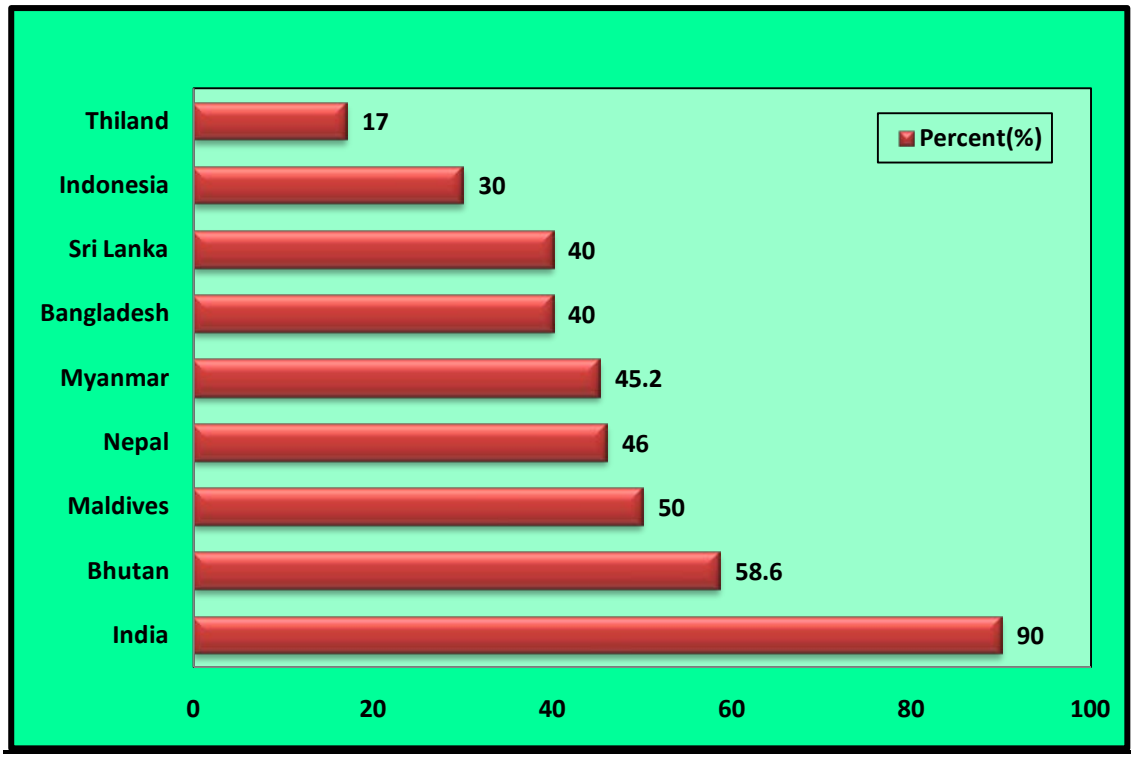


Figure: 2.1 Anaemia prevalence in adolescent girls (WHO 2011)

Adolescents constitute about 20% population in South - East Asian Countries. Figure 2.1 shows that in all South - East Asian Countries, except Thailand, more than a quarter of girls are anaemic, though there is a great disparity within the region. Irrespective of severity of anaemia, prevalence among adolescent girls ranges between 17 % - 90% within the region. The National data from India, Nepal and Myanmar also show that adolescent anaemia as moderate to severe public health problem. According to WHO guidelines, there are almost no countries in the region where anaemia is not at least a mild public health problem in the adolescent population **(WHO 2011).**

2.1.2 National prevalence of anaemia

Seetharam *et al.* (1997) conducted a study on prevalence of nutritional anaemia in selected girls of Mysore city. In this study 510 girls in the age group of 16-22 years from Maharani's science college were selected. 68% of them had a family income of Rs 2001 – 5000 per month and majority (82 %) of them had college education. A significant percentage of the girls (60%) were anaemic. Among the anaemic girls, 32%, 36%, and 2 % of them were moderately, mildly and severely anaemic respectively. Distribution of difference was similar in all the age groups. Paleness of the tongue and eyes were predominant clinical signs among the girls which indicated anaemia. The mean weight of the girls (16-17 years) was 45.5 kg and height was 157 cm. The mean

height and weight of these girls were lower than the NCHS standards. As per the BMI classification, all the girls of 18-22 years belonged to grade I chronic energy deficiency. Height and weight had no impact on anaemic conditions. However, weight and BMI decreased as the severity of anaemia increased, which were not statistically significant. Educational level of the parents and income of the parents showed no influence on occurrence of anaemia. It is noteworthy to mention here that the children of educated and high income families also suffered from anaemic condition. There is an urgent need for nutrition education of girls and parents to prevent anaemia.

Rawat *et al.* (2001) conducted a study on socio demographic correlates of anaemia among adolescent girls in rural areas of district Meerut (Uttar Pradesh). The present study was undertaken to find out prevailed anaemia among adolescent girls in rural Meerut and to study their socio-demographic characteristics indication to the anaemia. The study was carried out in Daruala block. The sample consisted of randomly selected 504 adolescent girls (10-18 years), covering 21 girls from each of the 24 sub center villages under Daruala, PHC. Detailed information was collected about socio-demographic characteristics for anaemia by oral questionnaire method, supplemented by physical examination and haemoglobin estimation. 174 (34.5%) of the 504 adolescent girls were anaemic. The prevalence of mild, moderate and severe anaemia among adolescent girls was 19 %, 14.1 % and 1.4 %, respectively. The proportion of mild, moderate and severe anaemia was 55.2 %, 40.8 % and 4.0 % respectively.

The prevalence of anaemia was significantly higher (45.2%) among adolescent girls from joint families as compared to those from nuclear families (28.3%) ($p<0.001$), which may be related to household food security. Anaemia was higher in socio-economic (50%) and it significantly reduced with rise in socio-economic status, being minimum (27.3%) ($p<0.001$), this may be because of better availability of high quality food with rise in socio-economic status (SES), an inverse association between SES and anaemia was observed. The prevalence of anaemia in relation to father's occupation was found to be significant ($p<0.001$) which may be because of availability of better quality foods to the girls of agricultural families. Adolescent girls, whose fathers were laborers (44%), were more anaemic than those whose fathers working in agriculture (27.1%). A significantly higher ($p<0.01$) prevalence of anaemia was seen in adolescent girls having illiterate (42.2%) and literate mothers (51.9%). A significantly high ($p<0.02$) level of anaemia was observed in adolescent girls belonging to families having family size > 3

(38%) than those from families of size ≤ 3 (27.2%), which may be due to availability of adequate diet to all the family members in small families.

WHO (2001) published a guide for programs managers on "Iron Deficiency Anaemia" in order to assess, prevent and control anaemia which occurs mainly due to iron deficiency. This document deals primarily with indicator for monitoring intervention to combat iron deficiency, including iron deficiency anaemia. However, it also reviews the current methods of preventing iron deficiency in the light of recent significant scientific advances. Prevention program strategies for preventing iron deficiency through food based approaches include dietary improvement or modification and fortification, were discussed. A schedule for using iron supplements to control iron deficiency, and to treat mild to moderate IDA according to age, gender and physiological status is provided. Iron deficiency can impair cognitive performance at all stages of life, moreover, the effects of iron deficiency anaemia in infancy and early childhood are not likely to be correlated by subsequent iron therapy.

India, DLHS – RCH, (2002-04) showed prevalence of severely and moderately anaemic adolescent girls (10-19 years) by State and in India, 49% and 27 % of adolescent girls were moderately and severely anaemic. The state of Chattisgarh has the highest percentage of adolescent girls who are either moderately or severely anaemic (88%) followed by Haryana (86%). In the states of Andhra Pradesh, Bihar, Delhi, Gujarat, Himachal Pradesh, Jharkhand, Madhya Pradesh, Maharashtra, Orissa, Punjab, Uttar Pradesh and West Bengal, the combined prevalence of either moderate or severe anaemia among adolescent girls is in the range of 70-80 %. The states where this percentage is between 50-70 % included Karnataka, Tamil Nadu, Uttaranchal, Arunachal Pradesh, Tripura and Nagaland. In the rest of the states in India, the percentage of adolescent girls who are either moderately or severely anaemic is less than 50 %.Among them , the low percentages in Jammu and Kashmir (26%) and Kerala (32 %) are noteworthy. High concentration of anaemic adolescent girls is found in Gujarat, Maharashtra, Punjab, Haryana, Orissa and Assam. In India as whole, only 61 out of 542 district fall in the category of low prevalence of moderately anaemic adolescent girls, 186 districts fall in medium prevalence and 295 districts in high prevalence categories. In more than 50% of the districts of Uttar Pradesh, Madhya Pradesh, Maharashtra, Punjab, Haryana, Orissa and Assam more than three-fourth of adolescent girls in the age group 10-19 years are either moderately or severely anaemic.

It is remarkable that the states such as Punjab and Haryana, despite being economically and agriculturally more advanced than other states, show relatively high prevalence of moderate and severe anaemia among adolescent girls.

Bentley and Griffiths (2003) conducted a study for the burden of anaemia among women in India .The research investigates the prevalence and determinants of anaemia among women in Andhra Pradesh from the data of The National Family Health Survey 1998-99. A total of 4032 married women aged 15-49 years from 3872 households and found 32.4 % of women had mild ,14.19% had moderate and 2.2 % had severe anaemia. Protective factors include Muslim religion, reported consumption of alcohol or pulses, and high socio- economic status, particularly in urban areas. Poor urban women had the highest rates and odds of being anaemic. 52% of them were underweight and 41 % of women were overweight. New program strategies are needed, particularly, those to improve the overall nutritional status of women of reproductive ages.

Malhotra and Passi (2004) studied the haemoglobin status of adolescent girls in rural blocks of Delhi, Rajasthan and Uttar Pradesh, and reported that the incidence of mild, moderate and severe anaemia was found to be 50 %, 44.4 % and 2.8 % of the subjects and only 2.8 % of subjects had normal haemoglobin level.

Shekhar (2005) conducted a study on iron status of adolescent girls and its effect on physical fitness. 150 college going adolescent girls aged 17-19 years were enrolled for the study. Background information, anthropometric measurements, dietary intake and menstrual history were recorded. The mean age of girls was 18.5 years, with 95.2 % being of 17-18 years of age. The mean height was found to be 156.6 cm, and mean weight was 51.5 kg. The mean BMI of the subjects ranged from 16.8 to 20.8. Out of 150 subjects, 68 students were found to be normal, although none were observed to be severely anaemic (Hb < 7 g/dl); 12.6 % and 46 % subjects were moderately and mildly anaemic, respectively. Approximately 74 % girls with moderate anaemic, approximately 28 % girls with mild anaemia were correctly identified when pallor of conjunctiva, eyes and tongue was used to examine and assess anaemia. The sensitivity of identifying girls with symptoms like weakness, tiredness, irritability and breathlessness for moderate, mild and severe anaemia was 61 % and 20 %; respectively. The mean age of menarche was 13 years and the menstrual cycle was regular among 75 % of adolescents. Mean daily iron intake was observed to be less than 50 % of the

RDA, whereas the ascorbic acid intake was adequate, leading to many adolescent girls having normal hemoglobin levels in spite of iron consumption being less than RDA.

Kumar *et al*. (2006) conducted a study on influence of family's vegetable cultivation on prevalence of anaemia among adolescent girls. The objectives of the study were to assess whether the cultivation of vegetables in families benefits the adolescent girls in terms of vegetable consumption and maintaining normal haemoglobin levels; and whether the prevalence of anaemia varies in vegetable grower and non- grower families. The study was conducted in rural areas of the Trans Ganga region in Allahabad, Uttar Pradesh, India. A total of 80 adolescent girls, 40 from vegetable grower (VG) and 40 from non-grower (NWG) families were purposively selected. A combination of general and dietary survey, anthropometric measurements, clinical assessment and laboratory test was used to obtain the required information. Data for two groups of subjects, VG and NVG were compared and statistically tested for any significant difference. The research revealed that the vegetable growers commonly cultivated leafy vegetables like soya, spinach, amaranths and onion stalks. About 15 % of the families produced vegetables for their own consumption. The remaining had surplus quantities, which were either sold or fed to the animals. Preservation was not at all practiced for any leafy vegetable. In VG group 62.5 % girls consumed green leafy vegetables daily and the remaining consumed 4-6 times per week. The average quantity consumed was higher in the VG groups than in their NVG counterparts.

A comparison between the two groups showed that the mean height of adolescent girls from VG families was better than the NVG ones. However, the t-test did not reveal any significant difference between the two categories ($p>0.05$). Weight difference of the adolescent girls was somewhat similar to difference in height, which fell below the NCHS standard value, the reference value for well-to-do Indian adolescent girl's weight which was 40.87 kg, was not satisfactory. The values ranged from 22.5 to 50 kg among the adolescent girls were studied. Various signs and symptoms of anaemia were present among subjects belonging to both the groups. Breathlessness and tiredness were experienced by about one-fourth of the subjects in both the groups. Pale nails were observed in 6 of VG and 10 of NVG group, whereas in the latter group, pale conjunctivitis was noticed in a small proportion. The mean haemoglobin level (10.23 g/dl) in the VG groups was greater than that of NVG groups (9.74 g/dl) and varying degrees of anaemia were present in higher proportion of the NVG than the VG. T-test revealed that the prevalence of anaemia did not differ between

the two groups. Only 8 NVG group members as compared to 19 of VG subjects had haemoglobin levels within the normal range. The findings showed that food and nutrient consumption, anthropometric status (height and weight) and haemoglobin status of adolescent girls did not differ significantly in the categories of families whether they cultivated or did not cultivated leafy vegetables.

Mehnaz *et al.* (2006) reported that a very high overall prevalence of iron deficiency anaemia (98.87%), was found to be in urban area of Aligarh. The level of anaemia was categorized as 14.8% with mild, 72 % with moderate and 13% with severity.

Sen *et al.* (2006) conducted a study on deleterious functional impact of anaemia on young adolescent school girls. The study was planned with the objective of assessing the physical work capacity and cognition of underprivileged anaemic school girls in early adolescence as compared to their non-anaemic counterparts.

The study was conducted in 4 Vadodara Municipal Primary School where in 350 girls from low income families studying in standards V and VI was selected. Data on haemoglobin (n = 322), height and weight (n = 350) were collected. A random sub-sample of 60 % of the total students was taken for physical work capacity (PWC) and cognitive tests (n = 230). The cognitive functions of the girls were assessed using modified selected tests from the Gujarati version of Wechsler Intelligence Scale for Children (WISC), mean and standard deviation were calculated for PWC and cognition score. Percentage of anaemic girls was calculated using WHO cut off of haemoglobin < 12 g/dl. On a smaller subset of data, anaemic and non-anaemic girls were compared within well nourished and under nourished groups. Under nutrition was defined as body mass index (BMI) < 5^{th} percentile of standards.

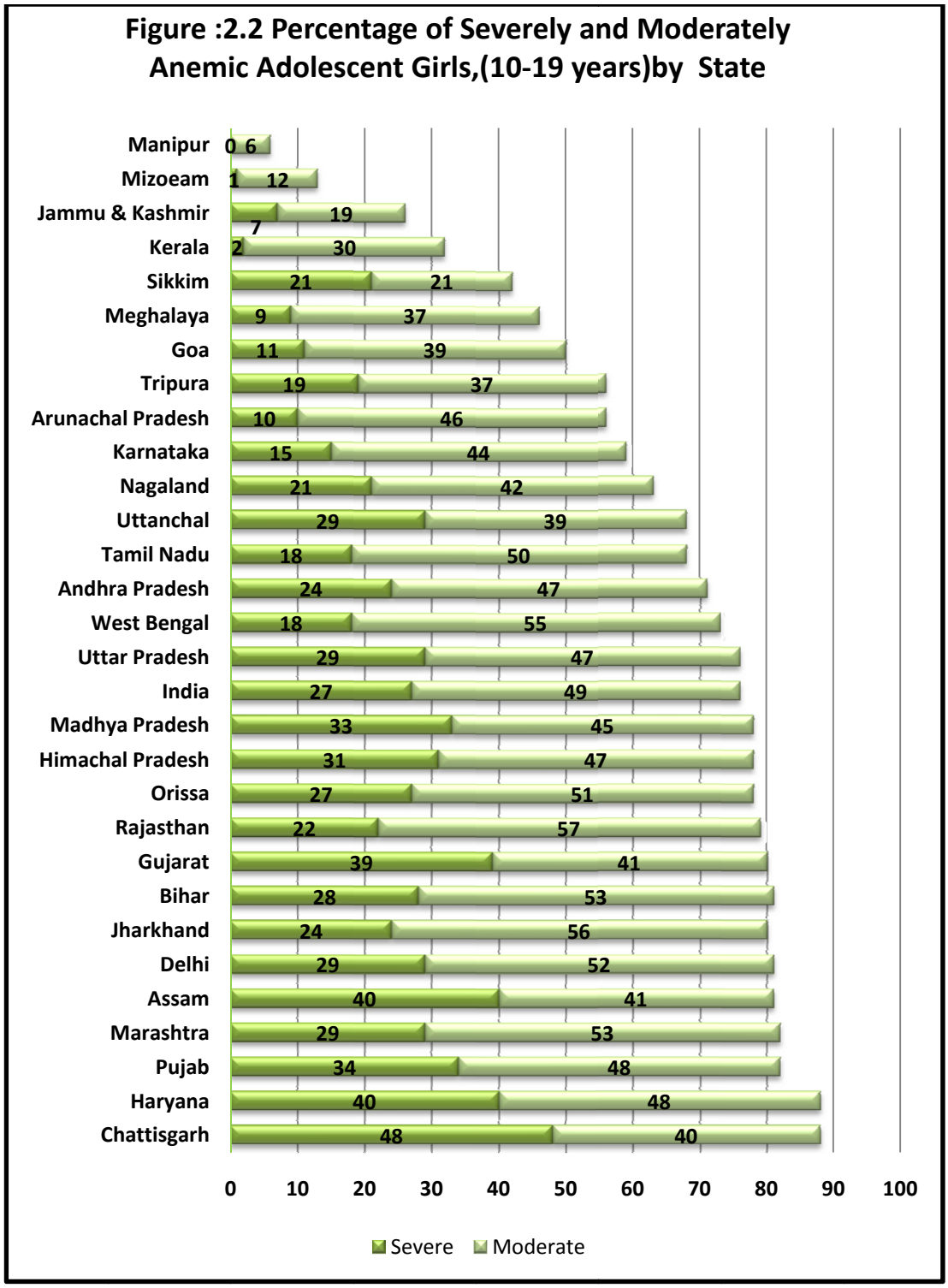
The mean haemoglobin level of total sample of girls (n= 332) was 11.32 g/dl to 10.67 g/dl for anaemic (n=217) and 12.68 g/dl for non-anaemic (n=105) girls. The prevalence of anaemia was very high (67%) with 32.6 % girls being mildly anaemic (Hb =11.0 – 11.9 g/dl) and 34.7 % girls moderately anaemic (Hb =7.1 – 10.9 g/dl).Though the mean number of steps climbed by the 59 non-anaemic girls (175 steps) in 3 minutes was not significantly higher than 171 anaemic girls (172 steps) but the time taken to recover to the basal pulse rate was significantly higher ($p<0.001$) for anaemic girls, even mildly anaemic girls took longer to recover to their basal pulse rate compared to non-anaemic girls, the moderately anaemic girls similarly showed a longer recovery time that those mildly anaemic. The non-anaemic girls scored higher than their

anaemic counterparts in cognitive tests, the difference being significant in digit span and visual memory tests. Both, mildly anaemic and moderately anaemic girls were fared significant poorer as regards to recovery time ($p< 0.05$) and digit span scores ($p<0.01$). Even the mildly anaemic girls tended to have lower scores than non-anaemic girls, and the moderately anaemic girls further had lower scores than those mildly anaemic girls. In the undernourished groups non-anaemic girls (174 steps) performed significantly better than their counterparts (143 steps). This indicated that the adverse effects of anaemia are compound due to overall under nutrition and that being well-nourished was an important as being non-anaemic for normal PWC.

Diwaker (2007-08) conducted a study in rural area in India and it revealed that 6,948 (69.40%) women were anaemic among 10,000 rural women. The largest proportion of anaemic rural women (43.52%) fell into the category of moderate anaemia, while largest proportions of the urban group (35.7 %) were in the mild anaemia category.

Gupta *et al.* (2007) conducted a study on prevalence of anaemia among female adolescents of different income ranges and studying in government and public educational institutions in District Kurukshetra (Haryana). In the present study, a sample of 160 females of early adolescents period (11-13 years) and 100 females of late adolescence period (14 – 17 years) were randomly selected from different educational institutions to see the prevalence of anaemia and they suffered from anaemia with hemoglobin level less than 12 g/dl of blood barring two subjects of late adolescence period who had haemoglobin more than 12 g/ dl of blood. Anaemia was highly prevalent in the subjects of early adolescence as compared to late adolescence period. Maximum subjects in both early and late adolescence period were suffering from moderate (58.08 %) followed by mild anaemia (33.85 %) and minimum (5.77 %) with severe anaemia. Only four subjects, one from early and three from late adolescence periods were marginally anaemic. Incidence of anaemia was noticed in maximum subjects in low income range of both early and late adolescence period. But the severity of anaemia was observed maximum in the subjects of middle and high income ranges in early adolescence period. The anaemic conditions can be improved through creating nutritional awareness among the suffers and supplementing iron rich food.

Figure: 2.2 Prevalence of anaemia in Gujarat and India



Source: India, DLHS – RCH, 2002-04

Pande *et al.* (2008) conducted a study on reducing iron-deficiency anaemia and changing dietary behaviors among adolescent girls in Maharashtra, India. The specific objective of the study were to increase number of daily meals from 2 to 3 or 4 in the

case of adolescent girls, to encourage girls to consume iron rich food on daily basis; to encourage girls to consume vitamin C rich foods in combination with iron-rich foods daily, and to reduce the prevalence of anaemia, especially in the severe and moderate categories. The unmarried adolescent girls aged 10-19 years were selected from 10 intervention slums (1000) and 6 control slums (752) for the baseline and end line with two cross sectional samples. Ultimately, out of, 1,142 girls, 811 were surveyed for information on dietary and morbidity history, anthropometric parameters, menstrual history and workload within and outside the house. Blood samples from 803 girls were taken to assess haemoglobin status. Logistic regression was used to determine the predictors of anaemia, with haemoglobin status as the dependent variable. Independent variables included economic status, consumption of iron rich foods, number of meals eaten in a day, use of lemon with meals, morbidity in the past year, number of hours worked in a day and whether menses had started. The average age of the study population was 14 years and 76 % of them were currently in school and 50 % had achieved menarche.

Around 58 % of the sample was anaemic (Hb < 12 g/dl), 1.3 % severely anaemic (Hb < 7 gm/dl) and 40 % of them were eating two or fewer meals daily. Logistic regression of baseline data showed that anaemia was significantly more likely among girls who ate two or fewer meals in a day had been sick in the past year and consumed few iron rich foods. Thus, the intervention focused on changing dietary behavior. End line comparisons showed that the intervention has influenced dietary behavior, with a significant increase in percent of girls who ate more than 3 meals a day and consumed lemon with their meals, as well as in the frequency of eating fruits in the intervention group. Between baseline and end line, blood testing showed that mean haemoglobin levels increased from 5.8 to 9.5 g/dl for severely anaemic girls, and from 8.9 to 11.2 g/dl for moderately anaemic girls. Participatory nutrition education can influence adolescent girl's anaemic status and dietary behavior. Key dietary behavior messages for girls include; eating more than 3 meals a day, eating with family so as to eat enough, eating green vegetables daily and eating lemon or amla with meals, iron supplementation programs need to include nutrition education programs to be effective.

Subhra Srimani *et al.* (2008) the study was a comparative as well as co-relational on prevalence of anaemia among rural and urban school going adolescent girls (16 to 18 years) was conducted, the main objectives of the study were to assess prevalence of anaemia among adolescent girls of rural and urban community and

identify the relationship of occurrence of anaemia with selected factors. Non probability convenience sampling technique was used to obtain 96 samples from class X, 48 each from rural and urban schools. Varieties of developed tools as well as standard tools were utilized to collect data. Study result identified that prevalence of anaemia in adolescent girls was 56%. Rural prevalence was high (81%) than urban prevalence (31%). Knowledge score about anaemia in both settings were at average. Dietary data indicated that frequency intake of green leafy vegetables was remarkably less among adolescent girls. Intake of protein, iron, and folic acid was significantly deficient in respect to recommended dietary allowance (RDA) for both the settings.

Mehta (2009) reported about prevalence of anaemia in the world, 1.5 to 2.0 billion people suffer from anaemia, from this, 70% of women contributed to anaemia prevalence in the world. 45% - 50% of pregnant women of all over world suffer from anaemia. In India 1.5 crore women are suffering from anaemia. Every year 50 lakh women death occur due to anaemia. 82% of 6-20 years of school and college girls are suffering from anaemia. 93% of women and girls are suffering from anaemia from lower income group in India.

Ajgonkar *et al.* (2010) conducted a study on prevalence of Iron Deficiency Anaemia (IDA) among adolescent girls (11-21 years) residing in urban slum areas of Dharavi, Mumbai. The study was on iron deficiency anaemia which is a widespread condition in adolescents of developing countries. The rapid rate of linear growth, increase in blood volume and onset of menarche during adolescence all increases the need for iron. Adolescent iron requirements are even higher in developing countries because of infectious disease and parasitic infestations that cause iron loss. Therefore an attempt has been made to report the prevalence of IDA among adolescent girls residing in urban slum areas of Dharavi, at Mumbai. To determine the prevalence of IDA in adolescent girls (11-21 years) residing in urban slum areas of Dharavi, Mumbai. The study was carried out in the 100 adolescent girls (11-21 years) who are the beneficiaries of ICDS and Kishori project from slum areas of Dharavi, Mumbai using purposive sampling technique. Standardized questionnaire was used to determine the eating habits of the subjects. Anaemia detection was done by estimation of complete blood count using mythic – 18, an automated blood cell counter. The prevalence of IDA was found to be 50 %, despite majority of the subjects (42%) being non-vegetarians. The highest frequency was found among the Hindu (24%) and Muslim (21%) community. One of the reasons for the same could be that none of the subjects had undergone deworming so

far. It was also seen that consumption of micronutrient rich foods was less, there by emphasizing the need for creating awareness of personal hygiene and providing nutrition education for the participants.

Avashia (2010) conducted a study on anaemia prevalence. Anaemia is more commonly prevalent among adolescents, preschool children, pregnant and lactating mothers. Anaemia among adolescent have gained more importance as they are the most crucial segment of the population whose wellbeing influences the future generation as todays young girls are future mothers. Micronutrient deficiency, especially iron deficiency in adolescent girls can seriously affect their health. 8% of adolescent girls of 10-19 years of age are suffering from iron deficiency anaemia. During adolescence, iron deficiency anaemia not only reduces work productivity but also leads to complications of pregnancy in the later years. Targeting adolescent girls in anaemia prevention programs would not only have an immediate curative effect, but may also have long term preventive effect during pregnancy and lactation. UN reemphasize that "control of nutritional anaemia should be one of the global development goals to be achieved in the early years of this new millennium". Food based approaches have higher potential for achieving and reaching and long lasting benefits for the control of iron and other micronutrient deficiency. Hence the research was undertaken to develop an iron rich health drink which was made up with locally available ingredients, evaluates its acceptability and its efficacy by supplementing the drink to selected anaemic adolescents girls.

Hanan *et al.* (2010) conducted a study on anaemia in adolescent college girls. Effect of age, nutritional status and nutrient intake was to observe overall prevalence of IDA. It was found to be 26 %. The mean haemoglobin (Hb) in non-anaemic girls was 13.04 ± 0.013 g/dl and in anaemic girls it was 10.2±0.45 g/dl. 38% girls were underweight having body mass index (BMI > 18.5) out of which 42.07% were anaemic. In terms of nutrient intake only 20 % of the girls consumed energy according to recommended dietary allowance (RDA) and another similar number could meet 90 % of the RDA. Only 8 % of the girls met RDA for protein and another 18 % could meet 90 % of the RDA. 46 % girls satisfied their needs for iron according to RDA and another 14 % could meet 90 % of the RDA.

Siddharam *et al.* (2011) conducted a study to estimate the prevalence of anaemia among adolescent girls and to study the socio-demographic factors associated with anaemia. A cross sectional survey was conducted in selected Anganwadi centers of

rural area of Hassan district.314 adolescent girls (10-19 years) were included in the study. The study was conducted from February to April 2011 (3 months). Data analysis was done by using proportions and chi-square test. Prevalence of anaemia was found to be 45.2%, a statically significant association was found with iron deficiency anaemia, weight loss and anaemia; pallor and anaemia. In the present study it was seen that among the 45.2% of anaemic adolescent girls 40.1% had mild anaemia, 54.92% had moderate anaemia and 4.92% had severe anaemia. A high prevalence of anaemia among adolescent girls was found, which was higher in low economic strata. It was seen that anaemia affects overall nutritional status of adolescent girls.

Premlatha *et al.* (2012) conducted a study to estimate prevalence of iron deficiency anaemia among adolescent schoolgirls in the age group 13-17 years in Chennai and to study the associated factors. A cross sectional survey was carried out among 400 school students. The prevalence e of anaemia was found to be 78.75% among school girls. The results of the study show that the factors such as age, literacy status of mother , types of family, community, weight, diet, frequency of intake of green leafy vegetables and fruits, menstrual discharge and deworming are the factors contributing to the prevalence of anaemia.

Savita *et al.* (2013) studied the impact of education intervention on nutritional knowledge of iron deficiency anaemia among 207 post adolescent girls of 18-25 years of age in Bangalore. The prevalence of anaemia observed that 53.14 % were found to be moderately anaemic, 42.51 % were found to be mildly anaemic and 2.89 % were to be found severely anaemic and only 1.44 % had normal haemoglobin level. The prevalence of anaemia in the study population was very high i.e.98.66%.

2.1.3 Prevalence of anaemia in Gujarat

India, DLHS – RCH (2002-04) reported that data on anaemia levels were available for about 8,000 adolescent girls aged 10-19 years who constituted 60% of the total sample. It shows anaemia level for adolescent girls aged 10-19 years by selected characteristics. In Gujarat, overall, 99 % of adolescent girls have anaemia. 19 % of them were mildly anaemic, 41 % of were moderately anaemic and 39 % were experiencing severe anaemia. No significant age difference was found in the prevalence of anaemia among adolescents in Gujarat. Though there is no rural-urban difference in the prevalence of anaemia, it varies substantially by its degree. While the prevalence of mild and moderate anaemia was higher in urban areas, but that of severe anaemia was found to high in rural areas. The prevalence of anaemia does not vary much with the

educational attainment of girls. The level of anaemia was higher among Muslim adolescent girls (99 %). Adolescent girls from 'other caste' were more likely to suffer from any anaemia. The adolescent girls from households with lower standard of living were slightly more likely to be anaemic.

Verma *et al.* (2003) conducted a study on school going girls (n=1295) from the slum area of Ahmedabad city and found that 81.8 % of girls were anaemic, out of which, 55.2 % were mildly anaemic, 0.6 % were severely anaemic. Anaemia was found to be significantly higher among girls with the habit of post meal consumption of tea or coffee i.e.94.4%, at $p<0.01$ level and whose fathers were working as semi- skilled or skilled workers i.e.77%, at $p<0.02$ level. Those having a BMI of 18.5 or lower i.e.82.4%. The prevalence of anaemia was significantly lower in girls consuming green leafy vegetables, at $p<0.01$ level.

Acharya (2010) stated that good nutrition is a basic component of health and health is man's natural condition. Minerals are minute amounts of metallic elements that are a vital for the healthy growth of teeth and bones. Iron is a key mineral for the synthesis of haemoglobin. The researcher had selected 20 children and 20 women for the assessment of iron deficiency. It was observed that 45% children and 35% women were found anaemic. It is suggested that we should provide iron tablets and iron supplemented food and iron rich dishes to the affected respondents.

Davda *et al.* (2010) conducted a study on assessment of haemoglobin value in students of Home science and the study says haemoglobin is a conjugated protein synthesized inside the immature erythrocytes in the bone marrow. It consists of two components (1) Heme (Iron + protoporphyirn) gives red color to blood. The present study attempted to find the value of haemoglobin in students of Home science. 30 girls were selected Upleta city who were studying in T.Y.B.Sc. Home science. Haemoglobin was estimated by Sahil's method. It was observed that 16% students had low, 20% students had average and 64% students had normal haemoglobin when compared to standard haemoglobin value for female.

Shah (2010) conducted a study on tribal women, the result reported that tribal women are suffering from many health problems due to their illiteracy, ignorance, poverty, lack of health facilities and lack of health education that leads to various diseases. Anaemia is major contributor to maternal mortality in tribal areas. Most of the women were identified to have moderate to severe anaemia. (Hb less than 10g/dl) the

prevalence of anaemia was higher in pregnant women than that of lactating women particularly tribal area of Rajkot district of Saurashtra, Gujarat.

Shah (2011) conducted a study on prevalence of anaemia and nutritional status of girls of Mahila college of Mehsana city. Total 152 college girls were selected by purposive random sampling technique and pre tested questionnaire was used to collect information from girls about their personal, socio-economic and nutritional information. Body mass index (BMI) was calculated on the basis of their body weight and height. Blood haemoglobin was estimated by cyanamethhemoglobin method. Anaemia and BMI were categorized according to WHO criteria. Study shows that the prevalence of mild anaemia was (34.65 %), moderate anaemia (36.85%) and severe anaemia (8.55%). 18.42% of girls were underweight, 20.11% were overweight and obese. Consumption of iron rich foods, fruits, protein rich foods were very less in amount as compared to their recommended dietary allowances. Prevalence of anaemia was statistically significant with dietary intake. Overall study shows that prevalence of anaemia was 80% and only 61% of college girls shows normal body mass index i.e., ≥ 18.5 – 24.9.

2.2 Etiology of anaemia

Anaemia in a population is caused by several factors that often exist together. The principle cause, however, is a negative balance due to inadequate dietary intake or low dietary bioavailability and iron loss. Rapid growth is always accompanied by an expansion in blood volume and thus increased iron requirements. Periods of rapid growth occur during infancy, early childhood, adolescence and pregnancy. Iron loss occurs mainly during menstruation. Iron transfer to the fetus during pregnancy and due to blood loss during child birth. It is therefore difficult for adolescent girls and women, to maintain positive iron balance during these periods of increased needs. Other important nutritional causes of anaemia are inadequacy of hemopoietic nutrients mainly folic acid, vitamin C, vitamin B_{12},parasitic infections, especially hook worm and schistosomiasis also produce iron deficiency anaemia. Malaria, chronic infections (including HIV/AIDS) and genetic factors (thalasemias and haemoglobinopathies) may also cause anaemia. However, iron deficiency is the main cause of anaemia everywhere and in developing countries, it is frequently associated with other factors

(UNICEF- WHO Joint Committee on Health Policy 1995) Various factors causing iron deficiency anaemia are summarized in Table:

Table: 2.3 Iron deficiency: Underlying and immediate causes of iron deficiency.

Sr. No	Underlying causes	Immediate causes
I	1. Low food supply	Inadequate diet (inadequate intake of iron).
	2. Erroneous feeding practices	Poor absorption.
	3. Low socio – economic status.	
II	1. Low intake of available iron.	
	2. Unsuitable meal composition.	
	3. Excess of inhibitors.	
	4. Lack of enhancers.	
III	1. Growth.	Increased requirements.
	2. Pregnancy and Lactation.	
IV	1. Acute bleeding.	Blood loss.
	2. Chronic blood loss and parasitism.	
V	1. Poor sanitation.	Infections.
	2. Inadequate health services.	

Source: Venkatachalam P.S. (1968)

Trumbo (1995) examined the interactions between iron and seven other micronutrients and compounds, Ethylene Diamine Tetracetic Acid (EDTA), ascorbic acid, peptides in meat, zinc, phytates, vitamin A and copper. EDTA is a common food additive in developing countries that chelates iron as well as calcium and magnesium in the stomach and duodenum. Inclusion of EDTA in the diet does not affect other minerals that are known to chelates to EDTA. Phytates also reduces iron absorption by binding to iron. Soaking and fermenting phytates rich food such as grains and cereals results in the release of zinc, selenium, and calcium from phytates complexes, thus by increasing intestinal iron absorption. Ascorbic acid reacts with iron in a manner similar to EDTA where the solubility of iron is increased enhancing absorption. Zinc reduces iron absorption by competing for the carrier involved in the uptake of non-heme iron. Vitamin A status affects the release of iron bound to ferritin, thus by increasing plasma iron concentrations. Both Vitamin A and copper are important for the release of iron from the liver.

2.3 Pica- Eating disorder of non nutritional substances

Pica is characterized by an appetite for substances that are largely non-nutritive, such as paper, clay, metal, chalk, soil, glass, or sand. There are different variations of pica, as it can be from a cultural tradition, acquired taste, or a neurological mechanism such as an iron deficiency or a chemical imbalance. It can lead to intoxication in children, which can result in impairment in both physical and mental development. In

addition, it can also lead to surgical emergencies due to an intestinal obstruction as well as more subtle symptoms such as nutritional deficiencies and parasitosis. Pica has been linked to mental disorders and they often have psychotic co-morbidity. Stressors such as maternal deprivations, family issues, parental neglect, pregnancy, poverty, and a disorganized family structure are strongly linked to pica. Pica is more commonly seen in women and children, and in areas of low socio economic status. Particularly it is seen in pregnant women, small children, and those with developmental disabilities such as autism. Children eating painted plaster containing lead may suffer brain damage from lead poisoning. There is a similar risk from eating soil near roads that existed before tetra ethyl lead in petrol was phased out (in some countries) or before people stopped using contaminated oil (containing toxic PCBs or dioxin) to settle dust. In addition to poisoning, there is also a much greater risk of gastrointestinal obstruction or tearing in the stomach. Another risk of eating soil is the ingestion of animal feces and accompanying parasites.

Epidemiology

The prevalence of pica is difficult to establish because of differences in definition and the reluctance of patients to admit to abnormal cravings and ingestion. Thus leading to the prevalence recordings of pica being in the range of 8% and 65% depending on the study. A study published in 1994 found that 8.1% of pregnant African – American women in the United States self-reported pagophagia, the ingestion of large quantities of ice and freezer frost. A study conducted in 1991 found a prevalence of pica in 8.8% of pregnant women in Saudi Arabia. Rates of pica among pregnant women in developing countries, however, can be much higher, with estimates of 63.7% and 74.0% reported for two different African populations. This is due to different cultural norms as well as greater levels of malnutrition. Two studies of intellectual disability in adults living in institution found that 21.8 % and 25.8 % of these groups suffered from pica. Prevalence rates for children with and without developmental disabilities are unknown **(Rose *et al*.-2000)**.

History

The term pica originates in the Latin word for magpie, a bird that is famed for its unusual eating behaviors, where it is known to eat almost anything. In 13 century Latin word, pica was referenced by the Greeks and Romans; however, it was not addressed in medical texts until 1563. The Southern United States in the 1800s, geophagia was a common practice among the slave population. Geophagia is a

form of pica in which the person consumes earthly substances such as clay, and is particularly prevalent to augment a mineral-deficient diet. Search on eating disorder from 16th century to the 20th century suggests that during that time in history, pica was regarded more as a symptom of other disorders rather than its own specific disorder. Even today, what could be classified as pica behavior is a normative practice in some cultures as part of their beliefs, healing methods, or religious ceremonies **(Wikipedia).**

2.4 Nutritional Status

Vasanthi *et al.* (1993) assessed iron nutritional status of adolescent girls from rural area and urban slum by measuring serum ferrritin levels. Overall, anaemia was observed in 25 % of girls irrespective of their urban or rural residence. A higher prevalence of rural girls (37.5%) especially below the age of 12 years showed evidence of anaemia. The prevalence was similar in both urban and rural girls who attained menarche. With increasing age, urban girls who had attained menarche showed an increase in the prevalence of anaemia. Overall, iron deficiency was of much higher order in the rural girls irrespective of the menarcheal status.

Suba *et al.* (1997) conducted a study on the nutritional status of selected adolescent girls of Coimbatore slums of 16 -18 years of age. A total number of 1000 adolescents were selected from ten slums of Coimbatore city. Socio economic background and dietary habits of the subjects were collected by administering a questionnaire. Anthropometric measurements such as height, weight, clinical examination and haemoglobin estimation were done for all the selected subjects. A three day food consumption survey was carried out on a sub sample of 50 subjects. The major findings of the study were, among the 1000 girls, 9.2% of them were married, the mean age of menarche was 13.62 ± 1.43.Anthropometric measurements revealed that the percentage deficit of weight was from 18.5 ± 2.3 up to 20.2 ± 2.1 %. The percentage height deficit of height from that of standard value was found to be 4.9 ± 1.3, 4.0 ± 1.2 and 3.2 ± 2.3 for 16, 17 and 18 years respectively. Clinical examination revealed that higher prevalence of anaemia had spongy bleeding gums. The mean haemoglobin levels of adolescents in age 16 – 18 years were found to be 10 ± 2.3 which was less than WHO standards. The food consumption survey showed inadequate intake in amounts of all the nutrients. Thus, it may be concluded that the low socio- economic environment and poor sanitation in slum areas are the main causative factors for the poor anthropometric and biochemical indicators of nutritional status.

Chaudhary *et al.* (2003) conducted a study on nutritional status of adolescent girls in rural area of Varanasi. The cross sectional community-based study covering 270 adolescent girls were enrolled for the study in Chicagoan block selected by simple random sampling. Data was collected through interviews and examination schedules anthropometric measurements of weight, height and mid arm circumference (MAC) recording and hemoglobin estimation. Data were analyzed with the help of the SPSS package. Nutritional status of study subjects was assessed by using various parameters viz. weight for age, height for age, weight for height, MAC for age and BMI at different age points were compared with the corresponding reference values.

Average haemoglobin of adolescent girls was 12.44 ± 1.29 g/dl. As many as 30.74 % study subjects were anaemic (Hb < 12 g/dl). It was found that average haemoglobin of menstruating girls (12.65 ± 1.3 g/dl). Mean haemoglobin of adolescent girls using footwear, during defecation (12.6 ± 1.5 g/dl) was significantly ($p< 0.001$) higher than of subjects without footwear (0.2 ± 1.4 g/dl). Extent of anaemia (Hb < 12 g/dl) in this group (20 %) was significantly less ($p<0.000$) in subjects not using footwear (43.30 %).A considerable proportion of adolescent girls had critical nutritional deficiency diseases. Two-third of study subjects were undernourished (BMI < 18.5) nearly one-third experiencing chronic energy deficiency grade-III (BMI < 16). However, with varying parameters, the extent of under nutrition in adolescent girls also varied. Nearly one-third girls were anaemic (Hb < 12 g/dl); anaemia was significantly more in non-menstruating girls and subjects not using footwear during defecation. Thus, there is a need to promote sound eating and personal hygiene-related habits in rural adolescent girls, besides improving intra-family food distribution and economic empowerment of rural households.

Deshmukh et *al.* (2006) conducted a study on nutritional status of adolescents in rural Wardha. (Maharashtra). The cross sectional study was carried out in two public health centre area of Wardha district with two stage sampling method. In the first stage, cluster sampling method was used to identify 30 clusters in each Rural Health Training Centre (RHTC) area separately. All adolescents in the household thus selected were included in the study. The mean body mass index (BMI) for age was used for classifying the nutritional status with CDC 2000 reference. Out of 764 adolescents 420 (54.9%) were boys and 344 (45.1%) were girls. Majority (53.8%) of the adolescents were underweight, only 2.2 % were overweight. The mean BMI was significantly higher among boys (16.38 ± 3.09) as compared to girls (15.54 ± 3.25). The prevalence of

thinness was significantly higher in early adolescence (57.0%) than in late adolescence (48.5%). Moreover, the prevalence of thinness was significantly more (169.7%) in girls than boys (40.7%). The significant higher prevalence of thinness was observed among adolescents from lower family income group (63.2%) than the higher (38.1%) family income group. The prevalence of thinness was significantly ($p< 0.05$) higher (60.3%) in those having education less than 8^{th} standard than those educated at least up to the 8^{th} standard (49.6%).The anthropometric assessment at the community level is to provide an estimate of prevalence and severity of malnutrition. The prevalence of thinness ($<5^{th}$ percentile of BMI for age) was observed to be 53.8 %, chronic energy deficiency (BMI < 18.5) 75.3 % and wasting (< -2 Z-value of weight for height) was observed to be only 20.8 %.

WHO report (2011) reveals that anaemia prevalence in adolescent girls is very high ranging from 50% to > 90%. In 2006, the overall prevalence of anaemia has been reported to be extremely high at 90.1 % in adolescent girls of 11-18 years of age, from 16 districts in 4 regions of India. The study also confirms that 85 % of pregnant women were anaemic. The earlier study from Western India reports that in the low income group 80-90% had haemoglobin less than 12 %. In a study of adolescent girls (10-19 years) in urban slums of Southern India, Andhra Pradesh, anaemia prevalence is reported to be 67.9 % where moderate anaemia 37.05%, mild anaemia 21.42 % and 9.4% severe anaemia was seen, while another study from Ranga Reddy district of Andhra Pradesh reported anaemia prevalence in girls 13-15 years to be 83%.Where as under nutrition is reported (stunting) in one – third of adolescent population, prevalence of anaemia is almost universal. A similar high prevalence of anaemia in rural Rajasthan between 73.3% and 85.4% had been reported. About 62% of urban adolescent girls from the lower socio economic group are estimated to be anaemic. Anaemia in adolescent girls is now recognized to be a public health problem along with anaemia in other population groups such as young children and pregnant women.

2.4 Intervention strategies for eliminating IDA

The growth spurt during early adolescence and early adulthood mounts pressure on the overall nutritional requirements of girls and micronutrients too are, therefore, required in higher proportion. The increase in height and the related skeletal growth and increase in blood volume and menarche raise the requirements for dietary calcium and iron among adolescent girls. The major micronutrients of concern in adolescent growth and development are iron, calcium and iodine. Anaemia has been reported to be a major

micronutrient deficiency among adolescent girls across the country through several studies. The prevalence of anaemia was reported to be above 80 % in various states of India. Weekly supplementation of iron was found to be as effective as daily supplement of iron. Non-anaemic girls had higher scores in cognitive skills tests than the anaemic girls. Data has shown an inverse relationship between anaemia and the socio-economic status of the family. Anaemia among adolescent girls was found to have an association with the literacy status of the mother, occupation of the father and structure of the family (joint or nuclear) and these factors need to be confirmed through multi-factorial studies in different parts of the country in order to develop appropriate intervention strategies. One such intervention through school system for rural adolescent girls was successful in generating awareness about symptoms, prevention and control of anaemia. Studies have shown a positive impact of iron supplement, leaf concentrate administration and cooking in cast iron utensils on the iron status of adolescent girls. Following are the major key ways to eliminate iron deficiency anaemia among girls.

2.4.1 Supplementation

Supplementation is a form of direct intervention to solve the problem of iron deficiency anaemia. It is the distribution of hematinics (iron and folate) in tablet or other suitable form. There are two types of supplementation with tablets viz.

(1) Therapeutic supplementation where prevalence of anaemia is high and must be cured in a short time and (2) Prophylactic supplementation where prevalence of anaemia is low requiring smaller doses of iron for its prevention (**WHO 1972,INACG, 1977, Baker and DeMayer, 1979**). In many developing countries iron supplementation through tablets to a large group is difficult because of a poorly organized health delivery system, under such circumstances fortification may be a more acceptable program to improve iron intake by population. To set up an iron fortification program, a suitable vehicle to carry iron must be identified and the source and amount be added should be determined.

Baxi M. (1991) assessed the awareness regarding anaemia on haemoglobin level and growth in girls and found no significant impact of intervention was seen on weight and height of the experimental subjects. However, the percentage prevalence of anaemia decreased significantly after the intervention. Prevalence of severe anaemia (Hb < 8g/dl) decreased from 16 % to 3 % and subjects having(Hb <11 g/dl) from 13 % to 3 % .The impact was more marked in the older girls (16 – 18 years) in whom the prevalence of severe anaemia decreased from 29 % to 4 %. The mean haemoglobin level and the mean

change in haemoglobin level increased with increased consumption of iron tablets compared to baseline (2 %). 59 % of subjects were aware about anaemia after intervention. Awareness of the symptoms of anaemia and importance of diet for the prevention of anaemia were observed.

Budhwaker S. (1996) assessed the prevalence of anaemia in upper income group women of ages 19 -25 years. The results indicate that a significant rise of 2.2 g/dl was noticed in the haemoglobin level of fruit supplemented group at the end of month period, while the control group showed no significant increase in haemoglobin of 0.3 g /dl. There was however, no significant change in the iron store of the fruit supplemented group as indicated by the serum ferritin levels which remained the same at baseline and final data. From this, it was postulated that on correction of anaemia, haemoglobin levels received a priority and thus all the iron replenish haemoglobin levels. Percentage iron absorption was calculated using rise in the haemoglobin levels and total iron intake during the supplementation period.

Beaton and McCabe (1999) analyzed the efficacy of intermittent iron supplementation in the control of iron deficiency anaemia in developing countries. It is based on the analysis of results of 22 completed trials of iron supplementation. Out of 22, 14 trials including 5100 individuals contain completed data sets. The results in individual projects are grouped into three categories: pregnant women, school children and adolescents and preschool children. Overall, it was found that both daily and weekly iron supplements are efficacious. However, weekly iron supplementation is likely to be less effective than daily administration except in situation where supervision is feasible with weekly regimens and not with daily supplementation. Moreover, weekly supplementation was found to be disadvantageous during pregnancy and in situation where the base line prevalence of anaemia is very high.

IIHFW (2000) conducted a study, on prevention and control of anaemia in rural adolescent girls through school system in Andhra Pradesh. The study was undertaken with the objectives of assessing the feasibility and acceptability of supervised weekly supplementation of iron folic acid to school going adolescent girls (10-15 years) to prevent and control anaemia, improving the knowledge attitude and understanding of adolescent girls regarding ill effects of anaemia and usefulness of weekly iron folic acid supplement through appropriate informational and educational counseling interventions, assessing the impact of the program in reducing the prevalence of anaemia using haemoglobin as an indicator. All (n=1811) adolescent girls between 10 to 15 years of

age, studying in 6th to 10th standards in 16 high schools located in two randomly selected mandals, viz. Hathunura and Kondapur of Medak district were enlisted. A combination of anthropometry, biochemical assessment and interviews were used for assessing the nutritional anaemia status and awareness about anaemia among subjects. Data pertaining to knowledge, attitude and practices, nutritional status (height and weight) and blood samples for estimation of blood haemoglobin levels were collected. The mean age of students was 12.4 ± 1.44 years. Signs and symptoms of anaemia like pallor (eyes, tongue and nails), fatigue, breathlessness, poor appetite and lack of concentration in studies were reported by 12.5 %, 14 %, 9.2 %, 26.5 % and 86 % of girls respectively, respondents who were aware of anaemia (7.4 %) and the national program to control it (4.6 %). Consumption of iron rich foods like ragi, greens, meat and vitamin C rich foods like, sprouted grams on the previous day was reported by 36.3 %, 20.1 % and 7.3 % of subjects respectively. Iron deficiency was found in 81 % of respondents, mild, moderate and severe grades of anaemia were observed in 63.2 %, 12.5 % and 5.3 % of respondents respectively. Though the pattern of growth of the girls were similar to that kind of NCHS standards, the heights and weights of study subjects at any given point of age were far below the NCHS standards and the deficit increased with age .Side effects like abdominal pain, nausea, vomiting, diarrhea were reported in 5.15 % of girls at the beginning of project and remained 3 % at midterm survey evaluation. In majority of cases, such effects were reported when supplementation was taken on empty stomach or during mild sickness without sufficient intake of water. About 62 % of subjects did not skip even a single iron folic acid tablet, indicating good compliance. Mean blood haemoglobin level at the baseline survey was 10.6 ± 1.1 g/dl which increased to 11.6 ± 1.0 g/dl during midterm survey. Haemoglobin level improved in 45.6 % while it remained static in 49.4 % and declined in only 5 % of subjects. Thus, it was evident from the results of midterm survey that iron folic acid supplementation to school going girls, under teacher's supervision, for proceeding six months together with informational and educational counseling, intervention resulted in a significant increase in haemoglobin levels, indicating the feasibility of this approach.

Shobha *et al.* (2003) conducted a study on efficacy of twice weekly iron supplementation in anaemic adolescent girls. The study examined the comparative effectiveness of a twice a week supplementation program to a daily supplementation program in enhancing the haemoglobin levels of adolescent girls with different grades of anaemia and in reducing its side effects. A sample of 244 girls aged 13-15 years from

Andhra Pradesh, Social Welfare Residential School for girls in Ranga Reddy District was studied. The haemoglobin was estimated to classify girls as normal, mildly, moderately or severely anaemic, as per WHO standards and were further randomly divided into sub groups to follow a daily or a twice weekly supplementation regimen for the period of 84 days. The subjects were dewormed with a single dose of 400 mg albendazole and haemoglobin was estimated at the beginning and at the end of the 3^{rd} ,6^{th} 9^{th} and 12^{th} weeks. Group means and standard deviations were calculated and student 't' test and paired 't' test were carried out to test the significance of difference between different groups, as well as within the groups at different periods of supplementation. 83 % adolescent girls were anaemic. The haemoglobin level increased steadily in all supplemented subjects as the period of supplementation increased. By the end of 21 days of supplementation, all categories of both group showed significant improvement in the base line haemoglobin level. In the mildly anaemic girls, the daily groups had significantly higher haemoglobin level than the weekly group. The same trend was observed by the 41^{st} day of supplementation. By the 63^{rd} day the subjects reached normal levels of haemoglobin, while weekly supplemented adolescent girls had near normal haemoglobin levels. At the end of the study period (84 days), all mildly and moderately anaemic subjects given either daily or weekly twice supplementation became normal (12g/dl).Moreover, majority of the severely anaemic subjects also reached near normal levels. Severely anaemic subjects showed maximum overall increment (58.78 % in daily and 52.64 % in weekly groups), followed by moderately (33.44% in daily and 29.69 % in weekly groups) and mildly anaemic subjects (23.22 % in daily and 18.95 % in weekly groups).Thus, it was observed that lower the initial haemoglobin level, the greater the increase on supplementation while 57.84 % of the daily supplemented subjects suffered unpleasant side effects. This could probably be due to the avoidance of iron overload in the stomach of the subjects due to intermittent supplementation. Thus, the study concluded that supervised administration of weekly twice supplementation of iron to anaemic subjects was found to as advantageous as daily supplementation, as far as raising the haemoglobin levels were concerned. Even the severely anaemic adolescent girls had near normal haemoglobin status after the 84 day supplementation program. It has an edge over the traditional supplementation method with regard to occurrence of unpleasant side effects like nausea and epigastric pain, which could perhaps lead to better compliance among subjects to iron supplementation.

Kotecha *et al.* (2002) conducted a study on adolescent girls anaemia reduction programs – impact evaluation (mid- term) of Vadodara district. The objectives of the survey were to measure the anaemia prevalence and haemoglobin level of the school girls and measure the change due to intervention, to study the utilization of informational and educational counseling material and to study the consumption of iron rich and Vitamin C rich foods, and to evaluate the supplementation compliance of the school girls and out of school girls using existing school based records and self-reporting by the girls.

A stratified random sample (baseline survey) of 2,860 adolescent girls aged 12-19 years from schools a Vadodara district were selected. The sample consisted of rural, urban and tribal girls. Intervention trial was adopted as the same population was studied during the mid-term of anaemia reduction program. Both biochemical tests and verbal enquiry were employed to collect the data. Haemoglobin estimation was done by ABACUS cell counter and serum ferritin was assessed using immolate. Mean, median and percentages were calculated. Anaemia prevalence (Hb<120 g/dl) was recorded at 53.2 %, as compared to baseline anaemia prevalence of 74.7 %. There was a reduction of 20.5 % in anaemia prevalence after the initiation of the programs. The reduction achieved was maximum in rural areas followed by urban areas, with both showing a net reduction of anaemia 23 %, while the tribal areas showed a reduction of anaemia by about 16 %. Mean rise of haemoglobin was seen to the extent of 6.4 g/dl, with regional differences and maximum rise was seen in rural areas followed by urban areas and relatively, the least rise was seen in tribal area. Severe anaemia prevalence was reduced from 1.6 % at baseline to 0.5 % suggesting a reduction of 68 % in severe anaemia from the base line value. Similar reduction value for moderate and mild anaemia was 51 % and 22 %, respectively.

A total of 804 samples were studied for serum ferritin and a proportion of girls having serum ferritin less than 12 mg/ml, indicative of poor iron storage, declined from 49.7% to 39.7 % and was consistent in all the areas. The mean value of ferritin increased by 5mg/ml across all areas. Overall, the proportion of girls below 12mg/ml serum ferritin level decreased, along with an improvement in the medians after intervention. The frequency of consumption of iron rich food was not very high except jaggery, which was consumed daily by one fourth of the girls as compared to other iron-rich foods. Frequency of consumption of Vitamin C rich foods was better than that of iron rich foods. Overall, 32.7 % of the girls consumed vitamin C rich fruits along with

snacks or food. The evaluation revealed that the coverage of school girls to the extent of 90 % has already been achieved under the programs. The intervention was more successful among adolescent girls in rural areas than in tribal areas though even in the tribal areas the reduction in prevalence of anaemia was substantial. Thus, there is a need for modification of intervention strategy and methodology for tribal areas, as per the local socio-cultural context. Even though consumption of Vitamin C rich foods improved among adolescent girls, yet greater effort would be required to promote consumption of iron rich foods for long term gains in iron status of the girls.

Mathur *et al.* (2005) conducted a study on a comparative study of impact of leaf concentrate and iron and folic acid supplementation on blood profile of anaemic adolescent girls. Despite impressive gains in the field of health and nutrition, significant proportion of your people in developing countries suffers from nutritional anaemia. The effect of earlier nutritional status is visible in the adolescent age particularly in girls. Adolescence is a time of major physical, cognitive and psychological growth and development. Due to various reasons like irregular supply chain, poor compliance, the National Anaemia Prophylaxis programs has not made an appreciable stand in prevention of anaemia. Hence it prompts us to look at other alternative use of leaf concentrate (LC), which is a good source of micronutrients, is one such alternative.

The overall objective of the present study was to compare the effects of leaf concentrate and iron and folic acid tablet supplementation on blood profile of adolescent girls. The present study was conducted on adolescent girls aged 14 to 18 years residing in Shastri Nagar, Kacchi Basti, an urban slum area in Jaipur city. A total of 120 unmarried anaemic girls willing for the intervention trial were divided into two experimental groups, I (IFA supplementation) and II (LC supplementation). One IFA tablet (60 mg iron and 500 mg folic acid) was given to group I every day and 10 gm of leaf concentrate powder (8 mg iron and 0.03 mg folic acid) was used as herbal medicine for the second experimental group for 135 days. After excluding dropouts, the results of 90 subjects (40 subjects in IFA group and 50 subjects in LC group) were tabulated and compared. A statistically significant improvement had taken place in hemoglobin levels, as well as other blood parameters i.e., TRBC, PCV, MCV, MCH. MCHC, serum iron, serum ferritin of the subjects in both the groups.

There was about 15 % increase in haemoglobin level of subjects in both the groups. This data was even tested for larger sample size and it indicated that if LC was

used as a supplement for larger population size then the result will prove to be more promising as compared to IFA. The iron content of an IFA tablet is 60 mg. although 10gm of LC powder supplied only 8 mg of elemental iron which is not at all comparable. In spite of this fact, the results of both the groups were comparable, with no statistically significant difference between the two groups. This can be attributed to perhaps better absorption of LC. Microscopic examination of the slides at initial, as well as final stage was also studied. Initially, the slides showed anisocytosis, poikilocytosis, severe hypochromic macrocytes, ovalocytes and macrocyte cells, these showed a shift towards normocytic, normochromic and few macrocytes and mild hypochromic cells in both the groups after supplementation. The results of the study are promising for LC, which gave similar and comparable results on the iron status of the subjects, both the supplements showed similar improvements, in spite of the small doze of LC given to the subjects, the other factors like presence of other micronutrients, e.g., copper and zinc must have helped in bringing significant change in haemoglobin levels, as well as other blood parameters of the subjects.

The LC powder has grassy flavor and subjects initially have problems in consuming 10gm of powder at a time. Due to close monitoring and rapport with the subjects, during the present trial, they were advised to consume this 10gm LC powder by taking a spoonful; 2-3 times in a day. It is not that 10 gm dose of LC powder is very problematic to consume; it can be taken orally with glass of water or lemon juice or buttermilk or mixed with chapatti dough, yoghurt or lentils. Perhaps a lower dose of 5 gm LC powder can be introduced on long-terms basis into the existing supplementary feeding programs and Mid Day Meal (MDM) programs so that the vulnerable groups of people can get some additional amounts of micronutrient in their diets besides their usual intake.

Deewan A. (2007) conducted a study on impact of iron, folic acid and vitamin C supplementation on the prevalence of iron deficiency anaemia in non-pregnant woman of Shimla. The study was conducted on randomly selected 180 non-pregnant females of the age group of 15-65 years. They were interviewed using a pretested performa. Physical examination, haemoglobin estimation and standard blood smear analysis were also done. The experimental group was divided into two sub-groups 1 and 0. Sub-group 1 was supplemented with iron, folic acid and vitamin C. No supplements were given to the control group. The haemoglobin measurements were done at the start of the study, at

30 days, 150 days after supplementation. There was considerable improvement in the haemoglobin status of the anaemic females on supplementation with iron and folate alone but more with vitamin C. Emphasis should be made on the need to improve the diet through increased intake of fruits and vegetables rich in vitamin C. Method of cooking, fermentation and germination can help to increase the availability of free iron.

Sehjpal and Gupta (2007) conducted a study on the impact of lotus stem supplementation on the haemoglobin status of the college students (17-19 years). This study was done on 62 students and their dietary data was gathered (24 hour dietary recall). Initially, indicating that a large majority of the girls have diets deficient in energy, protein and iron but sufficient in vitamin C. During supplementation phase (8 weeks), the food supplements i.e. providing lotus stem biscuits to the experimental group and plain biscuits to the control group. Height, weight and haemoglobin levels were assessed both in the pre supplementation and post supplementation phase. Data indicate a significant impact of supplementation on various parameters. Especially haemoglobin levels of the experimental group which increased from 11.20 g/dl ± 0.95 to 13.13 g/dl ± 1.25 and also seen for the control group which could be attributable to plain biscuits given to them, but the increase in the case of experimental group was many fold without the impact on height. Thus, food supplementation can be looked upon as effective long term measure to control and prevent iron deficiency anaemia.

Bansal *et al. (*2007) conducted a study on nutritional status and the effect of leaf concentrate supplementation on iron status of women (25 -45 years) residing in Jaipur city. The present study was designed with the objective to assess the nutritional status and the effect of Lucerne Leaf Concentrate (LLC) supplementation on iron status of women (25 – 45 years) with three and more than three pregnancies and residing in slums of Jaipur city. At pre intervention, the nutritional status of 44 women was assessed through anthropometric measurements, dietary intake data, complete blood count and serum iron. The diets of thirteen anaemic women (25 – 45 years) were supplemented with 15 g LLC on alternate days over a period of 12 weeks. At post intervention, the iron status was assessed through determination of complete blood count and serum iron. On the bases of body mass index, 45.5 % of the women (n = 44) suffered from chronic energy deficiency. The mean intake of all the nutrients was lower than the RDAs. The mean iron intake of the women was 43 -53 % of the RDAs. As a consequence of LC supplementation, it was observed that women (n = 13) had a significant weight gain of 1.55 kg. Haemoglobin levels improved significantly by

10.5 to 11.82 g/dl from pre to post intervention. Results highlighted increases in haematocrit and total iron binding capacity levels as well. A highly significant increase in serum iron levels was also observed on intervention. Therefore, it was concluded that LLC supplementation led to an improvement in the nutritional and iron status of women.

Aggarwal *et al.* (2007) conducted a study on effect of frequency and dosage of iron folic acid supplementation on blood haemoglobin status of anaemic adolescent girls in Delhi. The subjects were drawn from an NDMC school in Green Park. Blood haemoglobin was tested for all the girls (140) in age group (13 to15years) and those with haemoglobin less than 12g/dl i.e. anaemic (N =89) were divided by random sampling into two groups. Group I received the supplement thrice a week while group II received it once every week for twelve weeks. Haemoglobin levels were assessed by the cyanmethaemoglobin method before and after supplementation. Data indicated a significant impact of iron folic acid supplementation on the blood haemoglobin levels in both the groups. However, the mean increase in haemoglobin levels was not significantly different (1.42g/dl in Group I and 1.33g/dl in Group II). A significant improvement in haemoglobin levels was achieved even with a lower frequency dosage of once a week. Further, weekly administration of the supplement caused lesser intestinal discomfort as compared to thrice a week supplementation. Thus, a lower frequency must be considered for benefits of lesser cost and side effects as well as easier monitoring since its effect in improving haemoglobin status is not significantly different from that of a higher dosage.

Vyas *et al.* (2007) conducted a study on impact of leaf concentration and iron folic acid supplementation on blood profile of anaemic adolescent girls. The study aims at determining the incidence of nutritional anaemia among adolescent girls and the effect of giving therapeutic dose of LC and IFA tablets on the blood haemoglobin and complete iron status of adolescent girls. Adolescent girls between 14-18 years from Jaipur city were selected. For screening Haemoglobin assessment was done by cyanmethamoglobin method. Anaemic adolescent girls were then selected and divided into two experimental groups: Group I (IFA supplementation), Group II (LC supplementation). Initial blood profile was performed which included tests for all the blood parameters and indices. Intervention period was 135 days. Subjects were dewormed prior to intervention by Albendazole tablets (Zental tablets containing 400

mg Albendazole). Group I was supplemented with one big tablet of iron and folic acid (50mg elemental iron and 500 microgram of folic acid).Group II was supplemented with 10g of LC powder (8 mg iron and 0.03mg of folic acid). The prevalence of anaemia among the population studied was about 66.25 %. The results even highlighted that there was significant improvement in all the blood parameters (i.e. TRBC, PCV, MCV, MCH, MCHC, serum iron and serum ferritin). There was 15 % increment in haemoglobin levels of the subjects. This data was even tested for larger population size and it indicated that if LC was used as a supplement for larger population then the results will prove to be more promising as compared to IFA tablets. The results of the study are promising for LC. In spite of the small dose of LC giving to the subjects, the other factor like presence of micro nutrients like copper and zinc must have helped in bringing significant change as they play a specific role in haemoglobin regeneration. Although LC powder has grassy flavors but it could be taken orally with glass of water or lemon juice or buttermilk or mixed with chapattis dough and also can be consumed like herbal medicine.

Kotecha *et al.* (2009) conducted a study in June 2000, Adolescent anaemia control program was initiated as a pilot program in Vadodara district of Gujarat covering over 69,000 girls in over 426 schools. Strategy was to provide once weekly fixed day (Wednesday) supervised iron folic acid (IFA) supplements to all adolescent girls of grade 8-12. Currently, program covers 10 lakh school girls and 2.6 lakh out of school girls with a compliance rate of over 90 % as reported by education department. This study was undertaken to institutionalize once a week IFA supplementation in the schools for adolescent girls with built in compliance monitoring in one district and scale up the program from its learning to all the districts as feasible.

Baseline survey for three areas of Vadodara district, tribal, rural and urban from 10 schools each was conducted to collect data for anaemia prevalence. Education inspectors were assigned responsibility to supervise and motivate teachers to try out innovative ideas to promote the programs. Simultaneously anganwadi workers of urban Vadodara were motivated to initiate IFA supplementation for out of school girls on similar strategy. After approximately 17 months of intervention, impact study was conducted in the same 30 schools in November 2001 to obtain levels of anaemia and some of the paired data from the students who were part of the baseline study also included knowledge and practices of the adolescent girls with reference to their dietary

habits and package of intention included nutrition education through schools by providing information and education material prepared by the government.

Baseline study had shown around 75 % anaemia prevalence, which was similar in all the three areas. Level of serum ferritin was also low. Impact evaluation showed reduction in anaemia prevalence by 21.5 % that is, from 74.7 % to 53.2 %. ($p<0.05$) further improvement in Hb was recorded among 80 % girls. Pre and post intervention also showed improvement in serum ferritin value.

Bhanushali *et al.* (2011) conducted an intervention study among 104 unmarried adolescent girls with an objective to study the effect of change in dietary behaviors and iron supplementation for reduction of iron deficiency anaemia. The relevant information was collected with anthropometric measurements and haemoglobin estimation, socio-economic status was collected using pre- tested questionnaires. The girls were administered iron folate and calcium tablets on alternate days for three months. Results showed there was increment 19.55 % haemoglobin in the group of girls receiving IFA supplements where as haemoglobin decreased slightly in girls of the control group. A significant weight gain of 2.66 kg was seen in the intervention group, here as girls in the control group showed little weight gain. In conclusion, considering the bio feasibility and effectiveness of the intervention, adolescent girls of the control group for prevention of anaemia and IFA supplementation in this population.

2.4.2 Fortification of foods

A number of vehicles have been proposed for iron fortification on a large scale, cereals, sugar or condiments like fish sauce **(World Health Organization, 1972, INACG, 1977).** Several iron sources have been employed in fortification.

Cereals and salt

Several countries (e.g. Sweden, UK and USA) have programs in operation for the fortification of wheat flour with ferrous sulfate, reduced iron or carbonyl iron **(Council on Foods and Nutrition, 1941 and INACG, 1977).** In, India where the stable food varies with each ethnic group, salt has been used as a vehicle for iron fortification as it is universally consumed and centrally processed (**Narsinga Rao and Vijaya Sarathy, 1975**). Although fortification of salt with iron at level of 5mg/g has been shown to produce a significant rise in haemoglobin levels of school children (**Food and Nutrition Board and UNICEF, 1981**) the amount that can be derived from fortified salt (about 10-15 mg /day based on average salt consumption of 10-15 mg) is adequate for the increased demands during pregnancy. Therefore, it can only be used as complementary

measures for combating the problem of iron deficiency anaemia in pregnant women. In Thailand fortification of fish sauce has shown great promise in improving the iron status of the general population (**Garby and Areekul, 1974**).

The **USAID Report (1996)** and the Guatemala National Micronutrient Survey (1995) provided information on the nutritional situation of iron and the levels of fortification of foods. Plasma and haemoglobin: 1637 women aged 15-44 years in whom haemoglobin was measured. The prevalence of anaemia was 35.5% in fertile aged women and 39.1 % in pregnant women.

Table salt can be fortified with iodine and iron without interaction and without loss of potency **(Boulet, 1997)**. According to Levente Diosady, professor of food engineering at the university of Toronto, the amounts of the micronutrients available to the human body have been significantly reduced when the two interacted. In the new technology, the iodine is covered with a dextrin (a water soluble starch) capsule that serves as a physical barrier to the iron. The efficiency of absorption of the two micronutrients in the new double fortified salt in the human body is being tested at the hospital for sick children in Toronto. Iron deficiency, the most common nutritional in the world (particularly among women, infants and children) is associated with anaemia, fatigue, learning problems, pregnancy complications, premature births and maternal mortality.

Miller and Saade (1997) report that staple foods can be fortified with micronutrients in a cost – effective way. The consequences of deficiencies include low birth weight due to lack of iron, iodine and vitamin A with mental retardation, night blindness, lower intelligence quotient, low school program less energy and strength, and decreased productivity. Correction of micronutrient deficiencies can result in greater child survival and reduce maternal deaths. **Saade (1997)** campaigned for fortification of corn flour with micronutrients.

Draper (1998) quotes that in developing countries , street foods are widely consumed by millions of people. These foods provide an affordable source of nutrients to various sectors of population, including the urban poor. Street foods include commercially produced snacks that are retailed by street food vendors as well as food items made by vendors. As micronutrient deficiencies are major public health concerns in these countries, fortification should be considered to prevent and control micronutrient malnutrition. Fortification with micronutrients could improve the nutrient profile of these foods and serve as a means of introducing micronutrients rich foods to

consumers. Street foods present two fortification opportunities: 1) Ingredient based fortification of universal ingredients like flour or sugar, 2) Food based fortification of specific processed foods or drinks, particularly with vitamin A and C as well as with iron and iodine. A fortification program will be most successful if it concentrates on foods that are sold through a target group and delivers the appropriate micronutrient for that population.

Ricardo *et al.* (2002) concluded that iron fortification is a methodology utilized worldwide to address iron deficiency. Fortification of foods with iron has been a commonly used strategy to combat iron fortification through the world. Iron fortification of staple foods: wheat, maize, rice and cereal flours are currently the most common vehicles for iron fortification to reach the general population. **(UNICEF, 1999)**. Fortification of rice requires additional research before it can be considered ready for program implementation. Implementation of complimentary food fortification or preventive supplementation is important to meet their daily iron requirements. Ferrous sulfate and fumarate are suitable for refined wheat flour with low levels of iron inhibitors. Elemental iron despite being very compatible with most food matrixes is very poorly absorbed and, thus, is not useful even at high levels of fortification. The exception is electrolytic iron, which has better absorption and is widely used in commercial infant cereals. Finally, effectiveness requires that the fortified food is consumed by the target population, is low in cost and has good organoleptic properties. Failure of fortification efforts to prevent iron deficiency can be explained in most cases by lack of compliance with these criteria. The process of selecting the best food vehicle and iron source may appear simple but is actually a complex process that requires evaluation at every step.

Complimentary foods

The contribution of iron from fortified complementary foods has great potential because it may provide the major source of iron at a critical time in infant growth and brain development. There are two major technical constraints when cereals are selected as vehicles: high levels of phytic acid and the extreme sensitivity of unsaturated fat to oxidation during storage in the presence of highly reactive forms of iron (ferrous sulfate or fumarate). One option for increasing nonabsorption is to hydrolyze the phytic acid in cereals, but nearly all of it needs to be removed **(Hurell *et al.* 1999).** Activating natural phytases from legumes and some cereals (rye, buckwheat, and wheat) helps to hydrolyze phytic acid. In the future, it may be possible to develop crops with low phytic

acid through plant breeding to prevent fat oxidation and preserve organoleptic problems. Infant cereals are usually fortified with elemental iron powders, which are not very reactive, but this form of iron has extremely poor bioavailability and should not be used in complementary foods. A new form of elemental iron (atomized iron) appears promising and is already being used. However, it should be evaluated for efficacy before recommending its continued use **(Yang *et al.* 2001)**. The presence of inhibitors and enhancers should be critically assessed to ensure bioavailability. EDTA and ascorbate act as enhancers and have additive effects. Bioavailability studies are crucial in the selection of fortificant for specific complementary foods but do not ensure effectiveness of the fortified food product. Choice of iron fortificant should be based on compatibility and bioavailability within the specific food matrix. Ferrous sulfate, fumarate and electrolytic iron are the better choices, provided that the food matrix, packaging and storage conditions are compatible for shelf life.

Condiments and Sauces

Condiments and sauces have several advantages as vehicles for iron fortification. They are traditionally part of the daily diet in most countries, widely consumed, reach vulnerable populations, can be added to multiple foods and can be combined with fortified staple foods. Iron fortification of condiments can have a significant contribution where central processing of staple foods is absent. However, successful experiences of fortified condiments have never gone beyond the pilot level: curry powder fortified with NaFeEDTA **(Ballot *et al.* 1989)**, sugar with NaFeEDTA **(Viteri *et al.* 1995)** salt fortified with ferric orthophosphate, ferrous fumarate, sulfate, or bisglycine chelate**(Foy, 1976)** soy sauce and fish sauce fortified with NaFeEDTA **(Yang *et al.* 2001 & Thuy *et al.* 2001)** and seasoning in noodles with ferrous sulfate. Recent investigations have shown that fortification of salt with iron could be very useful and possible even when combined with iodine.

For the most part, countries in the America are already fortifying with iron wheat flour, maize flour or both. Although the conditions for successful iron fortification programs are at hand, specific problems still exist. First, arbitrary criteria have often been adopted to select iron compounds. Second, fortification programs lack quality assurance systems, and countries have not implemented monitoring and surveillance systems. Third, legislation has not been adjusted in accordance with needed changes to mandate fortification with specific sources, to prevent contraband and to ensure monitoring and quality control. Because of the widespread use of elemental iron

powders (reduced and atomized iron) with uncertain bioavailability, these programs are likely to have limited impact. In light of the current situation, a Pan American Health Organization/United States Agency for International Development/International Life Sciences Institute expert group **(PAHO, 2001)** recently proposed the following recommendations for iron fortification in the American region.

- Wheat flour: fortificant, ferrous sulfate or fumarate or electrolytic iron at twice the amount at level, 45 ppm, but in countries where consumption of wheat products per capita is > 100 g/day, lower levels may be considered.
- Maize flour: fortificant, NaFeEDTA, ferrous fumarate at level, at least 5 mg/day of additional iron, but no < 25 ppm (above current level available).
- Complementary foods and school programs: fortificant, ferrous sulfate + ascorbic acid or ferrous fumarate + ascorbic acid at level: based on specific requirements for age.

Pahwa *et al.(*2007) conducted a study and assessed the impact of double fortified salt (DFS) on iron and iodine status of adolescent girls(17-19 years).A sample size of 61 was randomly divided into experimental group (n = 31) which was given DFS and control group (n = 30) which was given iodized salt for a period of 11 weeks. Eight subjects from the experimental group were dropped because of non compliance to the use of DFS. Therefore, the study was completed by a total of 54 subjects. Baseline information like age, family size, amount of salt consumed etc. was collected. Anthropometric measurements like height, weight, mid upper arm circumference, body fat percentage, waist and hip circumference were taken and waist hip ratio and BMI was calculated at both pre and post supplementation phase. 24 hour dietary recall was done for calculating the nutrient intakes. Biochemical estimations for haemoglobin and urinary iodine excretion were carried out. The monthly salt consumption by the subject ranged from 1.0 – 2.2 kg. The diets of majority of the subjects were found to be deficient in energy, protein, iron, thiamine, riboflavin, vitamin A and niacin. However, they met the RDAs for calcium, folic acid and ascorbic acid. No significant changes were seen in the anthropometric measurements after supplementation. A significant increase in the haemoglobin level of both the groups was seen but the percentage increase was higher in experimental group.

2.4.3 Bio availability of dietary iron

Bio availability of a nutrient particularly with reference to a trace mineral is defined as the proportion of a nutrient in food which is absorbed, transport to its site of

action and converted to its biologically active form **(O'Dell ,1984).**Iron availability depends on iron exchange reactions in which ligands of digestive tract act as donors and mucosal iron receptor protein as the acceptor. The rate and extent of this reaction depends on the number and activity of mucosal iron receptor site determined physiologically by iron status of individual and chemical state of iron in the digestive mixture **(Chidambaram *et al.*, 1989).**

Table: 2.4 Mean total intake of iron and the bio available iron (mg) in the vulnerable groups in India.*

Group	Total Dietary intake of iron (mg/day)	Intake of bio available iron (mg/day)
Pregnant Women	25-30	0.5 -1.5
Preschoolers	15	0.3 -0.75
Schoolers	20	0.4 -1.0
Adult Male	30	0.6 -1.5
Adult Female	25-30	0.5 -1.5

*Bio available iron calculated on the bases of 2- 5% of Bio available in Indian diet.
Source: **Sheshadri,1995.**

Table:2.5 Bio availability of iron from typical Indian meal

Sr. No	Meal	% of Bio availability	References
1	Wheat chapattis, Potato, Vegetable and Tea	1.8	Narsinga Rao,1983
2	Rice, Dal, Potato, Vegetable and Milk	4.5	Narsinga Rao,1983
3	Ragi balls, Potato, Vegetable and Tea	0.9	Narsinga Rao,1983
4	Sorghum ,Potato, Vegetable and Tea	0.8	Narsinga Rao,1983
5	Wheat Bhakris	3.7	Christian and Sheshadri, 1989
6	Wheat Bhakris + one cup of Tea.	2.5	Christian and Sheshadri, 1989

Soucre: Sheshadri, 1995.

Savitha *et al.*, (2011) designed to study the in-vitro bioavailability of various forms of iron compounds and to analyze the iron dialysability from the juices developed using the highly bioavailable form of iron. The in–vitro method involving gastro intestinal digestion and diffusion of iron through a semi- permeable membrane was used

in the study. The dialyzed iron was using u-v spectrophotometer. The iron bioavailability of various forms of iron such as anhydrous ferrous sulphate, ferrous sulphate hydrate, ferrous fumarate, ferrous sulphate ammonium sulphate, ferric fumarate, ferric pyrophosphate, ferric chloride, sodium ferrous EDTA and elemental iron ranged from 0.2 to 4.1 per cent. Iron bioavailability was doubled in fortified lime juice, which could be due to the ascorbic acid content which is an enhancer of iron absorption. The lime juice contained 6.3 mg% of ascorbic acid. Thus fruit beverages with ferrous sulfate as a fortificant can be recommended for the anaemic youth to improve their iron status.

2.4.4 Improving bioavailability of dietary iron

Accumulating evidence has suggested that a number of enhancers and inhibitors interact to determine the net bioavailability of iron from a given meal **(Monsen, 1988).** Manipulation of their dietary constituents would be necessary to bring about an improvement in the iron availability by (1) a reduction in the amount of inhibitors of iron absorption such as tea, coffee, wheat bran, phytic acid fibers, eggs, calcium, phosphate salts, and (2) an increase in the amount of enhancers of iron such as ascorbic acid, animal tissues like meat and flesh foods.

The germination of some cereals and legumes for 24-48 hours is associated with the appearance of 10-70 mg of ascorbic acid per 100 g and 8-25 % reduction in the tannic acid concentration and a 25-35 % decrease in the phytic acid concentration. The bioavailability of iron from such germinated grains, as determined invitro, increases almost two fold. The malting of millets has been Shawn to result in iron bioavailability **(Kumar *et al.*,1978)**.The two factors greatly enhance iron absorption are vitamin C and meat.

Accumulating evidence has suggested that a number of enhancers and inhibitors interact to determine the net bioavailability of iron from a given meal **(Monsen *et al,* 1988).** Manipulation of their dietary constituents would be necessary to bring about an improvement in the iron availability. This would be brought about by 1) A reduction in the amount of inhibitors of iron absorption and 2) An increase in the amount of enhancers of iron.

A reduction in the quantity of inhibitors such as tannic acid, phytic acid, oxalates, calcium, phosphorus and fiber can be achieved through common household processing methods such as (a) Germination (b) Malting (c) Fermentation (d) De hulling (e) Soaking **(Pawar and Parlikar 1990)**.

Nalwade *et al.* (1997) conducted a study on bioavailability of iron and calcium content of uncommon leafy vegetables. This investigation was undertaken to assess the bioavailability of iron and calcium content of selected uncommon leafy vegetables. Fourteen uncommon leafy vegetables namely Beet greens (Beta vulgaris),Cheel (Amaranthus sp.), Chopda math (Amaranthus vividis), Ghol (Portulacao leracea), Kante math(Amaranthus spinosus), Kunjeer (Digera orveniss), Pakla(Merremiya emerginta),Paatar (Sonchus arvensis), Rajgra leaves (Amaranthus paniculatus), Drumstick leaves(Moringa oleifera),Sarate (Tribulusntessestris), Tandulga(Amaranthus polygramous),Tarwata(Cassia tora),and Vavdinga pan(Embelica ribes)were selected from local market of Parbhani city and rural area of Maharashtra region of Maharashtra state. The total iron content of the uncommon leafy vegetables were found to be varying from 19.87 – 1.68 mg/100g, Kante math (19.87mg %) recorded the highest value of iron content as compared to other leafy vegetables followed by Rajgira leaves (17.91 %), Polka (17.72 mg %) and Chopda math (17.26 mg %). On the other hand, Rajgira leaves was found to have maximum (6.16 mg %) content of available iron content (1.08 mg %). In case of bioavailability of the iron Tandulga (62.47 mg %) recorded the highest bioavailability of iron, where as Ghol recorded the lowest (4.99 mg%). The calcium content of selected uncommon leafy vegetables ranged between 512 and 690 mg /100g. The maximum calcium content was found in Rajgira leaves (512 mg %), followed by drumstick leaves (423 mg %),Beet greens (322 mg %)and Chopda math (312 mg %). Hence Kante math ,Rajgira leaves and Tandulga can be considered as good and cheap sources iron and calcium ,therefore, it can be recommended for consumption in the diet of the people to reduce the prevalence of anaemia in the community.

Yadav *et al.* (1997) conducted in vitro study on the effect of certain household processing methods on the bioavailability of iron from the selected preparations. The present study attempted to investigate the total iron content and in vitro iron availability of certain products and their modified forms, which had undergone household processing like soaking, fermentation and germination. Three variations each of Idli (instant, soaking, fermentation), Soy chat (boiling, soaking, germination). Handwa (cooking in iron utensil, in steel pan, iron utensil with soaked and ground soya bean) and biscuit (normal, roasted soya flour, defatted soy flour) were prepared. Nutrient analysis revealed that soya bean containing products had comparatively higher total iron content. In vitro iron bioavailability was better in fermented and germinated products,

maximum increase of 10.0 ± 0.016 soluble iron and 11.8 ± 0.001 insoluble iron in idli sample (fermentation).Cooking in iron pan increased the total iron content but its bioavailability was not quite high. Products having soya bean also had relatively high calcium processing brought about a decline in phytate phosphorus content. All the products enjoyed high acceptability, which was judged by semi trained panel. Thus the results reinforce that simple household processing techniques are beneficial in improving iron bio availability. There is a need to emphasize this fact so that it can be incorporated in the designs to combat anaemia of iron deficiency.

2.4.5 Nutrition Education

Upadhyay *et al.* (2002) observed the impact of single vs. combination of media on nutrition knowledge and haemoglobin status. After a period of 60 days a significant rise in post exposure knowledge scores of both the groups was observed. Between the groups multimedia group scored significantly higher than print media group. Mean haemoglobin concentration were found to be higher though non- significant. Similarly in the present study the subjects were exposed to short lectures, and other visual aids such as folder, flash cards, posters and display of raw foods which showed a significant rise in post exposure knowledge scores.

Meenakshi and Vyas (2003) used a questionnaire to assess the nutritional knowledge of adolescent girls which contained 100 questions with multiple choices. A pre- test and post test study was conducted within the interval of seven days on the same questionnaire. The results indicated about 30 % gain in knowledge by comparing the scores of pre – test and post test, as against to a high score (>23) by the subjects in the post tests in the present study.

Dutta *et al.* (2004) revealed that 60 % of the girls (17-19 years) had correct knowledge about signs of anaemia and cheapest source of iron, 72 % of them knew the dietary cause of the disease. Their knowledge regarding the prevalence of anaemia among Indian women and the normal haemoglobin level of them, however, was poor as only 26 % and 37 % of the girls could correctly answer in this respect.

Patel (2009) conducted a study and the result revealed that nutrition deficiency diseases are widely prevalent in rural community due to poor awareness regarding nutrition. Because of poor knowledge regarding nutrition, their family suffers from deficiency diseases. Two villages Kamli and Sinhi of Unjha taluka were selected by purposive random sampling method. 100 rural women of 20-50 years age group were selected (50:50) or equally from two villages randomly. The intervention program was

conducted by poster exhibition and lecture. Data revealed that an awareness regarding nutritional requirement had increased after intervention program. Highest difference was observed in knowledge about vitamin requirement (50%). The respondents had highest unawareness about calorie and lowest awareness regarding vitamins requirements before an intervention program.

Savita *et al.* (2013) conducted a study on impact of education intervention on nutritional knowledge of iron deficiency among post adolescent girls and stated that approximately, 70 % of adolescents in India suffer from anaemia, making it one of the most important public health issues. Public intervention programs are essential to combat iron deficiency. Nutrition knowledge and nutrition education is also considered a long term approach to combat iron deficiency anaemia. A total 207 girls in the age group of 18 to 25 years were screened for the haemoglobin status and knowledge assessed among the volunteer subjects (156 girls) using the tool developed for the purpose. Nutrition knowledge intervention was carried out through a short lectures using the visual aids (flash cards, posters and display of raw foods such as rich sources, enhancers and inhibiters of iron absorption) followed by discussion. A folder was developed consisting brief information regarding iron, anaemia, sources, enhancers, inhibitors, consequences of anaemia and fortification. The knowledge assessment tool was tested thrice during the study period- initially before the education, soon after the nutrition education and one month later and the subjects were classified on the scores obtained. The classification was made as low, medium and high based on mean +1/2SD. 30 % of subjects scored low (<17) ,42.31 % scored medium (17-23)and 27.56 % scored high (>23) before education. Assessment of the knowledge immediately after the education program revealed that 97.44 % of subjects scored high (>23) where as 2.56 % scored medium (17-23) and one month later, the knowledge level revealed that 95.51 % scored high (> 23) and 4.49 % scored medium (17-23) reflecting that the retention of knowledge is quite satisfactory during follow up assessment. The percentage of correct response ranged from 39-69 % previously followed by 71% to 96 % at immediately after education intervention and 70 % to 91 % at one month after education intervention. The response improved after education intervention that could help to combat micronutrient malnutrition.

2.5.6 Beneficial effects of Garden Cress seeds

In India, garden cress seeds are, commonly used in the system of *Ayurveda* to prevent postnatal complications. Garden cress seeds, since ancient times, have been

used in local traditional medicine of India. Garden cress seeds are bitter, thermogenic, depurative, rubefacient, galactogogue, tonic, aphrodisiac, ophthalmic, antiscorbutic, antihistaminic and diuretic. Cress may be given to budgerigars. Garden cress is used as a mild stimulant, a source of phyto - chemicals and anti oxidants, diuretic, an expectorant and a digestive aide. It also helps purify blood and stimulate appetite. When taken regularly, cress helps to alleviate anemia as well. It is used during constipation as a laxative and a purgative. Paste made of these seeds can be taken internally with honey to treat amoebic dysentery. The germinating seeds soothes the irritation of the intestines in dysentery and diarrhea. Garden cress seeds are good expectorants and are chewed to treat sore throat, cough, asthma and headache. The plants parts are used in the treatment of asthma and cough. Cress is a good natural source of vitamins and minerals for new mothers. Cress is said to help regulate the menstrual cycle, and cress seeds help increase milk production and secretion in lactating mothers. It is good for post- partum and lactating mothers. Garden cress crushed and mixed with hot water is a good colic treatment for infants. One side effect of cress is that it is an abortifacient (substance that induce abortion), if used in excess, so garden cress should always be eaten in moderation if you are pregnant or trying to conceive. The seeds have been reported as possessing a hypoglycemic property. It is also very carefully prescribed to a hypothyroid patients because it belongs to cruciferous family and is a goitrogen that prevent iodine absorption.

Nutritive value of garden cress seeds is very high. It is available in almost all parts of the world. Its high nutritive value and cheaper availability makes it possible for people of all the sections of society to include in the diet and increases their nutritive value of meals. Garden cress seeds has significant amount of iron, folic acid, calcium, and vitamins A,E, and C. Garden cress seeds are very nutritious as well. Garden cress seeds are also good memory boosters because they contain arachidic and linoleic acids. It contains phytochemicals also.

In the study of **Sharma and Garg (2002)** that a significant rise in haemoglobin status was noted (0.99g/dl) with supplementation of chikki made with GCS and Niger seeds at the level of 60mg/day. **Iyer and Ratnani(2009)** noted 0.44g/dl rise in haemoglobin with supplementation of 5g GCS for 20 days**. Meghani and Nair (2011)** noted 1.32g/dl rise in haemoglobin with supplementation of 5g of GCS for two months among women. In the present study, blood haemoglobin level significantly improved at $p<0.01$ level. Thus, it can be concluded that GCS powder being not a common food

item and is also associated by some myths but nutritive value of these seeds is very high. So because of its health benefits, maximum people can make use of it in their lives and improve quality of their diet and nutrition.

Above marked studies showed that the efforts were put in the right direction which included the global burden of anaemia, causes of anaemia, etiology, seriousness of anaemia and intervention strategies to combat anaemia viz. supplementation, fortification and improving bioavailability of iron in the diet. Nutrition education and supplementation of indigenous food like Garden cress seeds helps in prevention of anaemia. Supplementation of locally available foods helps reduce the prevalence of anaemia at lower cost and useful to the community for combating anaemia.

METHODOLOGY

The scientific study requires adoption of appropriate methods and procedures in order to reach reliable, unbiased and specific conclusions. This chapter mainly deals with the research design, tools and techniques of scientific investigation employed for the collection of data in the light of the objectives of this study. It has also concern with the selection of proper sampling techniques for investigation as well as methods used for statistical analysis of data.

The theoretical frame work developed in this chapter defines the variables under study and sets boundaries of the study. The current chapter discusses the study set up, the methodology used in data collecting, data recording and management, measurement, analysis and data interpretation. The sub topics covering the methodology of the present study in brief are grouped as follows.

The study progressed in six steps: literature search, research design and procedure for contacting respondents, data collection methods, measurement of variables and data analysis followed with interpretation.

The study was conducted in different phases i.e. (1) Phase –I includes anthropometric measurements and observation of clinical signs and symptoms (N= 800). (2) Phase – II includes haemoglobin estimation by Haemocheck or Filter paper method (N= 600). (3) Phase –III includes haemoglobin estimation by cyanamethaemoglobin method and collecting the socio economic information by questionnaire (N= 405).

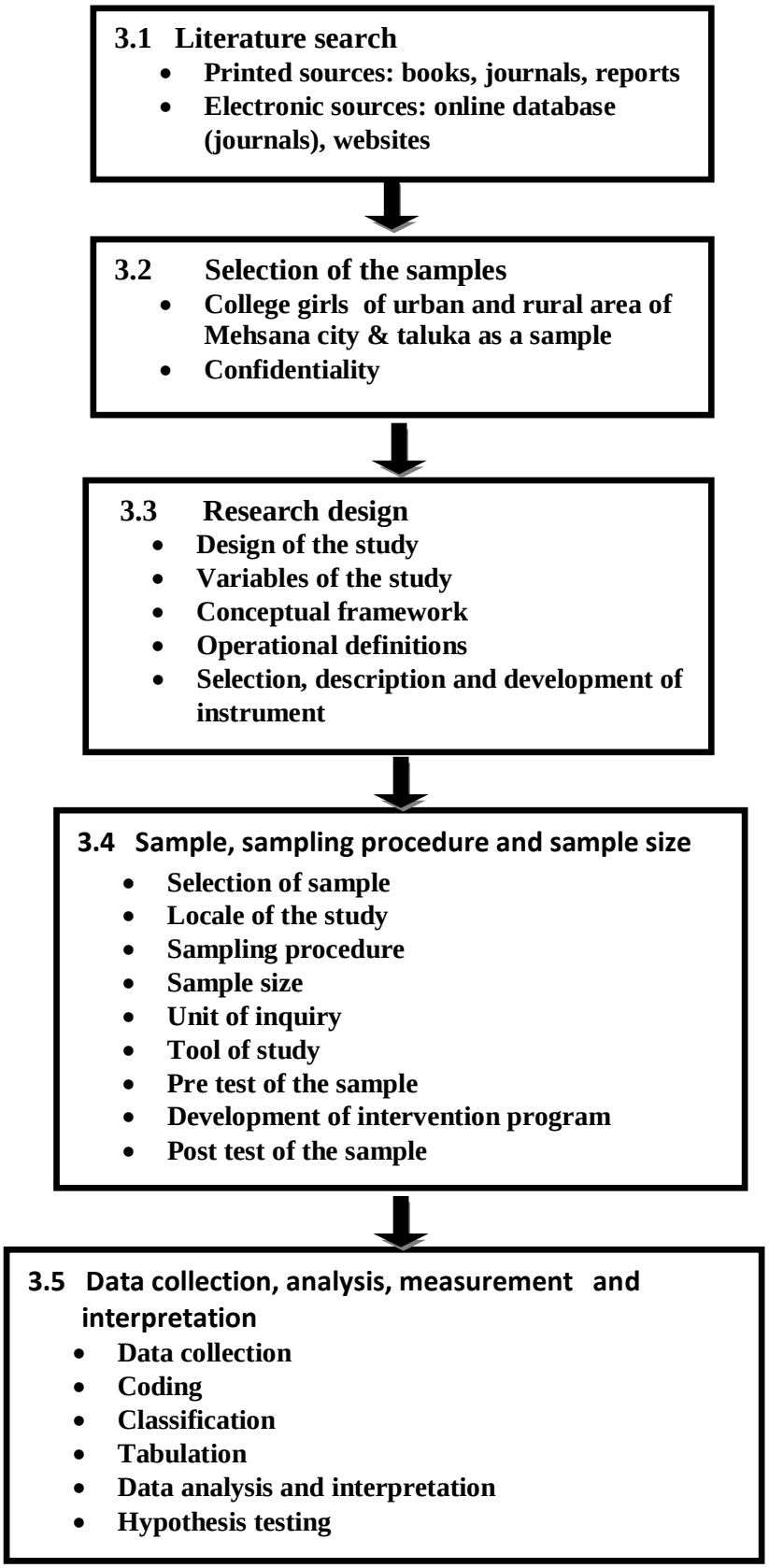


Figure: 3.1 The Research flow

The steps of the study are described in detail in the following sections.

3.1 Literature Search:

The literature search was carried out from both printed and electronic sources.

3.1.1 Printed sources: Printed materials included books, reports, dissertations, periodicals (journals, magazines and newspapers), statistical reports, manuscripts, dictionaries, conference proceedings and hand books.

3.1.2 Electronic sources: Online database were used to search electronically available information such as periodicals (journals, articles, magazines and newspaper articles) base includes (1) ERIC Digest Education Resources Information Center (2) Inflibnet Library (3) Electronic collection online (4) Expanded academic index (5) Proquest digital dissertation (6) Academic search elite, Management Source premier, news paper source (7) Expanded Academic Index (8) Electronic sites such as: http://www.cgsiindia.org, www.yahoo.com and rediffmail.com.

3.2 Selection of the sample

3.2.1 Specifications for the selection of samples

The samples were selected from five colleges of Mehsana city and taluka. City college girls were selected as urban area respondents and girls coming from nearby villages were selected as rural area respondents .College girls who were in the age group of 18 to 23 years were selected.

3.2.2 Confidentiality

The selected college girls were given the assurance about the confidentiality and the respondents were informed very clearly and well in advance that the data would be used for educational purpose only.

3.3 Research Design

3.3.1 Types of research: Quantitative research and Qualitative research

Quantitative research: Quantitative research results in numeric information, which can be analyzed by accepted statistical tests and models. QN data are most often analyzed on computer using standard software. Most QN data is presented as tables, graphs or subjected to other forms of structured analysis. Quantitative methods can be used to draw statistical inference-that is, drawing empirical conclusions about an entire population based on a sample **(Kanani, 2008, Creswell-2008).** Using the

literature reviewed, close end questions for the face to face interview were framed for this study. Survey methods generate quantitative information, which is gathered by asking the same set of closed- ended questions to a specific sample of a reference population, with answer recorded in numeric codes or actual numbers.

Qualitative research: In the context of the current exploratory study, qualitative research method was considered appropriate as it sought to delve in depth into complexities of processes on which little information exists **(Marshall & Rossman 1999).** Qualitative research include usually open – ended questions and result in textual or narrative information that is most often descriptive, and presented as running text organized by selected themes or flow charts, matrices, diagrams or other visual forms. Qualitative methods cannot be used to draw statistical or empirical inference, but can be used to draw logical or analytical inference **(Kanani, 2008).** Qualitative research also allowed the researcher for exploration, discovery, building and enhancement of theory on how the variables under study impacted on each other **(Miles and Huberman-1994).**

In the present study, combination of qualitative and quantitative data was reported by indicating the particular college girls from which the data was gathered, while the quantitative data was reported using percentages and frequencies. Combining the two sets of data was useful in validating findings, enhancing and testing emerging theories to make comparisons between responses and develop a coherent theoretical representation of findings based on valid arguments.

3.3.2 Types of design

A research design is the arrangement of conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy in procedure. In fact, the research design is the conceptual structure within which research is conducted; it constitutes the blue print for the collection, measurement and analysis of the data. There are several research designs and the researcher must decide in advance of collection and analysis of data as to which would prove to be more appropriate for his/her research project **(Kothari, 2004).**

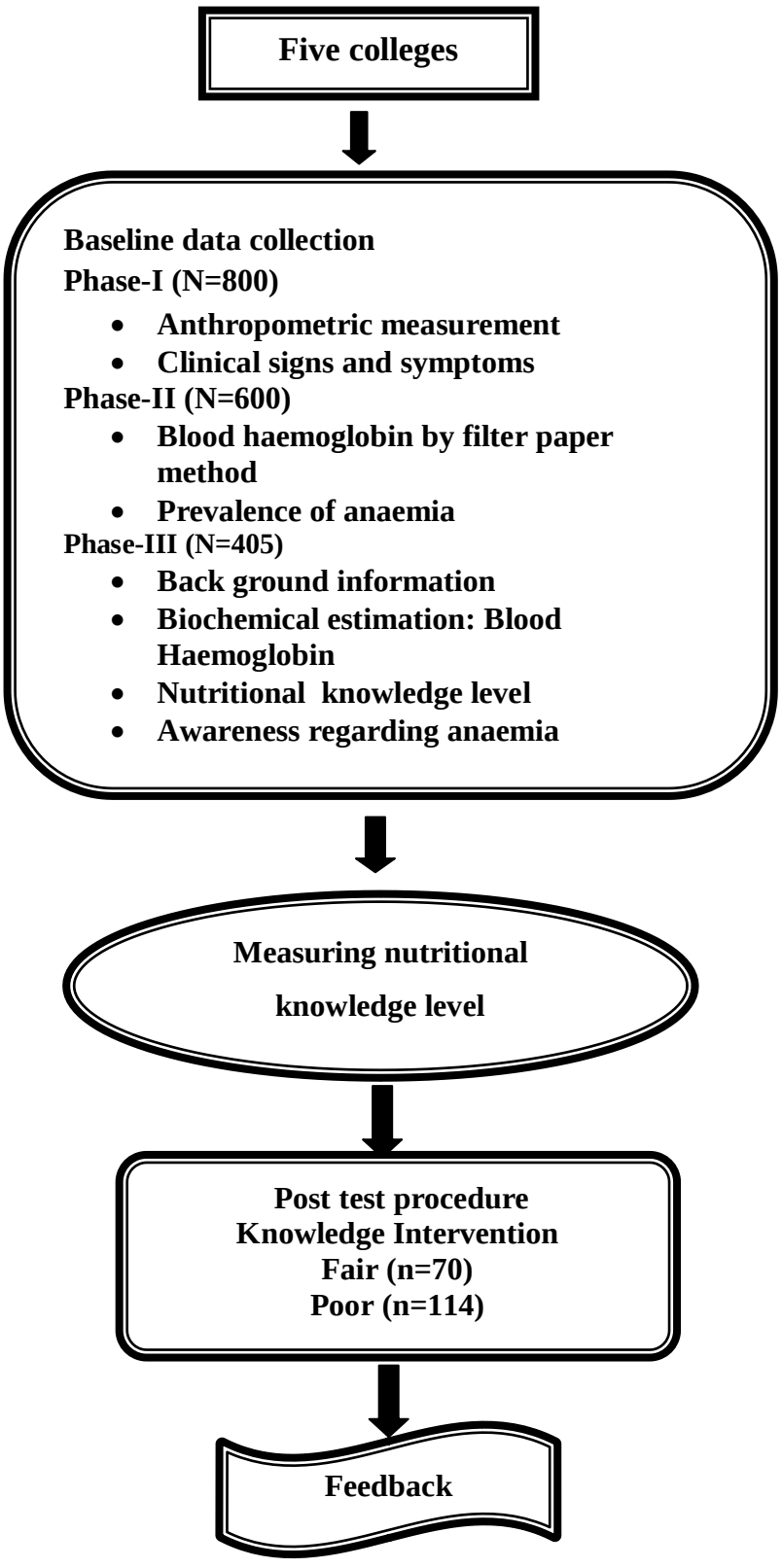
Descriptive research studies are those studies which concern with describing the characteristics of a particular individual, or of a group. In descriptive design, the subject is being observed in a completely natural and unchanged natural environment. Descriptive research is often used as a precursor to quantitative research designs, the

general overview giving some valuable pointers as to what variables are worth testing quantitatively.

Ex-post-facto is a Latin expression that literally translates to mean something that occurs after the fact. Present study have major concern with identifying important characteristics possessed by the college girls towards health which inspired them to become healthy and live in well being. Ex - post – facto research is systematic and empirical method in which scientist does not have direct control on independent variables because their manifestations have already been applied where the independent variables have already acted upon **(Kerlinger, 1976).** In the present investigation, ex-post-facto research design was therefore followed.

Experimental design refers to the framework or structure of an experiment and as such there are several experimental designs. Informal experimental designs are those designs that normally use a less sophisticated form of analysis based on differences in magnitudes. Informal experimental design include before – and – after without control design. In such a design a single test group or area is selected and the dependent variable is measured before the introduction of the treatment. The treatment is then introduced and the dependent variable is measured again after the treatment has been introduced. The effect of the treatment would be equal to the level of the phenomenon after the treatment minus the level of the phenomenon before the treatment **(Kothati, 2004).** Therefore, before – and – after without control or pre and post test design was followed in the study.

Figure: 3.2 Experimental Design



3.3.3 Variables of the study

Keeping in view the objectives of the study, the relevant variables for the study were selected on the basis of review of literature of previous related studies on the subject and consultation with experts in the field. The following different variables were studied.

Table: 3.3.3.1 Variables selected for the study

No	Variables	
3.3.3.1	**Independent variables**	
1.	Age of college girls	X_1
2	Age at menarche	X_2
3	Morbidity present	X_3
4	Types of work	X_4
5	Types of diet	X_5
6	History of heavy menstrual bleeding	X_6
7	Pica	X_7
8	Type of activities.	X_8
9	Area of residence(Urban and Rural)	X_9
10	Caste	X_{10}
11	Monthly income	X_{11}
12	Sources of information	X_{12}
13	Nutritional variable – frequency of iron and vitamin C rich food intake.	X_{13}
3.3.3.2	**Dependent variable**	
1	Body Mass Index	Y_1
2	Clinical signs and symptoms	Y_2
3	Nutritional knowledge level	Y_3
4	Awareness regarding anaemia	Y_4
5	Blood haemoglobin	Y_5

Description of each variable and its measurements:

The detail description and procedure for the measurement of the variables are given as under.

3.3.3.1 Independent variables

The personal, socio-economic, communicational and nutritional characteristics of college girls were independent variables of the study. The characteristics studied and the procedure adopted while classifying the college girls with respect to their characteristics and available data are given below.

3.3.3.1.1 Age of college girls

The age of the college girls were ascertained from the college registers and subsequently confirmed by girls. The age of college girls was recorded. According to their age. College girls were distributed and the data is presented in Table. The actual age was recorded for the analysis. No age score was given for the age of college girls.

Distribution of college girls according to their age.

Age in Years	Urban (n= 201)	Rural (n= 204)	Overall (N= 405)
18-19	91	96	187
20-21	82	72	154
22-23	28	36	64
Total	201	204	405

3.3.3.1.2 Age at menarche

The age at menarche of college girls were obtained during data collection and was also considered as actual age and it was used for the analysis. According to their age at menarche, college girls were distributed. The actual age was recorded for the analysis. No age score was given for the age at menarche of college girls. It was ranged from 12 – 16 years of age.

3.3.3.1.3 Morbidities present

Morbidities can also affect haemoglobin level, therefore, it was considered as an important independent variable for the study. The total of the morbidities present among college girls were recorded for the analysis. It was scored individually as under.

Types of morbidities	Score	Types of morbidities	Score
Fever	1	Malaria	1
Sneezing and cough	1	Viral Fever	1
Headache	1	Diarrhea	1
Typhoid	1	Worm infestation	1
Chicken guinea	1	Total	09

3.3.3.1.4 Types of work

According to types of work performed daily college girls were distributed in three categories as under.

Category	Score
Sedentary Work	3
Moderate Work	2
Heavy Work	1

3.3.3.1.5 Types of diet

According to types of diet consumed college girls were distributed in three categories as under.

Category	Score
Vegetarian	1
Ovo-Vegetarian	2
Non-Vegetarian	3

3.3.3.1.6 History of heavy menstrual bleeding

The history of heavy menstrual bleeding of college girls were recorded because prolonged heavy menstrual bleeding leads to anaemic condition and it was scored as under.

Heavy bleeding	Score
Yes	1
No	0

3.3.3.1.7 Pica

Pica was considered as an important independent variable because it is a sign of anemic condition. Total of pica was recorded and scored as under.

Types of Pica	Score
Roasted soil (Geophagia)	1
Raw ice (Pagophagia)	1
Chalk	1
Plaster chips	1
No pica	0
Total	4

3.3.3.1.8 Types of activities

The respondents were asked to state their daily activities that they performed and it was categorized as under.

Activity	Score
Animal husbandry and farm work	1
Sports	1
Cooking	1
Dusting	1
Mopping	1
Washing clothes	1

3.3.3.1.9 Area of residence (Rural – Urban)

The college girls were distributed according to the area of their living. The college girls who were living in villages were given rural area score while the college girls who were living in city area were assigned the following urban area score. According to their residence area, the college girls were categorized into the following groups.

Category	Score
Rural area	1
Urban area	2

3.3.3.1.10 Caste

Hereditary group of social class to which the college girls belonged the score was assigned to each category by conference method of the teachers. The college girls were asked to indicate their caste, which was then categorized as under.

Category	Score
General	3
OBC (Other Backward Class)	2
SC/ ST (Schedule Caste / Schedule tribes)	1

3.3.3.1.11 Family's monthly income

According to family monthly income of respondents distributed in three categorizes as mentioned below.

Income (Monthly)	Score
Below ₹ 10,000 /-	1
₹ 10,001 to 20,000 /-	2
₹20,001 to 30,000 /-	3
Above ₹ 30,001 /-	4

3.3.3.1.12 Sources of information

Source of information plays an important role in diffusion of knowledge of innovations. The college girls were asked to state sources from which they got information about health and nutrition. The college girls were distributed according to utilization of sources on the basis of frequency and it was considered as the score for each college girl. All the college girls based on their use of sources of information index were grouped into three different categories on the basis of ± mean and Standard Deviation (SD).

3.3.3.1.13 Nutritional variable

Food frequency method

Principle:

This method is used to find out the frequency of consumption of selected food items from a list of foods for a specific period. It enhances the data obtained from 24 hour dietary recall method and may also include approximate quantity of the foods eaten. The final questionnaire contained 90 food items rich in iron and vitamin C.

Procedure:

The diet history method was used for obtaining qualitative details of diet and pattern of food consumption of college girls at household level. The dietary habits score was measured using a food frequency questionnaire consisting common foods representing the seven food groups (cereals and its products, pulses and dhal,

vegetables, fruits, meat and fish, dry fruits, sugar and jaggery, milk and milk products). The score was measured using each item scale with a seven point scale ranging from "never"(0)," occasionally"(1), "monthly"(2), "half monthly"(3), "weekly"(4)," alternately" (5),"daily" (6).The college girls were asked to recollect usual frequency of consumption of various food items daily, alternately, weekly, , once in a fifteen days, monthly, occasionally and never eaten.

3.3.3.2 Dependent variables

3.3.3.2.1 Body Mass Index

It was calculated on the basis of data of weight and height measurements and calculated by BMI= weight(kg)/ht(m)^2 and the results were noted as same for mean measurements and score was given for coding are as under.

Category	Score
Normal weight	3
Obese category	2
Under weight	1

3.3.3.2.2 Clinical signs and symptoms

It is one of the most practical and important method used in assessing the nutritional status of community. External examination of the body for changes in superficial epithelial tissues especially skin, eyes, hair etc. was carried out. Clinical assessment can give very valuable but approximate information to the public health workers. It is an effective tool where severe malnutrition prevails. In present study, the clinical signs and symptoms were scored as the presence of total numbers of clinical signs and symptoms among college girls and used for coding.The details of the above clinical signs and symptoms can be reffered in the questionnaire in the appendix- I.

3.3.3.2.3 Nutritional knowledge

Nutritional knowledge was scored as the total numbers of true answers given by college girls and total score of nutritional knowledge was used for coding.The details of the same can be reffered in the questionnaire in appendix-I.

3.3.3.2.4 Awareness regarding anaemia

Awareness regarding anaemia was scored as the total numbers of true answers given by college girls and total score of awareness regarding anaemia was used for coding. The details of the same can be reffered in the questionnaire in appendix-I.

3.3.3.2.5 Haemoglobin level

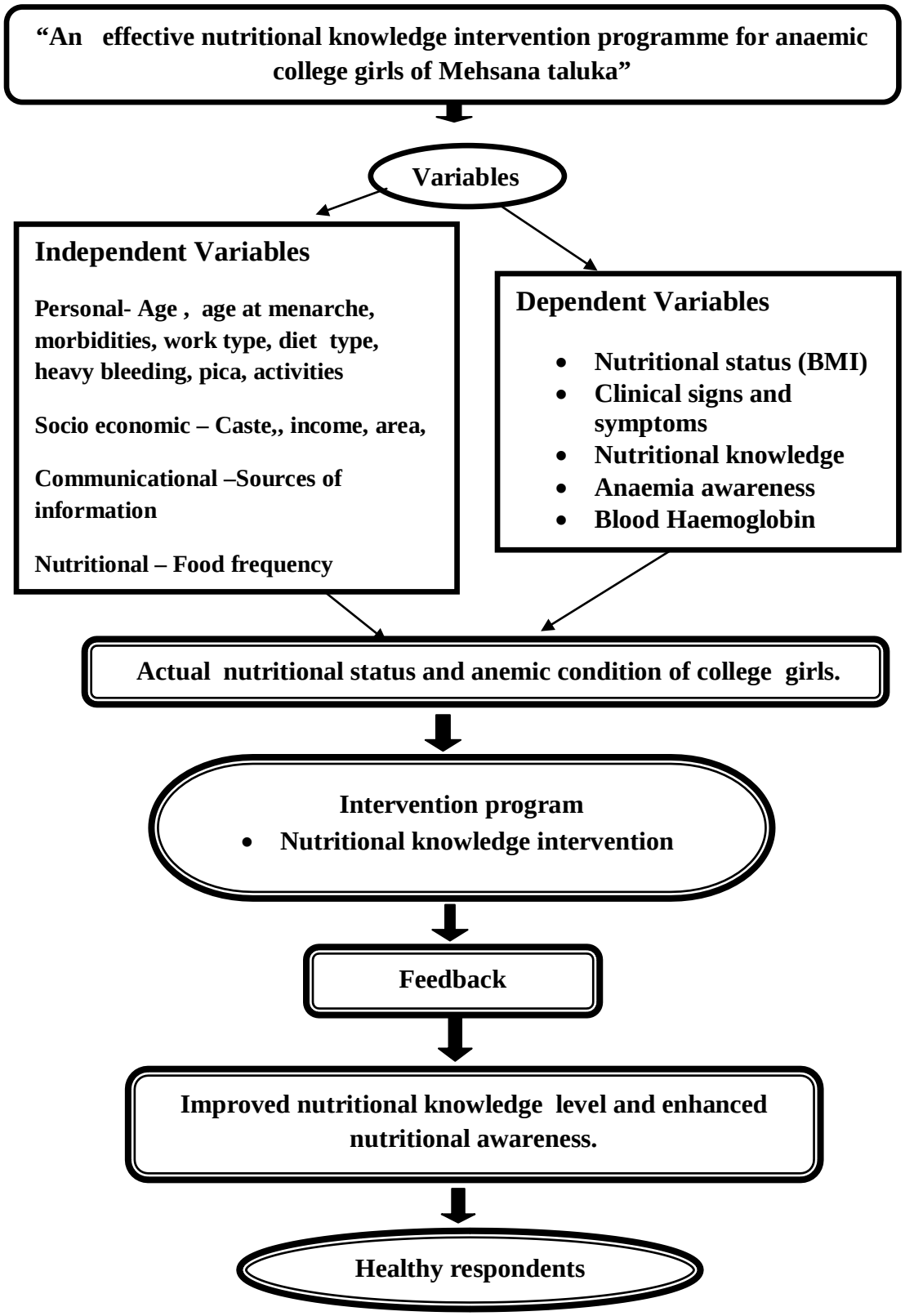
Haemoglobin was measured by cyanamethaemoglobin method. The results of haemoglobin level was used for mean calculation and score was given for coding are as under.

Category	Score
Normal	4
Mild anaemia	3
Moderate anaemia	2
Severe anaemia	1

3.3.4 Conceptual framework

Figure 3.3 show the clear concept of the investigation. The study was based on the variables, which were decided as per the objectives of the study. The dependent variables were nutritional status, clinical signs and symptoms, nutritional knowledge level, awareness regarding anaemia and blood haemoglobin level of college girls. The college girls of Mehsana city and taluka were selected for the study. The figure shows the frame work of the investigation to provide clear picture of the study. The study was divided into two parts such as pre test and post test**.** Pre testing was applied on decided universe and post test was applied on only those college girls that depicted abnormal haemoglobin level or need based intervention was conducted. The feedback (post test) was carried out to find the results of enhancement of the intervention program among the selected college girls.

Figure: 3.3 Conceptual frame work



3.3.5 Operational definition

The definition, which were used frequently in the entire study and used as key words for the study, is defined below:

3.3.5.1 Nutritional status: It is the condition of health of different phases of an individual as influenced by the utilization of the nutrients. The tissue of the body are acquired from an exchanged with the environment. Nutritional status is an index of state of this exchange and accretion. The measurements of nutritional status may represent an early indication of changing or unsatisfactory health condition. It can be determined by correlation of information obtained through medical and dietary history, through physical and laboratory examination. In this investigation, the college girls were assessed by nutritional anthropometry method, clinical examination and biochemical method. It is concerned with the measurements of the variations of physical dimensions and body composition at different stages of life cycle and nutrition.

Assessment of nutritional status by anthropometry: It refers to the technique that is concerned with the measurement of the physical dimensions and the gross composition of human body at different age levels and degrees of nutrition.

3.3.5.2 Prevalence of anaemia: It refers to total number of people who suffers from different types of anaemia from the total population of area by percentage.

3.3.5.3 Knowledge intervention: It refers to provision of complete details of food and disease associated and the informative and educational material which aids to overcome the disease. It may be in the form of lectures, demonstration, power point presentation and in other forms through which the selected college girls would be more aware and conscious about their diet, disease and health.

3.3.6 Selection, Description and Development of the instrument.

3.3.6.1 Development of instrument

A thorough review of literature helped to develop interview schedule so as to achieve the objective of the study. The details with various scales were selected carefully so that enough contains are covered. The interview schedule was constructed in such a way that it could be understood easily by college girls of Mehsana city and taluka that would enable them to answer the questions frankly and quickly. The schedule was prepared in English and Gujarati. To ensure the quality of the findings and conclusions, the number of factors that resulted the position in the study were taken into consideration in the research. These included measures of ensuring the

validity, reliability and objectivity of the research findings. The section describes how the researcher addressed these issues.

3.3.6.2 Selection of the instrument

Interview schedule was considered as an appropriate tool to collect data. An interview method for collecting data involves presentation of oral-verbal stimuli and reply in terms of oral-verbal responses. This method is suited for the intensive researches. More information and that to in greater depth can be obtained through this method. Observation can also be made with verbal information. One of the most important reasons to use interview as a tool for study was that the respondents were asked to recall their past experiences and apply it in the present situation, where in interview could help them through certain probe questions.

3.3.6.3 Description of the instrument

According to the objectives of the study, the interview schedule was designed and divided into different sections covering the following areas:

Background information of the respondents: This section had a set of questions to elicit the real backgrounds of respondents which include their age, age at menarche, place of residence, morbidities present, types of work, types of diet, history of heavy menstrual bleeding, pica, activities, caste, area, monthly family income, etc.

Information regarding clinical signs and symptoms: This section deals with set of questions related to the clinical signs and symptoms of hair, face, eyes, lips, tongue, teeth, gums, skin and nails.

Reproductive information : This section deals with set of questions related to the menstrual cycle information, pica and physical problems that occurs during menstrual cycle.

Anthropometric measurement and biochemical parameters: This section deals with actual anthropometric measurements including weight, height and body mass index of college girls. Biochemical parameters include blood haemoglobin estimation of 405 college girls.

Dietary pattern or food frequency of iron and vitamin C rich foods: This section includes food frequency of iron and vitamin C rich foods and stated as daily, alternately, weekly, 15^{th} day interval, monthly, occasionally and never consumed for particular food of all essential food groups i.e. eight food groups of Indian diet.

Nutritional knowledge level: This section includes a set of questions related to basic nutritional requirements of different nutrients, sources of nutrients, disease caused by deficiency of a particular nutrient. In this section total 30 questions were included.

Awareness regarding anaemia: This section includes a set of questions related to anaemia awareness, causes of anaemia prevalence and symptoms of anaemia. In this section total 24 questions were included.

Diet recall: This section includes a set of questions related daily food intake of college girls or their actual food intake during last 24 hours.

3.3.6.4 Validity

The researcher developed the scale to know level of awareness regarding anaemia and nutritional knowledge level among college girls. The validity and reliability was established. To established validity a panel of judges from the faculty of Home Science, faculty of Education and faculty of Social Sciences were selected. They were asked to check the positive and negative direction, (where applicable) clarity and relevance of the content for each statement of the scale.

3.4 Sample, Sampling procedure and Sample size

3.4.1 Selection of sample

The sample was selected on the bases of predefined variables on the study using purposive random sampling technique from the taluka of Mehsana from urban and rural area. The total sample size was 405.

3.4.2 Locale of the study

This investigation was carried out in Mehsana district of Gujarat state. The district of Mehsana is located in the Northern side of Gujarat and is surrounded by Patan, Banaskantha, Sabarkantha and Gandhinagar districts. Moreover the researcher belongs to Mehsana and is familiar with people, officials, organizations and language, which helped in collecting reliable and valid data (Figure: 3.6).

3.4.3 Sampling procedure

For this study, the multi-stage random sampling and purposive random sampling technique was used for the selection of the colleges and respondents. Total five colleges were selected from Mehsana taluka.

3.4.3.1 Selection of district, taluka and city.

The Mehsana district from the North Gujarat was selected for the study. The two different situation viz, urban and rural area were selected from the district. The Mehsana city which is the head quarter of the district was selected as urban area, whereas villages of Mehsana taluka was selected rural area of this district.

3.4.3.2 Selection of colleges

For the selection of the colleges, a list of colleges was prepared. It is situated in Mehsana city and in Mehsana taluka. Total five colleges were selected which are as under.

Table: 3.4.3.2 College wise distribution of the respondents selected and interviewed.

Sr. No	Name of the College	Number (N)
1	Smt.A.S.Chaudhary Mahila Arts and Home Science College , Mehsana 1. Arts 2. Home Science	120
2	Muni.Arts and U.B.Science college , Nagalpur, Mehsana. 1. Arts 2. Home Science 3.Science	112
3	Merchant college of Engineering and Computer science, Basana, Mehsana.	69
4	Shri A.J. Savla Homeopathic College, Mehsana.	52
5	Swami Vivekananda Education college, Mehsana	52
Total		405

These colleges are located in Mehsana city and it was obtained from the office of the Hemchandracharya North Gujarat University, Patan. Using this list, the five colleges were selected, and college girls who belonged to rural area were selected as rural situation from the Mehsana taluka and college girls who belonged to urban area were selected as a urban situation from Mehsana city. Thus, there were total five colleges which were selected for the study.

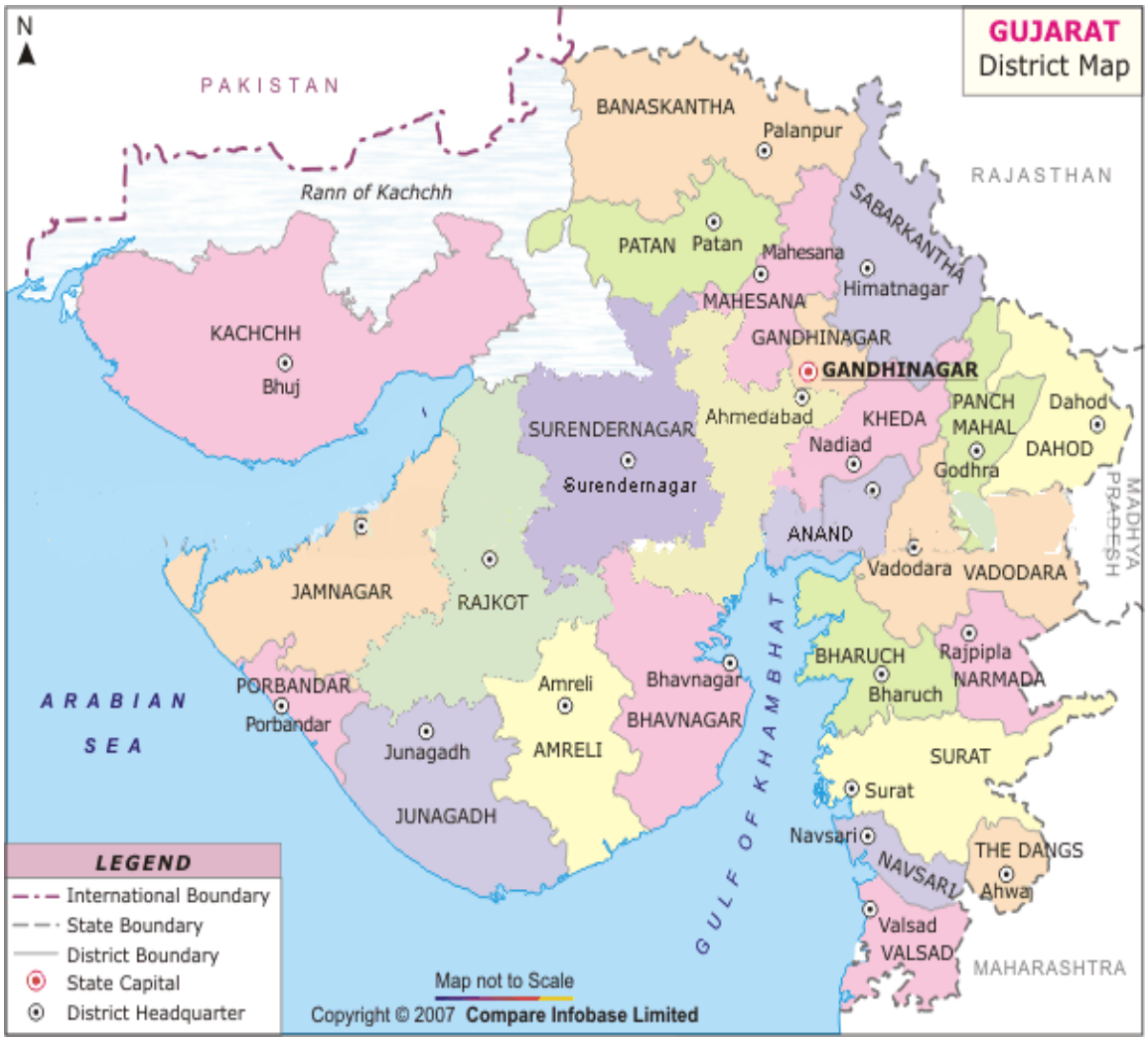


Figure: 3.4 Map of Gujarat

3.4.3.3 Selection of respondents

At the final stage, the purposive random sampling method was applied for the selection of respondents (college girls). A list of students of graduation and post graduation was prepared for each selected college in consultation with respective principals and class teachers. From these lists, total 405 students from five colleges were randomly selected making 201 students from urban and 204 students from rural area. Thus, finally 405 respondents (college girls) were selected from the localities of Mehsana city and Mehesana taluka of Mehsana district.

Purposive Sampling:

Purposive selection is confined to sampling the units which have the values of the known quantitative character, near the average. If the average value of any character such as size, is known for the whole population and also the size of the individual sampling units are known, it is possible to select a sample in such a

way that the average size of the selected units is equal to average size of the population. This method of sampling is known as purposive sampling. **(Chandel, 2004).**

3.3.4 Sample Size

Table No: 3.4.4.1 Classification of size of samples

Variables	Classification of size of samples			
Age of college girls (years)	18-19 Years n=187	20-21 years n=154	22-23 years n=64	
Area of residence	Urban n = 201	Rural n = 204		
Age at menarche (years)	10- 12 n= 119	13-15 n= 240	16-17 n =40	
Family monthly income	Below ₹ 10000/- n=151	₹10001/- to 20000/- n = 153	₹ 20001 to 30000 n=71	Above ₹ 30001/- n=30
Educational faculty	Arts n= 107	Science n= 52	Home Science n= 73	Homeopathy n= 52	B. Ed. and Computer science 52 & 69 N=121
Caste of college girls	General n=155	OBC n=158	SC/ST n=98	

3.4.5 Unit of enquiry

College girls of Mehsana city and taluka were selected as a unit of enquiry.

3.4.6 Tools of study

The well-structured interview schedule was prepared in light of the study and used as a tool for collection of data. The instrument used in the study was the interview schedule, which was considered to be the most appropriate to get the correct response and information from the college girls. Keeping in view the objectives of the study, the interview schedule in English was prepared.

At the initial stage, the schedule was prepared and circulated among all professors and experts of the field for their opinions and clarification of the statements. On the basis of their opinions and suggestions, the interview schedule was revised. Finally it was translated in to the Gujarati language in order to get correct responses and information from the respondents. Questions and statements on each and every aspect of the study were framed in order to study with maximum possible accuracy, clarity and objectivity. The English and Gujarati version of the final schedule which was used for the study has been given in appendix I and II.

3.4.7 Pre-testing of the schedule

Pre-testing of the interview schedule was carried out to know whether the questions were clearly understood to the respondents before finalizing. The interview schedule was pre-tested with 20 college girls who were not selected in present study. On the basis of the experience gained, suitable words in the questionnaire and statements were corrected, modified and restructured in the final format of the interview schedule. The revised interview schedule was used for final data collection.

3.4.8 Development of intervention program

One of the objective of the present study was to give need based intervention program to enhance the level of awareness regarding nutrition and anaemia among the college girls. Hence, on the basis of pilot study and pre test, weaker aspects of awareness regarding nutrition and anaemia were identified amongst the college girls.Intervention program was conducted as a dietary knowledge intervention. Dietary knowledge intervention was carried out with lectures given by experts, power point presentation and recipe demonstration.

Lectures , power point presentation and recipe demonstration

The lectures were organized for the provision of a good nutritional knowledge and to clear the myths related to anemic condition and nutritional status. It included all the details of causes, prevalence and prevention of anaemia. The complete details of the lectures that were given are presented in Appendix.

The power point presentation also included the details about definition of anaemia, red cell morphology of anaemia, normal levels and structure of haemoglobin, classification of anaemia, iron absorption, iron rich foods, symptoms of anaemia, management of anaemia, treatment, oral iron therapy and dietary guidance for anaemia.

Recipe demonstration was conducted for creating awareness regarding iron rich foods which included low cost ingredients. Recipes that were demonstrated are as follow.

1. Mix Sukhadi

Ingredients

Roasted ground nut powder - 50 g

Scrapped coconut (Dry) - 50 g

Garden cress seed powder - 50 g

Ghee - 50 g

Jaggery - 150 g

Method of preparation

Mix well, roasted ground nut powder and dry scrapped coconut, take ghee in a pan and allow to heat, add jaggery to it and let it melt properly,add premixed powder of roasted ground nut powder, dry scrapped coconut and Garden Cress seed powder in a pan. Mix well, spread in a dish allow to cool it and, cut it in to a pieces and serve it.

Plate: 3. 1 Garden cress seed (Leptidium sativus Linn)

Plate: 3.2 Garden cress seed powder

2. Niger seed chikki

Ingredients

Niger seed or Black sesame seeds - 100 g

Jaggery - 80 g

Ghee - 30g - 40 g

Method of preparation

Select good quality of niger seed and clean it properly, roast the niger seeds in a pan, take ghee in a pan and allow to heat.Add jaggery to it and let it melt properly, add niger seed into the ghee and jaggery mixture, mix well. Spread in a dish and allow to cool it and cut it in to a pieces and serve it.

3. Cow peas dhokali

Ingredients

Cow peas - 50 g

Wheat flour - 50 g

Curd - 25 g

Tomatoes - 25 g

Corriander leaves - 10 g

Onion - 25 g

Garlic, green chillies and ginger paste - 1 tsp.

Turmeric powder - As required

Salt and red chilly powder - to taste

Oil, Omum seeds, Asoafoetida - for seasoning

Method of preparation

Take clean cow peas and soak it in warm water for 5-6 hours, pressure cook the cow peas.Take wheat flour in a vessel, add oil and salt to taste, prepare a dough by adding sufficient amount of water, keep it for 10-15 minutes.Make rotis from the dough and cut in to a small square pieces. Now in a pan take oil for seasoning, add omum seeds, asofoetida, paste of chillies, garlic and ginger. Saute it. Add previously prepared square pieces of dough and curd. Cook until it prepared completely and serve.

4.Date laddoos

Ingredients

Dates – 100g

Coconut powder – 100 g

Sugar -50 g

Ghee- 50 g

Method of preparation

Take clean and deseeded dates and make a paste, in a pan take ghee, allow it to heat, add paste of dates and coconut powder, mix it well ,add sugar to it, mix well again. Let it cool and make laddoos of the mixture and roll it in a coconut powder. Serve it.

Other iron rich recipes like dates halwa, tandalja muthiya, tandulja dhokla, mix sprouted pulses chat and iron rich foods were suggested to college girls.

3.4.9 Post test of samples

Post test of college girls were carried out by anthropometric measurements and observation of clinical signs and symptoms.

3.5 Data collection, Analysis, Measurements and Interpretation

3.5.1 Data Collection (Pre test)

Looking to the extensive nature of the interview, it was considered essential to send a preliminary notification to the interviewees requesting their participation in survey **(Robson,1993)**.The notification outlined the nature of interview, the anticipated duration and requested the participation of one and all who were

respondents. The notification was made prior to the beginning of pre-test. The interview lasted between 15 to 20 minutes.

3.5.1.1 Assessment of nutritional status by anthropometry

Anthropometry is the measurement of the dimensions of human body. It is a quantitative method and is highly sensitive to nutritional status. Physical measurement such as height and weight reflect the total nutritional status over a life time. Anthropometric measurements, such as height and weight of the subjects were recorded according to procedure suggested by **Jelliffe (1966),** by using standardized scientific tools and procedures and then were compared with the cut-off values suggested by **WHO/NCSH (2000).**

Anthropometric measurements

Nutritional anthropometry is concerned with measurement variable of the physical body at different age levels and degrees of nutrition. The most usual measurements are those made to assess (a) body mass, as judged by weight (b) linear dimension, especially height and body mass index, measurements should be made and recorded in metric system.

Weight measurement

Weight is the anthropometric measurement most in use. Its potential value is appreciated not only by health personal but often by less educated people for whom it is useful as a source of health education. For weight measurement of selected college girls, standard digital platform scale was used. For adults, the platform scale is most usually employed. So in the present study digital platform scale was used for weight measurements. The respondents were asked to stand on the centre of the platform without touching anything else, shoes or chappals were removed and the minimum clothing worn. After body weight measurement immediately it was recorded for the interpretation. The data was compared with standard references of same age group.

Height measurement

The height of an individual is made of the sum of four components, legs, pelvis, spine and skull. While for detailed studies of body proportions, all of these measurements are required. In field nutritional anthropometry usually only the total height is measured. So in the present investigation, total height was measured for every selected college girls, the height of college girls measured in a standing posture without shoes and 4 parts of their body were touched to the wall. The measured data were recorded and compared with standard references.

Body Mass Index (BMI)

Body Mass Index (BMI) is a calculation based on height and weight that correlates with the amount of body fat. Body Mass Index (BMI) is used to estimate your best weight range for your health. It is calculated by finding weight in kilograms by height in meter squared $(mt)^2$. The body mass index is a useful tool in both clinical and public health practice for assessing the nutritional status. The body mass index (BMI) of respondents were calculated using following formula.

BMI = weight (Kg) / Height $(mt)^2$

Nutritional knowledge and awareness regarding anaemia

One of the dependent variables in the study was to examine the knowledge level of the college girls in respect to nutritional knowledge was operationalized as the amount of information and understanding of the college girls about nutritional requirement and other information.

For developing knowledge test, a number of knowledge statements about health and nutrition were collected from relevant literature and discussed with staff members of the Home Science college Mehsana and other experts of the respective field. These judges were asked to respond to each statement in terms of marking yes/no or true/false or marking the appropriate one alternative against each item. Scoring was done by giving equal weightage to each statement. The college girls were asked to state their awareness about information included in the knowledge test. Thus the answers of the respondents to each item were marked correct or incorrect. A score of one was given to correct answer and zero to an incorrect answer. The possible total score of respondent was in the range between 0-30 for nutritional knowledge and 0-26 for awareness regarding anaemia. In general, total knowledge score of each respondent was converted in to knowledge index by the formula as given below.

$$K_i = \frac{X_1 + X_2 + \text{----------} + X_n \times 100}{N}$$

Where,

K_i = Knowledge Index

$X_1 + X_2 +$ ---------- $+ X_n$ = Total number of correct answers

n = Total number of questions in the test.

All the respondents based on their knowledge index were grouped into three different categories of knowledge level as under.

Category	Score Limit
Poor level of knowledge	Below X – S.D.
Fair level of knowledge	Between X ± S. D.
Good level of knowledge	Above X + S.D.

Assessment of nutritional status by biochemical estimation (Detection of anaemia)

Anaemia occurs when the total volume of red blood cells (and/or the amount of haemoglobin in these cells) is reduced below normal values, as defined by healthy populations. Anaemia results from one or more of the following processes: defective red cell production, increased red cell destruction, or blood loss. There are often multiple causes of anaemia. Although iron deficiency is the most common cause of anaemia.The World Health Organization, over different periods of time has set different standards for the definition of anaemia. Based on research, it was recommended by WHO in 1998, that anaemia is said to exist if the haemoglobin went below the levels shown in the table below.

Haemoglobin level (WHO – reference for adult person)

Level (g/dl)	Condition
12g /dl – 14 g/dl	Normal
10 g/dl – 11.9 g/dl	Mild anaemia
7 g/dl - 9.9 g/dl	Moderate anaemia
< 7 g/dl	Severe anaemia

Methods of haemoglobin estimation

The most feasible quantitative measurement for iron deficiency anaemia is estimation of haemoglbin levels. There are several laboratory techniques for measuring haemoglobin concentrations. The most widely used quantitative estimation of haemoglobin is cyanmethemoglobin method. The gold standard for assessing haemoglobin concentration is direct cyanmethemoglobin method. In present investigation, same method was applied for the haemoglobin estimation.

Principle (Blood haemoglobin estimation):

Blood is mixed with Drabkin's solution, a dilute solution of potassium ferricyanide and potassium cyanide at a slightly, alkaline pH. The ferricyanide

converts haemoglobin to methamoglobin. The cyanide then reacts with the methahaemoglobin to form the stable cyanamethemoglobin. The colour intensity is measured colorimetrically at a wave length of 540 nm. The optical density is proportional to the concentration of haemoglobin.

Procedure:

The blood samples were collected by laboratory technician in a heparinised tube.

- Right hand near elbow was first wiped with spirit swab and wiped with clean filter paper, in order to avoid haemolysis with alcohol.
- A sterile syringe was injected to the disinfected vein.
- Draw the blood sample slowly into a pipette designed to contain 0.02 ml and collected in to EDTA vacutainer.
- Place the pipette into a tube containing 5.0 ml of Drabkin reagent so that the tip of the pipette is below the surface of the solution. Slowly expel blood from the pipette and then rinse the pipette several times with the reagent from top of the tube.
- Cap the tube and mix 5- 6 times by inversion.
- Allow the diluted haemoglobin solution to stand for at least 5 minutes to achieve full colour development.
- Measure the absorbance of the unknown sample and that of a standard of known haemoglobin content at 540 nm.

Three advantages of cyanamethemoglobin method are:

- Measure all the forms of haemoglobin except sulfohaemoglobin.
- It can be easily standardised.
- Cyanamethemoglobin reagent is very stable.

Plate:3.3 Blood collection

3.5.2 & 3.5.3 Coding and Tabulation

All the data was coded to maintain confidentiality and facilitate data entry, documentation and discussion of findings. Code numbers were given to each questionnaire. The information from each interview schedule was transferred on excel sheet of computer. The data was transferred from excel sheet into tabular form to give a clear picture of findings.

3.5.4 Data analysis and interpretation

The data was transferred in to the master table and frequencies were marked whenever necessary. The number and percentage were given to the various frequency items. The data were tabulated, statistically analyzed and presented in such way that it would give the proper results to the specific objectives of the study. The data was processed on manual and electronic computer. The following statistical tools were used for interpreting the data **(Kothari,2004, Parekh& Dixit,1995).**

3.5.4.1 Statistical analysis

The data collected through interview schedule were analyzed and interpreted in order to draw meaningful light of objectives of the study. The following statistical methods were used for analysis of the data.

3.5.4.1.1 Frequency and percentage

Simple comparison was made on the basis of frequency and percentage.

3.5.4.1.2 Arithmetic mean:

The arithmetic mean was calculated by using following formula.

$$\overline{X} = \frac{\Sigma X_i}{N}$$

Where,

$\overline{X}$ = Arithmetic mean

ΣX_i = Sum of individual score

N = Total number of respondents

3.5.4.1.3 Standard Deviation (S.D.)

These techniques were used for classification of the respondents in to different categories. The standard deviation was worked out using the following formula.

$$S.D. = \sqrt{\frac{\sum_{i=1}^{n} (X_i - \overline{X})^2}{n-1}}$$

Where,

X_i = Individual score

$\overline{X}$ = Mean score

n = Total number of respondents

3.5.4.1.4 Pearson's coefficient of correlation

This technique was used to find simple correlation to explore the association between two variables with the help of following formula.

$$r = \frac{SP\,(xy)}{\sqrt{SS\,(x)\,SS\,(y)}}$$

Where,

R	=	Correlation coefficient
X	=	Independent variable
Y	=	Dependent variable
SP (xy)	=	Sum of product of deviation of X and Y from their mean
SS (x)	=	Sum of square due to X variable
SS (y)	=	Sum of square due to Y variable

For testing the significance of 'r,' the 't' test was used. The formula for 't' test was as under :

$$t = \frac{r}{\sqrt{\frac{1 - r^2}{n - 2}}}$$

Where,

R	=	Correlation coefficient
N	=	Total number of observation

3.5.4.1.5 Multiple regression

This analysis was done to know the combined effect of all the independent variables in explaining the variation in the dependent variable. The prediction equation used was

$$\hat{Y} = a + \sum_{i=1}^{k} b_i x_i$$

Where,

$\hat{Y}$	:	Predicted dependent variable
A	:	Intercept or constant
b_i	:	Regression coefficient between i^{th} independent variable with dependent variable where i = 1,2,.....k
$x_i = x_1, x_2 ..... x_k$	:	Total number of independent variables included in the model.

3.5.5 Hypothesis testing

Hypothesis is usually considered as the principal instrument in research. Its main function is to suggest new experiments and observations. Quite often a research hypothesis is a predictive statement, capable of being tested by scientific methods, that relates an independent variable to some dependent variable. Hypothesis testing helps to decide on the basis of a sample data, weather a hypothesis about the population is likely to be true or false. It is carried out by parametric and non parametric testing **(Kothari, 2011, Parekh & Dixit-1995).** In present investigation parametric test like t- test and F-test was applied with following hypothesis.

Ho_1: There will be no significant difference between area of residence of college girls on haemoglobin level and nutritional knowledge level.

$Ho_{2:}$ There will be no significant influence of age at menarche on haemoglobin level.

Ho3: There will be no significant influence of income on haemoglobin level and nutritional knowledge.

Ho4: There will be no significant impact of intervention on knowledge intervention program on knowledge level.

Limitation of the study

- The limitation of the study was that only 405 college girls of Mehsana city and taluka were studied.
- Nutritional knowledge and awareness regarding anaemia was limited.
- The intervention program was conducted with only limited sample size.

This chapter provided the methods, materials and techniques applied for this study. It included detailed explanations of the research procedure followed. The methods used for data collection, how and why particular data was collected and the methods of analysis used have been presented. Issues of validity and reliability have been addressed. Interpretation and hypothesis testing have been presented and also the limitation of research has been discussed. The researcher of the project proceeds to describe and analyze the findings of the study. This is followed by discussion and conclusion.

RESULTS AND DISCUSSION

The present investigation was planned for study of an effective nutritional knowledge intervention programme for anaemic college girls of Mehsana taluka of Mehsana district, in the Northern part of Gujarat state. Keeping in view the objectives of the study, the data was subjected to the appropriate statistical tests and are presented in the classified and categorized forms, tables and diagrams. The results of the various aspects are presented under the following heads.

4.1 Personal, socio-economic and communicational characteristics of the selected college girls.

4.2 Nutritional status of college girls.

4.3 Nutritional knowledge and awareness regarding anaemia among college girls.

4.4 Dietary pattern of college girls.

4.5 Effect of knowledge intervention on nutritional knowledge level.

4.6 Relationship between personal, socio-economic and communicational characteristics of college girls and their nutritional status.

4.7 Testing of hypothesis.

The main objective of the present investigation was to assess the nutritional status, anaemia prevalence and nutritional knowledge level among college girls in urban and rural area. Malnutrition, poor nutritional knowledge and anaemia prevalence are one of the most common causes of morbidity and anaemic condition. The effects of nutrition on growth, physical development, social and cognitive development can endanger from childhood to adolescence. Therefore, the assessment of nutritional status, anaemia prevalence, assessment of nutritional knowledge level was carried out and the results are presented and discussed as under.

4.1 Personal, socio- economic and communicational characteristics

The nutritional status including anaemic condition of college girls was influenced by various personal, social, economical factors, which affect their life. Therefore, in the present investigation, relevant variables were selected for the study on the basis of previous related studies on the subject and consultation with experts in the field. These characteristics were studied and categorized under following five sub groups. The findings related to these characteristics are presented hereafter.

4.1 Personal socio economic and communicational characteristics

4.1.1 Age

Physical and psychological development of an individual is related to his or her age. Age influences behavior of an individual by exposing to varied situations for a number of times. Therefore, the age of the college girls were considered as an essential aspect in the study. The age of the college girls were ascertained from the college registers and subsequently confirmed by girls. The age of college girls was recorded and grouped in completed years. According to their age, the college girls were categorized into various groups and the data are presented in Table 4.1.1.

Data depicted in Table 4.1.1 shows that the age of college girls were found between ranges of 18 to 23 years. Among the college girls, 22.47 % of urban girls were of 18 to 19 years of age, 20.25 % were of 20-21 years of age, 6.91 % of urban girls were 22-23 years of age, respectively whereas 23.70 % of rural girls were of 18-19 years of age, 17.78 % of rural girls were of 20-21 years of age and 8.89 % were of 22-23 years of age respectively.

Table: 4.1.1 Distribution of college girls according to age.

Age (years)	Urban (n=201) F (%)	Rural (n=204) F (%)	Overall (N= 405) F (%)
18-19	91 (22.47)	96 (23.70)	187 (46.17)
20-21	82 (20.25)	72 (17.78)	154 (38.03)
22-23	28 (6.91)	36 (8.89)	64 (15.80)
TOTAL	201 (49.63)	204 (50.37)	405 (100)

Note: Percentage of urban and rural girls were calculated from overall sample size of 405 (201= 49.63 % and 204= 50.37 %).

Thus, it can be concluded that the college girls from both the categories were of age ranged from 18 to 23 years. Overall, 46.17 %, 38.03% and 15.80 % of college girls were found at the age of 18-19, 20-21 and 22-23 years of age respectively.

4.1.2 Age at menarche

Table: 4.1.2 Distribution of college girls according to age at menarche.

Age at menarche (years)	Urban (n=201) F (%)	Rural (n=204) F (%)	Overall (N= 405) F (%)
12-13	67 (16.54)	52 (12.84)	119 (29.38)
14-15	114 (28.15)	132 (32.59)	246 (60.74)
16	20 (4.94)	20 (4.94)	40 (9.88)
Total	201 (49.63)	204 (50.37)	405 (100)

The most dramatic sign of a girl's sexual maturity is menarche, the first menstruation or monthly shedding of tissue from the lining of the womb. Menarche occurs fairly late in the sequence of female development. **(Bullen *et al*. 1985 and Shengold M. 1978)**. Age at menarche also affect blood haemoglobin level of college girls. Therefore, the age at menarche of the college girls were considered as an essential aspect in the present study. The data related to age at menarche is depicted in Table 4.1.2. Among the college girls, about 16.54 % of urban girls were of 12-13 years of age at menarche, 28.15 % were of about 14-15 years of age at menarche, 4.94 % of urban girls were about 16 years of age at menarche, whereas 12.84 % of rural girls whose age at menarche was 12-13 years, 32.59 % were of about 14-15 years of age at menarche, 4.94 % of urban girls were about 16 years of age at menarche. The mean age of menarche is 14 years. Overall, 28.39 %, 60.74% and 9.88 % of college girls were of 12-13, 14-15 and 16 years of menarche respectively.

4.1.3 Types of diet

Types of diet affects overall food and nutrient intake of an individual. If the diet is full of all the essential nutrients, it leads to a good health of an individual. Therefore, the type of diet of college girls was considered as an important character in the study. The college girls were classified into three groups based on types of diet which they consumed. The information collected regarding the types of diet is categorized and presented in Table 4.1.3.

Table: 4.1.3 Distribution of college girls according to types of diet.

Types of diet	Urban (n=201) F (%)	Rural (n=204) F (%)	Overall (N= 405) F (%)
Vegetarian	201 (49.63)	204 (50.37)	405 (100)
Ovo – vegetarian	-	-	-
Non vegetarian	-	-	-
Total	201 (49.63)	204 (50.37)	405 (100)

Data presented in the Table indicates that all the college girls were consuming only vegetarian diet. 49.63 % of urban and 50.37% of rural girls were consuming only vegetarian diet, which may be one contributing factor of anaemic condition. Usually only vegetarian diets lack in complete protein and heam iron which is easily absorbed by body and iron from animal food sources have good bio availability of iron in the body which helps to prevents deficiency diseases like anaemia.

4.1.4 Types of work

Table: 4.1.4 Distribution of college girls according to types of work.

Types of Work	Urban (n=201) F (%)	Rural (n=204) F (%)	Overall (N= 405) F (%)
Sedentary	46 (11.36)	37 (9.14)	83 (20.49)
Moderate	142 (35.06)	151 (37.28)	293 (72.35)
Heavy	13 (3.21)	16 (3.95)	29 (7.16)
Total	201 (49.63)	204 (50.37)	405 (100)

Types of work also affect overall food and nutrient requirements and also affects basal metabolic rate of an individual. Therefore, type of work of college girls was considered as an important factor in the study. The college girls were classified into three groups based on types of work which they performed daily. The information collected regarding the types of work is categorized and presented in Table 4.1.4.

Data presented in the Table indicates that few of college girl's i.e.11.36 % of urban girls was performing sedentary work, 9.14 % of rural girls were performing sedentary work, 35.06 % and 37.28 % of urban and rural girls were moderate workers and 3.21 % and 3.95 % were heavy workers. Overall, 20.49 % of girls performed

sedentary work, 72.35 % of girls performed moderate work and 7.21 % girls performed heavy work. Thus, it can be concluded that majority of college girls performed moderate type of work.

4.1.5 Heavy menstrual bleeding

Table: 4.1.5 Distribution of college girls according to history of heavy menstrual Bleeding.

Heavy menstrual bleeding	Urban (n=201) F (%)	Rural (n=204) F (%)	Overall (N= 405) F (%)
Yes	24 (5.93)	27 (6.67)	51 (12.60)
No	177 (43.70)	177 (43.70)	354 (87.40)
Total	201 (49.63)	204 (50.37)	405 (100)

In the present investigation, 5.93 % of urban girls had heavy menstrual bleeding, whereas 6.67 % of rural girls had heavy menstrual bleeding. Overall, 12.6 % college girls had heavy menstrual bleeding. In the study of **Kamasamudram Vijayaaghvan (2004),** it was found that women of reproductive age, in addition to the basal loss, lose iron in menstruation. The median menstrual blood loss about 30ml/day, which is equivalent to an additional requirement of 0.5 mg of iron per day. This daily blood loss is computed from the content of blood lost during the menstrual period over a month. About 10 % of women lose as much as 80 ml of blood, corresponding to a loss of 1 mg of iron per day. Such women or college girls cannot maintain positive iron balance and this definitely leads to anaemic condition. Similar results were found in the study of **Shah and Joshi (2015)** that11.93 % of urban girls had heavy menstrual bleeding, whereas 11.75 % of rural girls had heavy menstrual bleeding and Overall, 34.27 % college girls had heavy menstrual bleeding.

4.1.6 Morbidities present

Prolong illness or any associated morbidities leads to poor health status of an individual. Table 4.1.6 provides information regarding illness or morbidities present in selected college girls.

Table: 4.1.6 Distribution of college girls according to prevalence of morbidities.

Type of Morbidities	Urban (n=201) F (%)	Rural (n=204) F (%)	Overall (N= 405) F (%)
Fever	26 (6.42)	33 (8.15)	59 (14.57)
Sneezing and cough	54 (13.33)	68 (16.79)	122 (30.12)
Headache	53 (13.09)	63 (15.56)	116 (28.64)
Diarrhea	23 (5.68)	22 (5.43)	45 (11.11)
Typhoid	09 (2.22)	07 (1.73)	16 (3.95)
Malaria	18 (4.44)	23 (5.68)	41 (10.12)
Chicken guinea	-	-	-
Viral Fever	24 (5.93)	28 (6.91)	52 (12.84)
Worm infestation	-	-	-

In the present investigation, 6.42 % and 8.15 % of urban and rural college girls were suffering from fever, while 13.33 % and 16.79 % of urban and rural girls were suffering from sneezing and cough. 13.09 % and 15.56 % of urban and rural girls were suffering from headache.5.68 % and 5.43% of urban and rural girls were suffering from diarrhea. Only 2.22 % of urban and 1.73 % of rural girls were suffering from typhoid. 4.44 % of urban and 5.68 % of rural girls were suffering from malaria.5.93% and 6.91 % of urban and rural girls were suffering from viral fever. No one suffered from chicken guinea and worm infestation. Overall, 14.57% , 30.12%, 28.64%, 11.11%, 3.95%, 10.12% and 12.84% of college girls were suffering from fever, sneezing and cough, headache, typhoid, malaria and viral fever respectively. Thus, it can be concluded that majority of college girls were suffering from headache, fever and sneezing and cough due to poor immunity among them.

4.1.7 Pica

There is no single test that confirms pica, but haemoglobin can be tested for anaemia. Pica is a neurologic involvement and can be manifested by behavioral changes such as fatigue, anorexia, pica i.e. (especially pagophagia – ice eating, geophagia –soil eating). Pica or perverted appetite may occur in some girls. Pagophagia or pica for ice, is considered quite specific for the iron deficiency state **(Sturmey & Harson, 2012, Lopez *et al.* 2004, Rose *et al.* 2000, Krause, 2008).**

4.1.7 Distribution of college girls according to Pica.

Pica	Urban (n=201) F (%)	Rural (n=204) F (%)	Overall (N= 405) F (%)
Geophgia (Roasted soil)	26 (6.42)	37 (9.14)	63 (15.56)
Pagophagia (Ice)	46 (11.36)	32 (7.90)	78 (19.26)
Chalk and clay	5 (1.24)	7 (1.73)	12 (2.96)
No pica	124 (30.62)	128 (1.60)	252 (62.22)
Total	201 (49.63)	204 (50.37)	405 (100)

Therefore, pica was considered as an important variable in the study. In the present investigation, 6.42 % and 9.14 % of urban and rural college girls had a habit of eating roasted soil i.e. Geophgea.11.36 % and 7.90 % of urban and rural college girls had a habit of eating ice i.e. Pagophgea. Very few i.e. 1.24 % and 1.73 % of urban and rural college girls had a habit of eating chalk and clay like material which is used to write in a slate. Similar results were found in the study of **Patel K.B. and Shah P.U. (2013) Shah P.U and Joshi S.D.(2015)** that 20 % and 20.09 % of urban and rural college girls had habit of eating black soil respectively, while 13.33 % and 12.28 % of urban and rural college girls had pica for ice i.e. pagophagia. Pica is the consumption of substances with no significant nutritional value such as soil, soap, ice, dirt, mud or clay. Subtypes are characterized by the substances eaten. There are different variations of pica, as it can be from a cultural tradition, acquired taste, or a neurological mechanism such as an iron deficiency or a chemical imbalance. Pica is more commonly seen in women and children, and in areas of low socio-economic status.

Plate: 4.1 Pica (Geophagia) –Roasted soil.

4.1.8 Activities

Daily activities also affects food and nutrients intake of an individual. Sedentary activities needs lesser amount of food and nutrients as compared to moderate and heavy activities. Table 4.1.8 gives information regarding daily activities performed by the selected respondents.

In the present study, 20.74 % of rural girls performed activities like animal husbandry. Only 7.16 % and 1.73 % of urban and rural college girls performed sports activities. 48.40 % and 44.94 % of urban and rural college girls helped in cooking the food daily. 46.91 % of urban and 41.73% of rural college girls was doing dusting daily. 47.41% of urban and 42.72 % rural girls were mopping and 48.15 % of urban girls and 44.20 % of rural college girls used to wash clothes daily.

Table: 4.1.8 Distribution of college girls according to activities.

Name of activities	Urban (n=201) F (%)	Rural (n=204) F (%)	Overall (N= 405)F (%)
Animal Husbandry	-	84 (20.74)	84 (20.74)
Sports	29 (7.16)	7 (1.73)	36 (8.89)
Cooking	196 (48.40)	182 (44.94)	378 (93.33)
Dusting	190 (46.91)	169 (41.73)	359 (88.64)
Mopping	192 (47.41)	173 (42.72)	365 (90.12)
Washing clothes	195 (48.15)	179 (44.20)	374 (92.35)

Overall, 20.74 % 8.89 %, 93.33 %, 88.64 %, 90.12 % and 92.12 % of selected college girls performed activities like animal husbandry, sports, cooking, dusting, mopping and washing clothes. Thus, it can be concluded that majority of college girls were helping their mother in daily household activities.

4.1.9 Caste

Caste is the social class, the membership of which is solely determined by birth with no vertical social mobility. Caste determines the role of an individual as well as the member of the society. It was therefore; felt that caste might influence the nutritional status of college girls. After considering this, the caste of college girls was studied. The data collected from college girls about their caste were categorized into three groups.

Table: 4.1.9 Distribution of college girls according to caste.

Caste	Urban (n=201) F (%)	Rural (n=204) F (%)	Overall (N= 405) F (%)
General	75 (18.52)	80 (19.75)	155 (38.27)
OBC	82 (20.25)	76 (18.77)	158 (39.01)
SC/ST	44 (10.86)	48 (11.85)	92 (22.72)
Total	201 (49.63)	204 (50.37)	405 (100)

The data regarding caste of college girls is presented in Table 4.1.9 shows that 18.52 % of urban girls were of general caste, 20.25 % of urban girls were of other backward class, and 10.86 % of urban girls were of schedule caste and schedule tribes. Whereas, 38.27 % of rural girls were of general caste, 39.01 % of rural girls were of other backward class and 22.72 % of rural girls were of schedule caste and schedule tribes. Overall, majority of 39.01 % of college girls belonged to other backward class. Thus, it can be concluded that majority of college girls were of other backward class group.

4.1.10 Family's monthly income

Income has a major influence on health. More affluent people benefit both from access to better health care and from a healthier life style. The association between poor living condition and poor health helps to explain why population has higher rates of sickness and death. But poverty is not the only reason.

Table: 4.1.10 Distribution of college girls according to family's monthly income

Monthly Income	Urban (n=201) F (%)	Rural (n=204) F (%)	Overall (N= 405) F (%)
< ₹10,000	62 (15.31)	89 (21.98)	151 (32.29)
₹10,001 to 20,000	80 (19.75)	73 (18.03)	153 (37.78)
₹20,001 to 30,000	42 (10.37)	29 (7.16)	71 (17.53)
> ₹30,001	17 (4.20)	13 (3.20)	30 (7.41)
Total	201 (49.63)	204 (50.37)	405 (100)

In the present investigation, 15.31 % and 21.98 %, of urban and rural girl's family had < ₹10,000 monthly income. 19.75 %, 18.03 %, of urban and rural girl's family had ₹10,001 to 20000 monthly income.10.37 % and 7.16 % of urban and rural girl's family had ₹ 20,001 to 30,000 monthly income.4.20 % and 3.20 % of urban and rural girl's family had > ₹ 30,001 monthly income. Thus, it can be concluded that majority of college girl's family had lower to medium monthly income.

4.1.11 Sources of information

There are various sources of information through which college girls can acquire information about health and nutrition. Sources of information are the physical bridges between its origin and the users. Several communication methods such as formal, informal, mass media and other methods are available to the college girls to get them acquainted with new technology, which are generally being used by girls for acquiring information. The information regarding sources of information used by the girls is presented in the below Table.

Table: 4.1.11 Distribution of college girls according to sources of information used.

Sources of Information	Urban (n=201) F (%)	Rural (n=204) F (%)	Overall (N= 405) F (%)
News paper	193 (47.65)	187 (46.17)	380 (93.83)
Books and magazines	169 (41.73)	156 (38.52)	325 (80.25)
Television	201 (49.63)	204 (50.37)	405 (100)
Internet	136 (33.58)	124 (30.62)	260 (64.20)
Government institutes and NGO's	15 (3.70)	09 (2.22)	24 (5.93)
Government programs and NGO's	164 (40.49)	142 (35.06)	306 (75.56)
Posters and Hoardings	195 (48.15)	104 (25.68)	299 (73.83)
Consultants	16 (3.95)	12 (2.96)	28 (6.91)

A perusal of data presented in Table 4.1.11 indicates that among various information sources used by college girls, 47.65 % of urban and 46.17 % of the rural girls acquired nutritional and health information from newspaper. 41.43 % of urban and 38.52 % rural college girls obtained nutritional and health information from books and magazines. 49.63 % of urban and 50.37 % of rural girls nutritional and health information from television programs. 33.58 % of urban and 30.62 % of rural girls acquired nutritional and health information from internet. 3.70 % of urban and 2.22 % of rural girls acquired nutritional and health information from government institutes and NGO's related institutes like anganwadi centers. 40.49 % of urban and 35.06 % of rural girls acquired nutritional and health information from government programs and NGO's program. 48.15 % of urban and 25.68 % of rural girls acquired nutritional and health information from posters and hoardings and 3.95 % of urban and 2.96 % of rural girls acquired nutritional and health information from consultants.

Overall, 93.83 % of college girls acquired nutritional and health information from news paper. 80.25 % of college girls acquired nutritional and health information from books and magazines. 100 % of college girls acquired nutritional and health information from television. 64.20 % of college girls acquired nutritional and health information from internet. 5.93 % of college girls acquired nutritional and health information from government institutes and NGO's. 75.76% girls acquired nutritional and health information from government programs and NGO's. 73.83 % of college girls acquired nutritional and health information from posters and hoarding. 6.91 % of girls used to get information from consultants. The most used and easily available source of information was news paper and television among selected college girls.

4. 1.12 Sources of information used

The data presented in Table 4.1.12 indicates that among various sources of information used by college girls, 20 % of urban and 24.69 % of rural college girls were in the category of poor range of sources used. 13.09 % of urban and 8.89 % of rural girls were in the category of fair range of sources used.16.54 % of urban and 16.69 % of rural girls were in the category of good range of sources used.

Table: 4.1.12 Distribution of college girls according to range of sources of information used.

Range of sources of information used	Urban (n=201) F (%)	Rural (n=204) F (%)	Overall (N= 405) F (%)
Poor (< Mean – S.D.)	81 (20)	100 (24.69)	181 (44.69)
Fair (Between Mean ± S.D.)	53 (13.09)	36 (8.89)	89 (21.98)
Good (> Mean + S.D.)	67 (16.54)	68 (16.79)	135 (33.33)
Total	201 (49.63)	204 (50.37)	405 (100)

Overall, 44.69 % of girls were in the category of poor range of sources of information used. 21.98 % of girls were in the category of fair range of sources of information used, 33.33 % of girls were in the category of good range of sources of information used Thus, it can be concluded that majority of college girls were in the category of poor and fair range of information sources used.

4.2 Nutritional status of college girls

Nutritional status is the state of our body as a result of the food consumed and their use by the body. Nutritional status can be good, fair and poor. The characteristics of good nutritional status are an alert, good natured personality, a well developed body, with normal weight for height, well developed and firm muscles, healthy skin, and reddish pink color of eyelids and membranes of mouth, good layer of subcutaneous fat, clear eyes, smooth and glossy hair, good appetite and excellent general health. General good health is evident by stamina for work, regular meal times, sound regular sleep, normal elimination and resistance to disease. Therefore, in present investigation, nutritional status of college girls were measured by nutritional anthropometry, clinical signs and symptoms and the details of haemoglobin estimation are discussed as under.

4.2.1 Mean measurements of college girls

Table: 4.2.1 Distribution of college girls according to mean measurements.

Mean Measurements	Urban (n=201) Mean ± SEM	Rural (n=204) Mean± SEM	Overall (N= 405) Mean ± SEM
Weight(kg)	46.45 ± 0.35	47.27 ± 0.37	46.86 ± 0.37
Height(cm)	153.4 ± 0.31	153.95 ± 0.30	153.68 ±.031
BMI	19.71 ± 0.15	19.93 ± 0.15	19.82 ± 0.15
Blood Haemoglobin (g/dl)	10.67 ± 0.07	10.66 ± 0.07	10.66 ± 0.07

Mean measurements of college girls are depicted in Table 4.2.1. Data shows that mean body weight of urban girls was 46.45 kg and mean body weight of rural girls was 47.27 kg. Overall mean body weight was 46.86 kg. Ideal standard body weight of college girls is 50 kg. But in present investigation majority of college girls had less than 50 kg of body weight which is categorized as underweight. Mean height of urban girls was 153.4 cm and for rural girls it was 153.95 cm. Overall, the mean height was 153.82 cm. BMI of urban and rural girls was 19.71 and 19.93 respectively. Overall, mean BMI was 19.82. Mean blood haemoglobin of urban and rural girls was 10.67 g/dl and 10.66 g/dl respectively. Overall, mean blood haemoglobin was 10.66 g/dl which is an indicator of mild anaemia.. Thus, it can be concluded that majority of girls fall in to underweight category and had lower than normal haemoglobin levels which is a sign of anaemic condition.

4.2.2 Body Mass Index (BMI) classification of college girls

Table 4.2.2 gives information regarding BMI of selected college girls. Data depicts that 18.03 % and 19.75 % of urban and rural college girls were underweight and they had BMI below 18.5. 29.14 %, and 26.67 % of urban and rural college girls had normal BMI of 18.6 to 24.9. 2.46 % and 3.95 % of urban and rural college girls were obese and they had BMI above 25. Overall, 37.78 % of college girls were underweight, 55.80 % had normal BMI and 6.42 % were obese. Thus, it can be concluded that majority of college girls had normal BMI.

Table: 4.2.2 Distribution of college girls according to BMI classification.

Body Mass Index Classification	Urban (n=201) F (%)	Rural (n=204) F (%)	Overall (N= 405)F (%)
< 18.5(Underweight)	73 (18.03)	80 (19.75)	153 (37.78)
18.6 – 24.9 (Normal)	118 (29.14)	108 (26.67)	226 (55.80)
>25 Obese	10 (2.46)	16 (3.95)	26 (6.42)
Total	201(49.63)	204 (50.37)	405 (100)

4.2.3 Blood haemoglobin classification

Blood haemoglobin is also health indicator for the study of health and nutritional status. Therefore, in the present study blood haemoglobin of college girls were measured by cyanamethaemoglobin method. Table 4.2.3 gives information related to haemoglobin level and anaemic condition of college girls. Data shows that 3.95 % of urban and rural girls had 13 -14 g/dl of haemoglobin level, which is a sign of good

health.14.82 % and 13.83 % of urban and rural girls had normal haemoglobin level i.e. 12 g/dl. 20.99 %, 22.46 % of urban and rural girls were mildly anaemic and had 10- 11.9 g/dl of haemoglobin. 7.65% and 9.14 % of urban and rural girls were moderately anaemic and had 7 – 9.9 g/dl of haemoglobin. 2.22 % and 0.99 % of urban and rural girls were severely anaemic and had haemoglobin 6-6.9 g/dl. Overall, 63.45 % of selected college girls were anaemic.

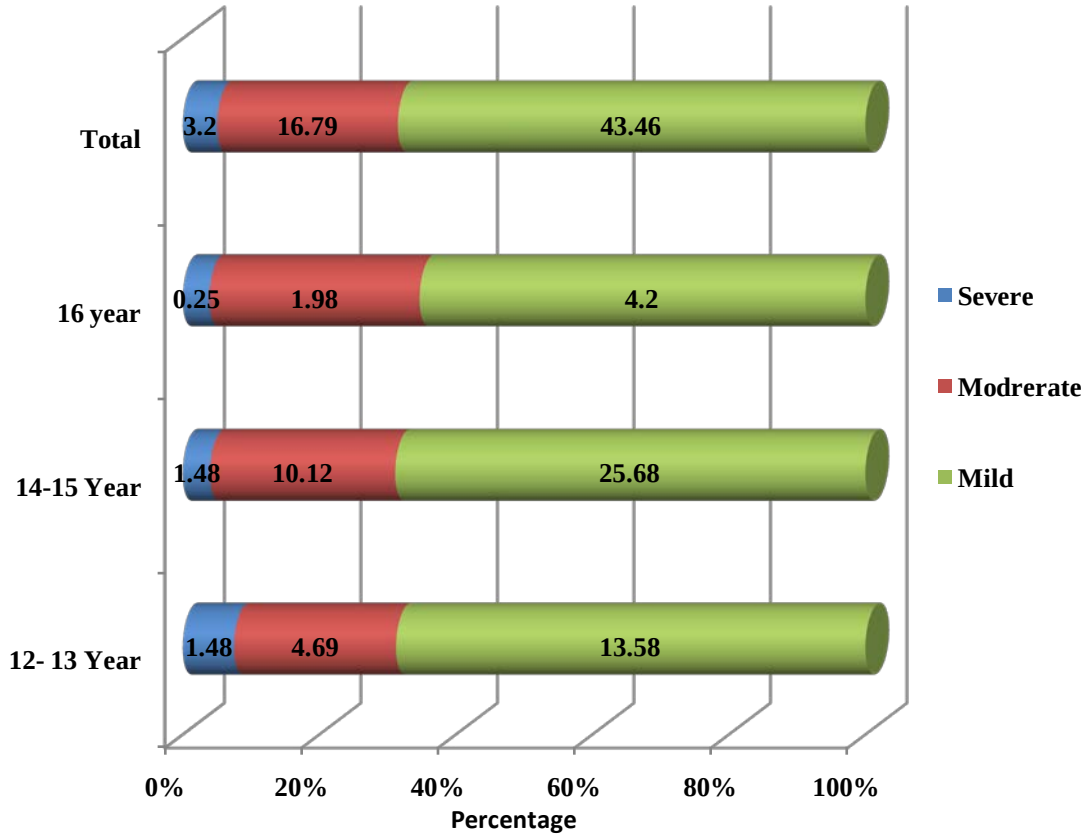
Similar results were found in the study of **Kotecha *et al.* (2004)** that there was 74.7 % of anaemia prevalence among adolescent girls of Vadodara district. In this study the frequency of consumption of iron rich food was not very high except jaggery, which was consumed daily by one fourth of the girls as compared to other iron rich foods

Table: 4.2.3 Distribution of college girls according to blood haemoglobin classification.

Blood haemoglobin level (g/dl)	Urban (n=201) F (%)	Rural (n=204) F (%)	Overall (N= 405) F (%)
Above normal (13–14 g /dl)	16 (3.95)	16 (3.95)	32 (7.19)
Normal (12 g /dl)	60 (14.82)	56 (13.83)	116 (28.64)
Mild anaemic (10 – 11.9 g/dl)	85 (20.99)	91 (22.46)	176 (43.46)
Moderate anaemic (7 – 9.9 g/dl)	31(7.65)	37 (9.14)	68 (16.89)
Severe anaemic (6 -6.9 g/dl)	9 (2.22)	4 (0.99)	13 (3.21)
Total anaemia prevalence	**125 (30.86)**	**132 (32.59)**	**257 (63.45)**
Total	201(49.63)	204 (50.37)	405(100)

Figure 4.1 provides information regarding prevalence of anaemic condition and age at menarche. 13.58 % of girls of 12- 13 years of age at menarche were mildly anaemic. 25.68 % of girls of 14-15 years of age at menarche were mildly anaemic and 4.2 % girls of 16 years of age at menarche were mildly anaemic. 4.69 %, of girls of 12- 13 years of age at menarche were moderately anaemic. 10.12 % of girls of 14-15 years of age at menarche were moderately anaemic and 1.98 % girls of 16 years of age at menarche were mildly anaemic. 1.48 % girls of 12- 13 years and 13-14 of age at menarche were severely anaemic. 0.25 % of girls of 16 years of age at menarche were severely anaemic.

Figure 4.1: Age at menarche and prevalence of anaemic condition among college girls.



4.2.4 Clinical signs and symptoms

Clinical methods for assessment of nutritional status is one of the most practical and important method used in assessing the nutritional status of a community. External examination of the body for changes in superficial epithelial tissues especially skin, eyes, hair etc. can be carried out. The main advantage of this method is that since it is based on observation of physical signs. It is relatively inexpensive and does not require any elaborate field equipment or even a laboratory. Clinical assessment can give very valuable but approximate information. It is an effective tool where malnutrition prevails. After the completion of clinical assessment, it may be useful to conduct therapeutic trials so that it is possible to establish and help in identification of a deficiency syndrome or to find difference between two conditions with similar clinical manifestations.

Table: 4.2.4 Distribution of college girls according to clinical signs and symptoms.

Signs and symptoms	Urban (n=201) F (%)	Rural (n=204) F (%)	Overall (N= 405) F (%)
Hair			
• Rough and thin hair	74 (18.27)	81 (20)	155 (38.27)
• White hair	10 (2.50)	15 (3.70)	25 (6.17)
• Hair fall	95 (23.46)	110 (27.16)	205 (50.62)
Mean of Hair problems	**14.74**	**16.95**	**31.69**
Face			
• Moon face	8 (1.98)	11 (2.71)	19 (4.69)
• Acne	58 (14.32)	68 (16.79)	126 (31.11)
• Paleness	19 (4.69)	24 (5.93)	43 (10.62)
Mean of face problems	**7**	**8.48**	**15.48**
Eyes - Paleness of eye lids	16 (3.95)	18 (4.44)	34 (8.40)
Bleeding gums	29 (7.16)	33 (8.15)	62 (15.31)
Dental caries	11 (2.71)	17 (4.20)	28 (6.91)
Redness of tongue	10 (2.47)	13 (3.20)	23 (5.68)

The clinical assessment of college girls were carried out. Table 4.2.4 gives information about clinical assessment and it reveals that 18.27 %, and 20 % of urban and rural girls had rough and thin hair. 2.50% and 3.70 % of urban and rural girls had white hair. 23.46 % and 27.16 % of urban and rural girls had a problem of hair fall. 38.27 %, 6.17% and 50.62 % of girls had different kinds of hair problem like rough and thin hair, white hair and hair fall respectively 1.98 % and 2.71 % of urban and rural girls had a moon face.14.32 % and 16.79 % of urban and rural girls had acne and 4.69 % and 5.93 % of urban and rural girls were paleness of facial skin. 3.95 % of urban and 4.44 % of urban and rural girls had paleness of eyelids. 7.16 % and 8.15 % of urban and rural girls had bleeding gums which is a sign of vitamin C deficiency. 2.71 % and 4.20 % of urban and rural girls had dental carries. And 2.47 % and 3.20 % of urban and rural girls had a redness of tongue which was due to deficiency of vitamin B complex. Overall, 4.69 %, 31.11 % and 10.62 % were suffering from moon face, acne and paleness of face and skin. Thus, it can be concluded that the presence of clinical signs and symptoms are result of the deficiency of nutrients. Overall, 8.40 %, 15.31 % , 6.91 % and 5.68 % of girls were suffering from paleness of eyelids, bleeding gums, dental carries and redness of tongue respectively. Thus, it can be concluded that above observed clinical assessment was may be due to presence of energy, protein, iron, vitamin C and B complex vitamin deficiency and because of poor dietary intake of these nutrients.

4.2.5 Clinical signs and symptoms of anaemia

As anaemia is the last manifestation of chronic, long- term iron deficiency, the symptoms reflect a malfunction of variety of body systems. Inadequate muscle function is reflected by decreased work performance and exercise intolerance. Neurologic involvement is manifested by behavioral changes such as fatigue, anorexia, and pica, especially pagophagia (ice eating).Therefore, clinical findings of anaemia were studied in this investigation.

Table: 4.2.5 Distribution of college girls according to clinical signs and symptoms of anaemia.

Clinical signs and symptoms	Urban (n=201) F (%)	Rural (n=204) F (%)	Overall (N= 405) F (%)
Moderate Anaemia			
Inadequate muscle functions			
Decreased work performance	122 (30.12)	134 (33.09)	256 (63.21)
Physical activity intolerance	100 (24.69)	103 (25.43)	203 (50.12)
Neurological involvement			
Behavioral changes			
Fatigue	83 (20.49)	105 (25.93)	188 (46.42)
Poor concentration	38 (9. 38)	46 (11.35)	84 (20.74)
Dullness	52 (12.84)	61 (15.06)	113 (27.90)
Reduced immune competence	79 (19.51)	82 (20.25)	161 (39.75)
Severe anaemia			
Paleness of skin	34 (8.40)	41(10.12)	75 (18.52)
Nails			
Thin and flat nails	32 (7.90)	42 (10.37)	74 (18.27)
Spoon shaped (Koilonychia)	-	-	-
Brittle nails	30 (7.41)	38 (9.38)	68 (16.79)
Tongue			
Burning sensation of tongue	45 (11.11)	50 (12.34)	45 (23.46)
Redness of tongue	40 (9.88)	48 (11.85)	88 (21.73)

The results shows that 30.12 % and 33.09 % of urban and rural girls reported decreased work performance. 24.69 % and 25.43 % of urban and rural girls said they had physical activity intolerance.20.49 % and 25.93 % of urban and rural girls reported quick fatigue. 9.38 % and 11.35 % of urban and rural girls had poor concentration. 12.84 % and 15.06 % of urban and rural girls had dullness of skin.19.51 % and 20.25 % of urban and rural girls had reduced immune competence.8.40 % and 10.12 % of urban and rural girls had paleness of skin.7.90 % and 10.37 % of urban and rural girls had thin flat nails and 7.41 % and 9.38 % of urban and rural girls had brittle nails.11.11 %

and 12.34 % of urban and rural girls had burning sensation of tongue and 9.88 % and 11.85 % had redness of tongue.

Overall, 63.21 %, 50.12 %, of girls reported reduced work performance and physical activity intolerance respectively. 45.42 %, 20.74%, 27.90 % of girls reported that they had quick fatigue, poor concentration and dullness respectively. 39.75 % had reduced immune competence. Mouth changes includes atrophy of lingual papillae, burning sensation, redness, and in severe cases a completely smooth, waxy, and glistening appearance of the tongue (glossitis). The clinical findings of severe anaemia in present investigation, 18.27% and 16.79 % of girls had thin flat and brittle nails. 2.46 % and 21.73 % of girls had burning sensation and redness of tongue. These are the clinical findings of moderate anaemia. As iron deficiency anaemia becomes more severe, defects arise in the structure and function of the epithelial tissues, especially of the tongue, nails, mouth, and stomach. The skin may appear pale, and the inside of the lower eyelid may be light pink instead of red. Finger nails can become thin and flat due to severe anaemia. **Nokes and colleagues,** in their Report of the **International Nutritional Anaemia Consultative Group (1998)**, supported earlier work by **Pollitt and colleagues(1986)** that abnormal cognitive development in children suggests the presence of iron deficiency before it has developed into overt anaemia. Growth abnormalities, epithelial disorders and a reduction in gastric acidity are common. A possible sign of early iron deficiency is reduced immune competence, particularly defects in cell- mediated immunity and phagocytic activity of neutrophils, which may lead to an increased propensity for infection. Similar results were found in the Annual report of **Indian Institute of Health and Welfare (2001 -2002)** that signs and symptoms of anaemia like pallor (eyes, tongue, nails) fatigue, breathlessness, poor appetite and lack of concentration were reported by 12.5 %, 14.1 %, 9.2 %, 26.5 % and 86 % of girls respectively. A study conducted by **A. Sadliwala (1996)** reported that clinical signs and symptoms related to anaemia revealed that, most of the adolescent girls suffered from fatigue and headache (21.59%), breathlessness (10.22 %), giddiness(5.7 %), dimness of vision (6.9 %). Pallor of eyes and pale nails was seen in 60.22 % and 30.7 % respectively.

4.2.6 Menstrual information of college girls.

Table - 4.2.6 Distribution of college girls according to menstrual bleeding days.

Days	Urban (n=201) F (%)	Rural (n=204) F (%)	Overall (N= 405) F (%)
Three	93 (22.96)	94 (23.21)	187 (46.17)
Four	99 (24.44)	98 (24.20)	197 (46.64)
Five	09 (2.22)	12 (2.96)	21 (5.19)
Six	-	-	-
Total	201 (49.63)	204 (50.37)	405 (100)

Menstrual bleeding days also affect haemoglobin level of college girls. Because if menstrual bleeding continues for many days it results in occurrence of anaemia among girls. Table 4.2.6 provides information about menstrual bleeding days. The data shows that 22.96 % and 23.21 % of urban and rural college girls had three menstrual bleeding days, while 24.44 % and 24.20 % of urban and rural girls had four menstrual bleeding days. 2.22 % and 2.96 % of urban and rural college girls had five menstrual bleeding days. Overall, 46.17 %, 46.64 % and 5.19 % of girls had three, four and five menstrual bleeding days respectively. Thus, it can be concluded that maximum number of menstrual bleeding days was four.

4.2.7 Regularity of menstrual cycle

Table: 4.2.7 Distribution of college girls according to regularity of menstrual cycle.

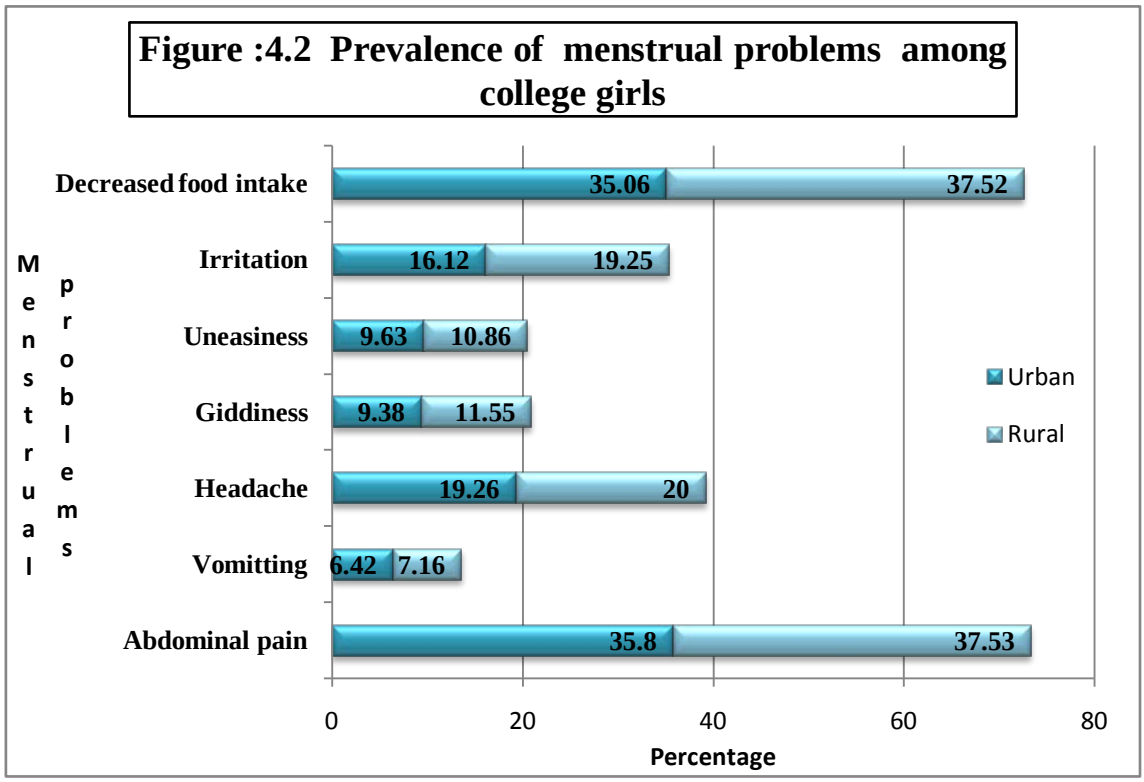
Regularity	Urban (n=201) F (%)	Rural (n=204) F (%)	Overall (N= 405) F (%)
28 days	95 (23.46)	99 (24.44)	194 (47.90)
30 days	93 (22.96)	95 (23.46)	188 (46.43)
Irregular	13 (3.20)	10 (2.47)	23 (5.67)
Total	201 (49.63)	204 (50.37)	405 (100)

Regularity of menstrual cycle is also affected by many factors such as food intake, hormones and other physiological activities. Data depicted in Table 4.2.10 shows that 23.46 %, 24.44 %, of urban and rural girls had 28 days regularity of menstrual cycle. 22.96 % and 23.46 % of urban and rural girls had 30 days regularity of menstrual cycle.3.20 % and 2.47 % of urban and rural girls had irregularity in their menstrual cycle. Overall, 47.90 %, 46.43 % and 5.67 % of girls had 28 days, 30 days and irregular

menstrual cycle. Thus, it can be concluded that majority of college girls had 28 days regularity of menstrual cycle.

Prevalence of menstrual problems

Figure 4.2 provides information related to menstrual problems among college girls and it shows that 35.8 % and 37.53 % of urban and rural college girls had abdominal pain during menstrual period. 6.42 % and 7.16 % of urban and



rural college girls had vomiting during menstrual period. 19.26 % and 20 % of urban and rural college girls had headache during menstrual period. 9.38 % and 11.55 % of urban and rural college girls had giddiness during menstrual period. 9.63 % and 10.86 % of urban and rural college girls had uneasiness during menstrual period. 16.12 % and 19.25 % of urban and rural college girls had irritation during menstrual period. 35.06 % and 37.52 % of urban and rural college girls decreased their food intake during menstrual period. Thus, it can be concluded that majority of college girls experienced abdominal pain, headache and decreased food intake during their menstrual period.

4.3 Nutritional knowledge and awareness regarding anaemia

Nutrition knowledge and nutrition education are also considered as a long term approach to combat iron deficiency anaemia. Nutrition education is equally important as

it helps to build up good nutritional status, firstly for themselves, her family and thus the community benefits by increasing the work output and on the whole benefits the national economy.

4.3.1 Knowledge of nutritional requirements

Nutritional knowledge measurement was considered for the development of nutritional knowledge intervention program for college girls.

Table: 4.3.1 Distribution of college girls according to knowledge regarding nutritional requirements

Nutrient requirements	Urban (n=201) F (%)	Rural (n=204) F (%)	Overall (N=405) F (%)
Energy (kcal)	68 (16.79)	62 (15.31)	130 (32.10)
Protein (g)	50 (12.35)	44 (10.86)	94 (23.21)
Fat (g)	45 (11.11)	36 (8.89)	80 (19.75)
Calcium (mg)	24 (5.93)	22 (5.43)	47 (11.61)
Iron (mg)	60 (14.82)	57 (14.07)	117 (28.89)
Vitamin A (IU)	23 (5.68)	19 (4.69)	42 (10.37)
Vitamin B_1 (mg)	19 (4.69)	13 (3.21)	33 (8.15)
Vitamin B_2 (mg)	20 (4.94)	13 (3.21)	33 (8.15)
Vitamin B_{12} (µg)	13 (3.21)	9 (2.22)	22 (5.32)
Vitamin C (mg)	25 (6.17)	22 (5.43)	47 (11.60)
Folic Acid (µg)	14 (3.46)	9 (2.22)	23 (5.68)
Mean	**8.10**	**6.87**	**14.97**

Table 4.3.1 shows the percentage of nutritional knowledge among college girls. 16.79 % and 15.31 % of urban and rural girls had knowledge of daily energy requirements. 12.35 % and 10.86 % of urban and rural had knowledge of protein requirements. 11.11 % and 8.89 % of urban and rural girls had a knowledge regarding fat requirements. As far as, mineral requirements were concern, 5.93 % and 5.43 % urban and rural girls had knowledge of calcium requirements.14.82% and 14.07 % of urban and rural girls had a knowledge of iron requirements.5.68% and 4.69% of urban and rural girls had knowledge of vitamin A requirements.4.69 % and 3.21 % of urban and rural girls had knowledge of vitamin B_1 requirements.4.94 % and 3.21 % of urban and rural girls had knowledge of vitamin B_2 requirements.3.21 % and 2.22 % of urban

and rural girls had knowledge of vitamin B_{12} requirements. 6.17 % and 5.43% of urban and rural girls had knowledge of vitamin C requirements. Very few college girls had knowledge of folic acid requirements.

Overall, 32.10 % and 23.21 % of girls had knowledge of daily energy and protein requirements.11.61 % and 28.89 % of girls had knowledge of calcium and iron requirements. 10.37%, 8.15 % of girls had knowledge of vitamin A and vitamin B_1 requirements.8.15 %, 5.32%, 11.60% and 5.68 % of girls had knowledge of daily requirements of vitamin B_2, B_{12}, C and folic acid respectively. Thus, it can be concluded that only 14.97 % had knowledge of daily nutritional requirement and said to be poor among college girls.

4.3.2 Knowledge of sources of nutrients

Table: 4.3.2 Distribution of college girls according to nutritional knowledge regarding sources of nutrients.

Sources of nutrients	Urban (n=201) F (%)	Rural (n=204) F (%)	Overall (N=405) F (%)
Energy (kcal)	158 (39.01)	137 (33.83)	295 (72.84)
Fat (g)	132 (32.59)	126 (31.11)	258 (63.70)
Protein (g)	108 (26.67)	102 (25.19)	210 (51.85)
Vitamin A (IU)	148 (36.54)	123 (30.38)	271 (66.91)
Vitamin C (mg)	148 (36.54)	136 (33.58)	284 (70.12)
Iron (mg)	90 (22.22)	82 (20.25)	172 (42.47)
Mean	**31.69**	**29.63**	**61.32**

Table 4.3.2 depicts knowledge regarding sources of nutrients.39.01 % and 33.83 % of urban and rural girls had knowledge of energy sources i.e. oil and ghee, cereals, sugar and jaggery. 32.59 % and 31.11 % 69.25 % of urban and rural girls had knowledge of fat sources i.e. oil, butter and ghee. 26.67 % and 25.19 % of urban and rural girls had knowledge of sources of protein i.e. cereals, pulses, milk and milk products. 36.54 % and 30.38 % of urban and rural girls had knowledge of sources of vitamin A i.e. GLVs and fruits. 36.54 % and 33.58 % of urban and rural girls had knowledge of vitamin C sources. 22.22 % and 20.25 % of urban and rural girls had knowledge of sources of iron i.e. GLVs, pulses and cereals.

Overall, 72.84 %, 63.70%, 51.85 % , 66.91%, 70.12, and 42.47 % girls had knowledge regarding energy, fat, protein, vitamin A, vitamin C and iron food sources

respectively. Thus, it can be concluded that 61.32 % girls had knowledge of sources of various nutrients.

Similar results were found in the study of **Shah and Joshi (2015)** that 67.33 % girls had knowledge of energy sources i.e. oil and ghee, cereals, sugar and jaggery. 69.25 % girls had knowledge of fat sources i.e. oil, butter and ghee. 48.56 % girls had knowledge of protein sources i.e. cereals, pulses, milk and milk products. 60.15 % girls had knowledge of vitamin A sources i.e. GLVs and fruits. 65.68 % girls had knowledge of vitamin C sources and 42.25 % girls had knowledge of iron sources i.e. GLVs, pulses, cereals and overall, 58.87 % girls had knowledge of sources of various nutrients.

4.3.3 Knowledge of nutrients in foods

Table: 4.3.3 Distribution of college girls according to nutritional knowledge regarding nutrients in foods.

Nutrients in foods	Urban (n=201) F (%)	Rural (n=204) F (%)	Overall (N=405) F (%)
Cereals and pulses	112 (27.65)	98 (23.95)	209 (51.61)
Vegetables	101 (24.94)	98 (24.20)	199 (49.14)
Fruits	99 (24.44)	94 (23.21)	193 (47.65)
Oilseeds	106 (26.17)	103 (25.43)	209 (51.60)
Sugar and jaggery	198 (48.89)	194 (47.90)	392 (96.79)
Milk	83 (20.49)	76 (18.77)	159 (39.26)
Mean	**28.76**	**27.24**	**56**

Table 4.3.3 depicts percentage of knowledge regarding nutrients presents in particular food group. It showed that 27.65 % and 23.95 % of urban and rural girls had knowledge of nutrients present in cereals and pulses i.e. energy and protein. 24.94 % and 24.20% of urban and rural girls had knowledge of nutrients present in vegetables i.e. vitamins and minerals. 24.44 % and 23.21% of urban and rural girls had knowledge of nutrients present in fruits i.e. vitamins and minerals.26.17 % and 25.43 % of urban and rural girls had knowledge of nutrients present in oil seeds. 48.89 % and 47.90 % of urban and rural girls had knowledge of nutrients present in sugar and jaggery. 20.49 % and 18.77 % of urban and rural girls had knowledge of nutrients present in milk.

Overall, 51.61 %,49.14 %, 47.65 5, 51.60 % , 96.79 % and 39.26 % of girls had a knowledge of nutrients present in cereals, pulses, vegetables, fruits, oilseeds, sugar and jaggery and milk respectively. Thus, it can be concluded that 56 % girls had knowledge of nutrients presents in different food groups. **Shah and Joshi (2015)** found that 51.96 % of girls had knowledge regarding nutrients presents in particular foods groups.

4.3.4 Knowledge regarding deficiency diseases

Table 4.3.4 Distribution of college girls according to nutritional knowledge regarding deficiency disease.

Deficiency disease	Urban (n=201) F (%)	Rural (n=204) F (%)	Overall (N=405) F (%)
Energy (kcal)	168 (41.48)	138 (34.07)	306 (75.56)
Protein (g)	100 (24.69)	96 (23.71)	196 (48.40)
Vitamin A (IU)	156 (35.52)	142 (35.06)	298 (73.58)
Vitamin D (IU)	97 (23.95)	88 (21.73)	185 (45.68)
Vitamin C (mg)	136 (33.58)	125 (30.86)	261 (64.44)
Iodine (mg)	139 (34.32)	129 (31.85)	268 (66.17)
Iron (mg)	126 (31.11)	115 (28.40)	241 (59.51)
Mean	**31.84**	**29.14**	**60.98**

Table 4.3.4 depicts knowledge of deficiency diseases among college girls. 41.48 % and 34.07 % of urban and rural girls had knowledge of energy deficiency. 24.69 % and 23.71 % of urban and rural girls had knowledge of protein calorie malnutrition a deficiency of protein. 35.52 % and 35.06 % of urban and rural girls had knowledge of vitamin A deficiency i.e. poor vision or night blindness. 23.95 % and 21.73 % of urban and rural girls had knowledge of rickets a vitamin D deficiency. 33.58 % and 30.86 % of urban and rural girls had knowledge of scurvy a vitamin C deficiency. 34.32 % of urban and rural girls had knowledge of goiter a iodine deficiency and 31.11 % and 28.40 % of urban and rural girls had knowledge of anaemia a iron deficiency.

Overall, 75.56 %, 48.40 %, 73.58 %, 45.68 %, 64.44 %, 66.17 % and 59.51 % of girls had knowledge regarding energy, protein, vitamin A, vitamin C, iodine and iron deficiency diseases respectively. Thus, it can be concluded that 31.84 % and 29.14 % of urban and rural girls and overall, 60.98 % girls had knowledge of dietary deficiency diseases.

4.3.5 Awareness regarding anaemia among college girls.

Table: 4.3.5 Distribution of college girls according to awareness regarding anaemia among college girls

Sr. no	Statements/ Questions	Urban (n=201) F (%)	Rural (n=204)F (%)	Overall (N=405) F (%)
1	Which element is lower in blood in anaemia?	79 (19.51)	70 (17.28)	149 (36.79)
2	Is there any relation between anaemia and menstrual bleeding?	70 (17.28)	66 (16.30)	136 (33.58)
3	Which color is given to blood by dietary iron?	121 (29.88)	117 (28.89)	238 (58.77)
4	Which foods make blood red?	76 (18.77)	72 (17.77)	148 (36.54)
5	Which foods make blood pale?	88 (21.73)	82 (20.24)	170 (41.97)
6	What is the role of iron in body?	81 (20)	80 (19.75)	161 (39.75)
7	Which are iron rich foods?	80 (19.75)	77 (19.01)	157 (38.76)
8	Is there any harmful effect of drinking excess amount of tea and coffee?	172 (42.47)	171 (42.22)	343 (84.69)
9	Is there any relation between anaemia and drinking of excess tea and coffee?	27 (6.67)	24 (5.92)	51 (12.59)
10	Does iron requirement increase or decrease during pregnancy?	86 (21.23)	83 (20.49)	169 (41.72)
11	Is iron essential for mother and foetus health?	89 (21.98)	86 (21.23)	175 (43.21)
12	Does haemoglobin level increase or decrease after menstrual bleeding?	75 (18.52)	74 (18.27)	149 (36.79)
Mean		**21.48**	**20.61**	**42.09**

Table 4.3.5 reveals awareness regarding anaemia among college girls. Present investigation shows that 19.51 % and 17.28 % of urban and rural girls and overall 36.79 % girls were aware about anaemic condition where iron level or haemoglobin level is lower than the normal. 17.28 % and 16.30 % of urban and rural girls and overall 33.58 % girls were aware about the relation between anaemia and menstrual bleeding. 29.88 % and 28.89 % of urban and rural girls and overall 58.77 % were aware that red colour of blood is due to dietary iron. 18.77 % and 17.77 % of urban and rural girls and overall 36.54 % girls had knowledge of foods that makes blood red i.e. fruits and GLVs, pulses, dates etc.

21.73 % and 20.24 % of urban and rural girls and overall 41.97 % girls had knowledge about foods that makes blood pale, like tamarind seeds, soil, junk foods etc.

20 % and 19.75 % of urban and rural girls and overall 39.75% girls had knowledge of role of iron in the body for synthesis of haemoglobin. 19.75 % and 19.01 % of urban and rural girls and overall 38.76 % girls had knowledge of iron rich foods i.e. dates, bajra, GLVs and pulses. 42.47 % and 42.22 % of urban and rural girls and overall 84.69 % girls knew that there is a harmful effect of drinking excess amount of tea and coffee. Only 6.67 % and 5.92 % of urban and rural girls and overall 12.59 % girls knew that there is a relation between anaemia and drinking of excess tea and coffee.

21.23% and 20.49 % of urban and rural girls and overall 41.72 % girls knew that iron requirements increases during pregnancy. 21.98 % and 21.23 % of urban and rural girls and overall 43.21 % girls knew that iron is essential for mother and foetus health. 18.52 % and 18.27 % of urban and rural girls and overall 36.79 % girls knew that haemoglobin level decreases after menstrual bleeding. Thus, it can be concluded that 21.48 % and 20.61 % of urban and rural girls and overall only 42.09 % college girls were aware about anaemia.

4.3.6 Knowledge regarding clinical signs and symptoms of anaemia

Table: 4.3.6 Distribution of college girls according to knowledge regarding clinical signs and symptoms of anaemia.

Signs and symptoms of anaemia	Urban (n=201) F (%)	Rural (n=204) F (%)	Overall (N=405) F (%)
Quick fatigue	91 (22.47)	86 (21.24)	177 (43.71)
Breathlessness	47 (11.61)	41 (10.12)	88 (21.72)
Weakness	67 (16.54)	60 (14.82)	127 (31.35)
Giddiness	20 (4.94)	19 (4.69)	39 (9.63)
Paleness of skin and eyes	121 (29.88)	116 (28.64)	237 (58.52)
Hair fall	82 (20.25)	74 (18.27)	156 (38.52)
Drowsiness/Laziness	21 (5.19)	15(3.70)	36(8.89)
Irritability	18 (4.44)	11(2.72)	29(7.16)
Poor appetite	8 (1.98)	4(0.99)	12(2.96)
Poor concentration	18 (4.44)	14(3.46)	32(7.90)
Mean	**12.17**	**10.87**	**23.04**

Table 4.3.6 reveals knowledge regarding signs and symptoms of anaemia among college girls. 22.47 % and 21.24 % of urban and rural girls and overall 43.71 % girls had knowledge of quick fatigue is a sign of anaemia. 11.61 % and 10.12 % of urban and

rural girls and overall 21.72 % girls had knowledge of breathlessness is a sign of anaemia.16.54 % and 14.82 % of urban and rural girls and overall 31.35 % girls had knowledge of weakness is a sign of anaemia.4.94 % and 4.69 % of urban and rural girls and overall 9.63 % girls had knowledge of giddiness is a sign of anaemia. 29.88% and 28.64 % of urban and rural girls and overall 58.52 % girls had knowledge of paleness of skin and eyes is a sign of anaemia. 20.25 % and 18.27 % of urban and rural girls and overall 38.52 % girls had knowledge of hair fall is a sign of anaemia. 5.19 % and 3.70 % of urban and rural girls and overall 8.89 % girls had knowledge of drowsiness is a sign of anaemia. 4.44 % and 2.72 % of urban and rural girls and overall 7.16 % girls had knowledge of irritability is a sign of anaemia. 1.98 % and 0.99 % of urban and rural girls and overall 2.96 % girls had knowledge of poor appetite is a sign of anaemia. 4.44 % and 3.46 % of urban and rural girls and overall 7.90 % girls had knowledge of poor concentration is a sign of anaemia. Thus, it can be concluded that 12.17 % and 10.87 % of urban and rural girls and overall 23.04 % girls had knowledge of signs and symptoms of anaemia. Similar results were found in the study of **Shah and Joshi (2015)** that overall, only 18.41 % girls had knowledge regarding clinical signs and symptoms of anaemia.

4.3.7 Nutritional knowledge level

Nutritional knowledge plays an important role in well being and health status of an individual. So, to measure the level of nutritional knowledge and awareness regarding anaemia in girls it was considered an important factor.

Table: 4.3.7 Distribution of college girls according to nutritional knowledge level.

Nutritional knowledge level	Urban (n= 201) F (%)	Rural (n= 204) F (%)	Overall (N= 405) F (%)
Poor (< mean – S.D.)	54 (13.33)	60 (14.82)	114 (28.15)
Fair (mean ±S.D)	30 (7.41)	40 (9.87)	70 (17.28)
Good (>mean + S.D)	117 (28.89)	104 (25.68)	221 (54.57)
Total	201 (49.63)	204 (50.37)	405 (100)

Table 4.3.7 reveals the nutritional knowledge level among college girls. 13.33 % and 14.82 % of urban and rural girls and overall 28.15 % of college girls had poor nutritional knowledge. 7.41 % and 9.87 % of urban and rural girls and overall 17.28 % college girls had fair nutritional knowledge. 28.89 % and 25.68 % of urban and rural

girls and overall 54.57 % of college girls had good nutritional knowledge level. Thus, it can be concluded that majority of college girls had good nutritional knowledge level. Only, 45.43 % girls had poor and fair nutritional knowledge. Similar results were found in the study of **Shah and Joshi (2015)** where only 47.33 % college girls had good nutritional knowledge level.

4.3.8 Nutritional knowledge level as per faculty

Table: 4.3.8 Distribution of college girls according to nutritional knowledge level as per faculty.

Level	Arts (n=107) F (%)	Science (n-52) F (%)	Computer Science (n= 69) F (%)	Homeopathy (n=52) F (%)	Home Science (n=73) F (%)	B. Ed. (n=52) F (%)	Overall (N= 405) F (%)
Poor	82 (20.25)	02 (0.49)	07 (1.73)	-	03 (0.74)	20 (4.94)	114 (28.15)
Fair	18 (4.44)	05 (1.24)	10 (2.46)	10 (2.47)	10 (2.47)	17 (4.20)	70 (17.28)
Good	7 (1.73)	45 (11.11)	52 (12.85)	42 (10.37)	60 (14.82)	15 (3.70)	221 (54.57)
Total	107 (26.41)	52 (12.84)	69 (17.04)	52 (12.84)	73 (18.03)	52 (12.84)	405 (100)

Table 4.3.8 reveals the nutritional knowledge level as per faculty wise distribution of college girls.20.25 %, 4.44 % and 1.73 % of Arts faculty girls had poor, fair and good nutritional knowledge level respectively. Science faculty girls had 0.49 %, 1.24 % and 11.11 % of poor, fair and good nutritional knowledge level. Computer Science faculty girls had 1.73 %, 2.46 % and 12.82 % of poor, fair and good nutritional knowledge level. Homeopathy faculty girls had 2.47 % and 10.37 % of fair and good nutritional knowledge level. Home Science faculty girls had 0.74 %, 2.47 % and 14.82 % of poor, fair and good nutritional knowledge level.

B.Ed. faculty girls had 4.94 %, 4.20 % and 3.70 % of poor, fair and good nutritional knowledge level. Poor and fair knowledge level girls were from Arts and B.Ed. faculty. Girls having good nutritional knowledge level were from Science, Home Science and Homeopathy and Computer science faculty. Overall 28.15 % girls had poor nutritional knowledge. 17.28 % girls had fair nutritional knowledge and 54.56 % girls had good nutritional knowledge. Thus, it can be concluded that half of college girls were in the category of poor and fair nutritional level.

4.4 Dietary pattern and average intake of college girls

Dietary Pattern

To know the dietary pattern and the actual intake of various foods and nutrients as well as the deficiency of various nutrients, a diet survey was carried out by 24 hours dietary recall method. In the present study, food consumption pattern of different foods of college girls was recorded and the results are presented in Table 4.4.1 to 4.4.10.

4.4.1 Cereals and cereal products

Table 4.4.1 Distribution of college girls according to the food consumption pattern of cereals and cereal products.

Food Item	Daily	Alternate day	Weekly	Half Monthly	Monthly	Rarely	Never
Wheat							
Urban	201 (49.63)	-	-	-	-	-	-
Rural	204 (50.37)	-	-	-	-	-	-
Rice							
Urban	103 (25.43)	55 (13.58)	31 (7.65)	12 (2.96)	-	-	-
Rural	96 (20.73)	55 (13.58)	29 (7.16)	16 (3.95)	8 (1.98)	-	-
Bajra							
Urban	-	-	5 (1.24)	47 (11.60)	30 (7.41)	119 (29.38)	-
Rural	-	-	7 (1.73)	45 (11.11)	55 (13.58)	97 (23.95)	-
Puffed Rice							
Urban	-	32 (7.90)	12 (2.96)	65 (16.65)	72 (17.78)	20 (4.94)	-
Rural	-	29 (7.16)	18 (4.44)	70 (12.28)	62 (15.31)	22 (5.43)	-
Rice Flakes							
Urban	-	-	4 (0.99)	96 (24.19)	31 (7.65)	70 (17.28)	-
Rural	-	-	03 (0.74)	83 (20.49)	42 (10.37)	76 (18.77)	-
Bread							
Urban	-	-	-	39 (9.30)	57 (14.17)	105 (25.93)	-
Rural	-	-	-	-	48 (11.85)	156 (38.52)	-

Cereals and cereal products are rich sources of carbohydrates and fair to good sources of proteins, certain minerals and B vitamins. The data presented in Table 4.4.1

shows that major cereals consumed by the college girls were wheat, rice and bajra. All the urban and rural college girls consumed wheat daily whereas, only 25.43 % of urban and 20.73 % rural girls consumed rice daily, it shows that rest of college girls consumed rice alternately, weekly and half monthly. Majority i.e. 28.40 % of urban girls consumed bajra occasionally. 1.73 %, 11.11 %, 13.58 % and 23.21 % of rural girls consumed bajra weekly, half monthly, monthly and occasionally.

Bajra is a good source of iron but the frequency of its consumption is very less among college girls. Among cereal products, puffed rice was also less frequently consumed, Only 7.90 % of urban and 7.16 % of rural girls consumed puffed rice alternate day, whereas 16.05 % and 12.28 % of urban and rural college girls consumed puffed rice half monthly.17.78 % and 15.31 % of urban and rural college girls consumed puffed rice monthly and 4.94 % and 5.43 % of urban and rural college girls consumed puffed rice occasionally.

Rice flakes was consumed less frequently, only 24.19 % and 20.49 % of urban and rural college girls consumed rice flakes half monthly whereas, 7.65 % and 10.37 % of urban and rural college girls consumed rice flakes monthly and 17.28 % and 18.77 % of urban and rural college girls consumed rice flakes rarely. Thus, it can be concluded that majority of college girls consumed rice flakes less frequently. Rice flakes are rich source of iron but the frequency of consumption was poor among college girls. The consumption of bread was also less among college girls. Only 9.30 % , 14.07 %, 25.93 % of urban college girls consumed bread half monthly, monthly and rarely, whereas, 11.85 % and 38.52 % of rural college girls consumed bread monthly and rarely. Cereals and cereal products are major energy giving food. In present investigation, only wheat was consumed daily by college girls and other cereals and cereal products were not frequently consumed which may result in poor calorie and nutrients intake and subsequently their deficiency diseases.

4.4.2 Pulses

Pulses are important and rich sources of protein in the dietaries of millions of people in the world. Therefore, consumption pattern of pulses were studied in present investigation. Not a single pulse was consumed daily. Pulses like black gram, bengal gram and green gram consumption, no one consumed it daily or even alternately and weekly (urban-9.38%, rural- 8.40%), half monthly(urban - 13.33%, rural - 13.09%), monthly(urban -10.57%, rural-11.85%)and rarely (urban - 16.54%, rural - 17.03%) respectively. Bengal gram was consumed weekly (urban - 14.07%, rural- 13.58 %),

half monthly (urban - 13.09 %, rural - 14.32 %), monthly(urban - 11.61%, rural-11.85%) and rarely (urban -10.86 %, rural - 16.62 %) respectively. Green gram was consumed weekly (urban - 2.47%, rural - 1.98 %), half monthly (urban - 20.49 %, rural-20.74 %), monthly(urban - 19.26 %,rural - 18.03 %) and rarely (urban - 7.41 %, rural-9.62 %) respectively.

Table 4.4.2 Distribution of college girls according to the food consumption pattern of pulses

Food Item	Daily	Alternate day	Weekly	Half Monthly	Monthly	Rarely	Never
Black gram							
Urban	-	-	38 (9.38)	54 (13.33)	42 (10.37)	67 (16.54)	-
Rural	-	-	34 (8.40)	53 (13.09)	48 (11.85)	69 (17.03)	-
Bengal gram							
Urban	-	-	57 (14.07)	53 (13.09)	47 (11.61)	44 (10.86)	-
Rural	-	-	55 (13.58)	58 (14.32)	48 (11.85)	43 (10.62)	-
Green gram							
Urban	-	-	10 (2.47)	83 (20.49)	78 (19.26)	30 (7.41)	-
Rural	-	-	8 (1.98)	84 (20.74)	73 (18.03)	39 (9.62)	-
Lentils							
Urban	-	-	-	-	21 (5.19)	117 (28.88)	63 (15.56)
Rural	-	-	-	-	16 (3.95)	111 (27.41)	77 (19.01)
Moth beans							
Urban	-	-	-	-	8 (1.96)	140 (34.57	53 (13.09)
Rural	-	-	-	-	7 (1.73)	140 (34.57)	57 (14.07)
Rajmah							
Urban	-	-	-	-	-	177 (43.70)	26 (6.42)
Rural	-	-	-	-	-	178 (43.95)	24 (5.93)

Lentils were consumed monthly, rarely and sometimes never by girls.. 5.19 %, 28.88 % of urban girls consumed lentils monthly and rarely, whereas,15.56 % of urban girls never consumed .3.95 %, 24.41% rural girls consumed lentils monthly and rarely, whereas, 19.01 % girls never consumed lentils. Similarly, moth beans and rajma was

consumed rarely by them. Most frequently consumed pulses were black gram, green gram and bengal gram. Thus, it can be concluded that majority of college girls consumed certain pulses monthly and almost rarely.

4.4.3 Dals

Dals are good sources of protein and some vitamins. Table 4.4.3 shows the data related to consumption pattern of dals anomg college girls.

Table:4.4.3 Distribution of college girls according to the food consumption pattern for dals.

Food Item	Daily	Alternate day	Weekly	Half Monthly	Monthly	Rarely	Never
Red gram dal							
Urban	107 (26.42)	34 (8.40)	19 (4.69)	22 (5.43)	19 (4.69)	-	-
Rural	103 (25.43)	32 (7.90)	23 (5.68)	29 (7.16)	17 (4.20)	-	-
Bengal gram dal							
Urban	-	-	-	10 (2.46)	131 (32.35)	60 (14.82)	-
Rural	-	-	-	9 (2.22)	127 (31.36)	68 (16.79)	-
Green gram dal							
Urban	-	19 (4.69)	22 (5.43)	74 (18.27)	39 (9.63)	50 (12.35)	-
Rural	-	27 (6.67)	20 (4.94)	73 (18.03)	43 (10.62)	38 (9.38)	-
Black gram dal							
Urban	-	-	-	54 (13.33)	48 (11.85)	99 (24.44)	-
Rural	-	-	-	52 (12.84)	68 (16.79)	84 (20.74)	-

Only 26.42 % and 25.43 % of urban and rural girls consumed red gram dal daily. Rest of urban girls consumed red gram dal alternately (8.40 %), weekly (4.69 %) ,half monthly (5.43 %) and monthly (4.69%) whereas, the rural girls consumed red gram dal alternately (7.90 %), weekly (5.68 %) ,half monthly (7.16%) and monthly (4.20 %) respectively. Bengal gram dal was not consumed daily, alternately and weekly. 2.46 % , 32.35 % and 14.82% of urban girls consumed bengal gram dal half monthly, monthly and rarely, whereas, 2.22 %,31.36 % and 16.79 % of rural girls consumed bengal gram dal half monthly, monthly and rarely. The consumption data of green gram dal and black gram dal shows that all the college girls consumed these dals alternately, weekly, half monthly, monthly and rarely. 4.69%, 5.43 %, 18.27 %, 9.63% and 12.35 %

of urban girls consumed green gram dal alternately, weekly, half monthly, monthly and rarely. 6.67%, 4.94 %, 18.03 %, 10.62 % and 9.38 % of rural college girls consumed green gram dal alternately, weekly, half monthly, monthly and rarely. 13.33 %, 11.85 % and 24.44 % of urban college girls consumed black gram dal half monthly, monthly and rarely. Thus, it can be concluded that very few college girls consumed dal daily and most frequently consumed dal was red gram dal.

4.4.4 Green Leafy Vegetables (GLVs)

Green leafy vegetables are rich sources of iron, calcium and some vitamins like pro vitamin A and vitamin C. The data was collected for the consumption pattern of green leafy vegetables of college girls. Table 4.4.4 depicts green leafy vegetables consumption among college girls. Cabbage was consumed by urban college girls, alternately (13.58%), weekly (24.94 %), half monthly (6.67 %),monthly (4.44 %) ,whereas, rural girls consumed it alternately (12.59 %), weekly (25.68 %), half monthly (7.90 %), monthly (4.20%).Coriander was consumed by urban girls, daily (28.15%), alternately (10.12%), weekly (4.20%), half monthly (4.94%) and monthly (2.22%) whereas, rural girls consumed coriander daily (26.67%), alternately (9.63 %), weekly (4.94 %), half monthly (7.16 %) and monthly (1.97%).Fenugreek was consumed by urban girls, weekly (11.85 %), half monthly (16.54 %), monthly (12.84 %) and rarely (8.89 %), whereas, rural girls consumed fenugreek ,weekly (10.37 %), half monthly (16.54 %), monthly (14.82) and rarely (8.64 %). Spinach was consumed by urban girls, half monthly (27.16%),monthly (19.01%) and rarely (3.46 %), whereas, rural girls consumed spinach half monthly (24.94%), monthly (22.22%) and rarely (3.21 %). Colocasia leaves were consumed by urban girls monthly (20%) and rarely (26.93%) whereas, rural girls consumed it monthly (22.22%) and rarely (28.15%). Mint leaves consumed by urban girls were half monthly (2.96 %), monthly (11.85 %) and rarely (34.81%) and rural girls consumed it half monthly (1.71%), monthly (16.79%) and rarely (31.85 %).

Table 4.4.4 Distribution of college girls according to the food consumption pattern for green leafy vegetables.

Food Item	Daily	Alternate day	Weekly	Half Monthly	Monthly	Rarely	Never
Cabbage							
Urban	-	55 (13.58)	101 (24.94)	27 (6.67)	18 (4.44)	-	-
Rural	-	51 (12.59)	104 (25.68)	32 (7.90)	17 (4.20)	-	-
Coriander							
Urban	114 (28.15)	41 (10.12)	17 (4.20)	20 (4.94)	9 (2.22)	-	-
Rural	108 (26.67)	39 (9.63)	20 (4.94)	29 (7.16)	8 (1.97)	-	-
Fenugreek leaves							
Urban	-	-	48 (11.85)	65 (16.05)	52 (12.84)	36 (8.89)	-
Rural	-	-	42 (10.37)	67 (16.54)	60 (14.82)	35 (8.64)	-
Spinach							
Urban	-	-	-	110 (27.16)	77 (19.01)	14 (3.46)	-
Rural	-	-	-	101 (24.94)	90 (22.22)	13 (3.21)	-
Colocasia leaves							
Urban	-	-	-	-	81 (20)	120 (29.63)	-
Rural	-	-	-	-	90 (22.22)	141 (28.15)	-
Mint leaves							
Urban	-	-	-	12 (2.96)	48 (11.85)	141 (34.81)	-
Rural	-	-	-	7 (1.71)	68 (16.79)	129 (40.99)	-
Amaranth leaves(Tandalja ni bhaji)							
Urban	-	-	-	44 (10.86)	145 (35.80)	12 (2.97)	-
Rural	-	-	-	60 (14.82)	126 (31.11)	18 (4.44)	-
Radish leaves							
Urban	-	-	-	34 (8.39)	167 (41.24)	-	-
Rural	-	-	-	38 (9.38)	166 (40.99)	-	-

Amaranth leaves were consumed by urban girls were half monthly (10.86 %), monthly (35.80 %) and rarely (2.97 %) and rural girls consumed it half monthly

(14.82 %), monthly (31.11%) and rarely (4.44 %). half monthly. Radish leaves were consumed by urban girls were half monthly (8.39 %), monthly (41.24 %) and rural girls consumed it monthly (9.38 %) and rarely (40.99%).Only, coriander was consumed daily and most frequent GLVs consumed were spinach, fenugreek and cabbage.

Table:4.4.5 Distribution of college girls according to the food consumption pattern of fruits

Food Item	Daily	Alternate day	Weekly	Half Monthly	Monthly	Rarely	Never
Apple							
Urban	-	-	29 (7.16)	139 (34.32)	-	33 (8.15)	-
Rural	-	-	27 (6.67)	139 (34.32)	-	38 (9.38)	-
Banana							
Urban	-	-	-	170 (41.48)	27 (6.67)	7 (1.72)	-
Rural	-	-	-	163 (40.24)	28 (6.92)	13 (3.21)	-
Dates							
Urban	-	-	86 (21.24)	44 (10.86)	40 (9.88)	31 (7.65)	-
Rural	-	-	87 (21.48)	36 (8.89)	42 (10.37)	39 (9.63)	-
Guava							
Urban	-	-	-	-	28 (6.91)	173 (42.72)	-
Rural	-	-	-	-	25 (6.17)	179 (44.20)	-
Lemon							
Urban	77 (19.01)	55 (13.58)	13 (3.21)	29 (7.16)	-	27 (6.67)	-
Rural	75 (18.52)	53 (13.09)	12 (2.96)	25 (6.17)	-	39 (9.63)	-
Orange							
Urban	-	-	-	113 (27.90)	41 (10.12)	47 (11.61)	-
Rural	-	-	-	110 (27.16)	42 (10.37)	52 (12.84)	-
Papaya							
Urban	-	-	-	129 (31.85)	- (-)	72 (17.78)	-
Rural	-	-	-	100 (24.69)	37 (9.14)	67 (16.54)	-
Tomato							
Urban	81 (20)	91 (22.47)	15 (3.70)	16 (3.95)	-	-	-

Rural	80 (19.75)	92 (22.71)	16 (3.95)	13 (3.21)	-	-	-
Amla							
Urban	-	-	39 (9.63)	44 (10.86)	85 (20.99)	33 (8.15)	-
Rural	-	-	39 (9.63)	37 (9.14)	88 (21.73)	40 (9.87)	-
Ripe mango							
Urban	-	-	113 (27.90)	23 (5.68)	21 (5.19)	44 (10.86)	-
Rural	-	-	108 (26.67)	25 (6.17)	15 (3.70)	56 (13.83)	-
Musk melon							
Urban	-	-	83 (20.49)	28 (6.91)	6 (1.48)	84 (20.74)	-
Rural	-	-	86 (21.24)	22 (5.43)	33 (8.15)	63 (15.56)	-
Pineapple							
Urban	-	-	82 (20.25)	- (-)	12 (2.96)	107 (26.42)	-
Rural	-	-	85 (20.99)	- (-)	13 (3.21)	106 (26.17)	-
Pomegranate							
Urban	-	-	86 (21.24)	27 (6.67)	5 (1.24)	83 (20.49)	-
Rural	-	-	85 (20.99)	24 (5.93)	13 (3.21)	82 (20.25)	-
Sapota							
Urban	-	-	83 (20.49)	28 (6.91)	6 (1.48)	84 (20.74)	-
Rural	-	-	86 (21.24)	22 (5.43)	11 (2.72)	83 (20.49)	-
Custard apple							
Urban	-	-	-	-	28 (6.91)	173 (42.72)	-
Rural	-	-	-	-	23 (5.68)	179 (44.20)	-
Grapes							
Urban	-	28 (6.91)	28 (6.91)	100 (32.10)	30 (7.40)	15 (3.70)	-
Rural	-	22 (5.43)	56 (13.83)	44 (10.86)	37 (9.14)	45 (11.11)	-

Fruits are rich sources of some vitamins like vitamin C and pro vitamin A. Table:4.4.5 gives information regarding consumption of fruits by college girls. It shows that apple, banana, dates, guava, orange, papaya, amla, mango, musk melon, pineapple, pomegranate, sapota, and custard apple were not consumed daily and alternately, but

weekly (urban- 7.16 %, rural- 6.67 %), half monthly (urban -34.32%, rural- 34.32) and rarely (rural -9.38%).Banana was consumed half monthly (urban -41.48 %, rural - 40.24 %), monthly (urban -6.67 %, rural -6.92) and half monthly (urban-1.72 %, rural-3.21 %). Dates are rich in iron but it was also consumed weekly (urban- 21.24 %, rural-21.48 %),half monthly (urban -10.86 %, rural- 8.89%), monthly (urban -9.88%, rural-10.37%) and rarely (urban -7.68%, rural -9.63 %).Guava was consumed monthly (urban-6.91%, rural-6.17%) and rarely (urban -42.72%, rural-44.20%). Lemon was consumed daily(urban-19.01%, rural-18.52%), alternately (urban- 13.58%, rural-13.04 %) weekly (urban -3.21 %, rural-2.96 %), half monthly (urban-7.16 %, rural-6.17%)and rarely (urban - 6.67 %, rural - 9.63 %). Orange was consumed half monthly (urban-27.90%,rural-27.10%), monthly (urban-10.12%, rural-10.37%) and rarely (urban - 11.61%, rural-12.84%). Papaya was consumed half monthly (urban-31.85 %,rural-24.69 %), monthly (rural-9.14%) and rarely (urban-17.78%, rural-16.54%).Ripe tomatoes were consumed daily(urban-20%, rural-19.75%) , alternately (urban-22.47%, rural-22.71%), weekly (urban-3.70%, rural-3.95%), half monthly (urban-3.95% , rural-3.21%). Amla was consumed weekly (urban and rural 9.63%), half monthly(urban-10.86%, rural- 9.14%), monthly (urban-20.99%, rural-21.73%) and rarely (urban-8.15%, rural-9.87%).Other fruits like mango, musk melon, pineapple, pomegranate, sapota, custard apple were consumed weekly, half monthly, monthly and rarely. Ripe mangoes were consumed weekly (urban-27.90 %, rural-26.67%) ,half monthly (urban-5.68%,rural-6.17%),monthly (urban-5.19 %, rural-3.70%) and rarely (urban -10.86%, rural- 13.83%). Musk melon was consumed weekly (urban-20.49 %, rural- 21.24 %),half monthly (urban-6.91 %,rural-5.43%), monthly (urban -1.48%, rural-8.15%) and rarely (urban -20.74%, rural- 5.56%).Pineapple was consumed weekly (urban-20.25%, rural-20.99%), monthly (urban-2.96%, rural-3.21%) and rarely (urban-26.42%, rural-26.17%). Pomegranate was consumed weekly (urban-21.24%, rural-20.99%), half monthly (urban-6.67%, rural-5.93%), monthly (urban -1.24%, rural-3.21) and rarely (urban-20.49%, rural-20.25%). Sapota was consumed weekly (urban-20.49 %, rural-21.24%), half monthly (urban-6.91%, rural-5.43%), monthly (urban - 1.48 %, rural-2.72%) and rarely (urban-20.74 %, rural-20.49%).Custard apple was consumed monthly (urban -6.91%, rural-5.68%) and rarely (urban-42.72%, rural-44.20%)Grapes was consumed alternately (urban-6.91%,rural-5.43%),weekly(urban-6.91 %, rural-13.83 %), half monthly (urban-32.10 %, rural-10.86 %), monthly(urban - 7.40 %, rural-9.14%) and rarely(urban-3.70 %, rural-11.11%).Only lemon, tomatoes

were consumed daily. Thus, it can be concluded that most frequently consumed fruits was lemon and ripe tomato.

Table 4.4.6 Distribution of college girls according to the food consumption pattern of milk and milk products.

Food Item	Daily	Alternate day	Weekly	Half Monthly	Monthly	Rarely	Never
Milk							
Urban	114 (28.15)	42 (10.37)	23 (5.68)	11 (2.72)	6 (1.48)	5 (1.24)	-
Rural	107 (26.42)	51 (12.59)	17 (4.20)	18 (4.44)	11 (2.72)	-	-
Curd							
Urban	-	-	33 (8.15)	-	-	168 (41.49)	-
Rural	-	-	39 (9.63)	-	10 (2.47)	155 (38.27)	-
Butter milk							
Urban	162 (40)	39 (9.63)	-	-	-	-	-
Rural	154 (38.02)	39 (9.63)	11 (2.72)	-	-	-	-
Cheese							
Urban	-	-	-	37 (9.14)	140 (34.57)	24 (5.93)	-
Rural	-	-	-	30 (7.41)	153 (37.78)	21 (5.19)	-
Khoa							
Urban	-	-	-	74 (18.27)	118 (29.14)	9 (2.22)	-
Rural	-	-	-	75 (18.52)	119 (29.38)	10 (2.47)	-

Milk and milk products are rich sources of complete protein and some vitamins. It is a complete diet for infants, children and old age people. Milk was consumed daily (urban-28.15%,rural-26.42%), alternately (urban-10.37 %,rural-12.59 %),weekly(urban-5.68 %,rural-4.20 %),half monthly (urban-2.72 %, rural-4.44 %), monthly (urban-1.48%, rural-2.72 %) and rarely (urban-1.24%). Curd was consumed weekly (urban-8.15 %, rural-9.63 %), monthly (urban-2.47%) and rarely (urban-41.49 %,rural-38.77 %). Butter milk was consumed daily (urban-40 %, rural-38.02 %), alternately (urban and rural -9.63 %). Cheese was consumed half monthly (urban-9.14 %, rural-7.14 %), monthly (urban -34.57 %, rural -37.78%) and rarely (urban-5.93%, rural-5.19 %). Khoa was consumed half monthly (urban-18.27 %, rural- 18.52 %),

monthly (urban -29.14 %, rural -29.38 %) and rarely (urban-2.22%, rural-2.47 %). Thus, it can be concluded that milk and buttermilk was most frequently consumed by college girls.

Table 4.4.7 Distribution of college girls according to the food consumption pattern of sugar and jaggery.

Food Item	Daily	Alternate day	Weekly	Half Monthly	Monthly	Rarely	Never
Sugar							
Urban	201 (49.63)	-	-	-	-	-	-
Rural	204 (5.37)	-	-	-	-	-	-
Jaggery							
Urban	56 (13.83)	28 (6.91)	47 (11.61)	20 (4.94)	50 (12.35)	-	-
Rural	98 (24.20)	32 (7.90)	49 (12.10)	25 (6.17)	-	-	-
Sago							
Urban	-	-	-	-	154 (38.03)	47 (11.61)	-
Rural	-	-	-	-	165 (40.74)	39 (9.63)	-

Sugar and jaggery are important sources of carbohydrates and energy. All the college girls consumed sugar daily. Jaggery was consumed daily (urban-13.83%,rural-24.20 %), alternately (urban-6.91 %,rural-7.90 %),weekly (urban-11.61 %, rural-12.10 %),half monthly (urban-12.50%).Sago was consumed monthly (urban-38.03%, rural-40.74%) and rarely (urban -11.61%, rural-9.63%).Thus, it can be concluded that sugar and jaggery was most frequently consumed by college girls.

Table: 4.4.8 Frequency of consumption of other types of food among college girls.

Food Item	Urban (n=201) F (%)	Rural (n=204) F (%)	Overall (N=405) F (%)
Street foods			
Panipuri	201 (49.63)	204 (50.37)	405 (100)
Pakodas	89 (21.47)	92 (23.46)	181 (44.69)
Vadapav	140 (34.57)	138 (34.07)	278 (68.64)
Dabeli	58 (14.32)	61 (15.06)	119 (29.38)
Pav bhaji	201 (49.63)	204 (50.37)	405 (100)
Sandwich	128 (31.61)	126 (31.11)	254 (62.72)
Restaurant foods			
Punjabi	158 (39.01)	147 (36.30)	305 (75.31)
Chinese	139 (34.32)	122 (30.12)	261 (64.44)
South Indian	201 (49.63)	204 (50.37)	405 (100)
Seasonal foods			
Vasana	59 (14.57)	62 (15.31)	121 (29.88)
Chayvanprash	38 (9.38)	35 (8.64)	73 (18.03)
Iodized salt	201 (49.63)	190 (46.91)	391 (96.54)
Non Iodized salt	-	14 (3.46)	14 (3.46)
Non vegetarian foods			
Egg, meat and fish	-	-	-

Other food items consumed by the college girls is given in Table 4.4.8. It depicts that majority of college girls consumed street foods like panipuri, pakodas, vadapav, dabeli, pav bhaji and sandwiches. All the urban and rural college girls consumed panipuri most frequently. 21.47 % and 23.46 % of urban and rural college girls consumed pakodas frequently. 34.57 % and 34.07 % of urban and rural college girls consumed vadapav frequently. 49.63 % and 50.37 % of urban and rural college girls consumed pavbhaji and 31.61 % and 31.11 % of urban and rural college girls consumed sandwiches frequently. Restaurant foods were also frequently consumed by the girls. 39.01 % and 36.30 % of urban and rural college girls consumed Punjabi foods, 34.32 % and 30.12 % of urban and rural college girls consumed Chinese foods and 50.7 % and 50.37 % of urban and rural college girls consumed South Indian foods. Seasonal foods or protective foods like vasana and chayvanprash were consumed by girls rarely. Only 14.57 % and 15.31 % of urban and rural college girls consumed vasana and 9.38 % and 8.64 % of urban and rural college girls consumed chayvanprash rarely. 49.63 % and 46.91 % of urban and rural college girls consumed iodized salt and

only 3.46 % of rural college girls consumed non iodized salt. Thus, it can be concluded that majority of college girls consumed panipuri, pakodas, pavbhaji,Punjabi, Chinese and South Indian foods most frequently.

4.4.9 Daily intake level of iron rich foods.

Daily intake level of iron and vitamin C among college girls were studied. Intake level was categorized as poor, fair and good.

Table: 4.4.9 Distribution of college girls according to intake level of iron rich foods.

Daily intake level (range)	Urban (n=201) F (%)	Rural (n=204) F (%)	Overall (N= 405) F (%)
Poor (< 223)	52 (12.84)	47 (11.61)	99 (24.44)
Fair (224-260)	48 (11.85)	57 (14.07)	105 (25.93)
Good (>261)	101 (24.94)	100 (24.69)	201 (49.63)
Total	201 (49.63)	204 (50.37)	405 (100)

In present investigation, 12.84 % and 11.61 % of urban and rural girls had poor intake of iron rich foods whereas, 11.85 % and 14.07 % of urban and rural girls had fair intake of iron rich foods. 24.94 % and 24.69 % of urban and rural girls had good intake of iron rich foods. Overall, 24.44 %, 25.93 % and 49.63 % of college girls had poor, fair and good intake of iron rich foods respectively. Thus, it can be concluded that majority of urban and rural girls had poor and fair intake level of iron rich foods.

4.4.10 Daily intake level of vitamin C rich foods.

Daily intake level of vitamin C rich among college girls were studied. Intake level was categorized as poor, fair and good.

Table: 4.2.10 Distribution of college girls according to intake level of vitamin C rich foods.

Intake level of vitamin C rich foods (range)	Urban (n=201) F (%)	Rural (n=204) F (%)	Overall (N=405) F (%)
Poor (< 210)	48 (11.85)	44 (10.86)	92 (22.72)
Fair (211-246)	49 (12.10)	53 (13.08)	102 (25.19)
Good (>247)	104 (25.68)	107 (26.42)	211 (52.10)
Total	201 (49.63)	204 (50.37)	405 (100)

In present investigation, 11.85 % and 10.86 % of urban and rural girls had poor intake of vitamin C rich foods, whereas, 12.10 % and 13.08 % of urban and rural girls had fair intake of vitamin C rich foods. 25.68 % and 26.42 % of urban and rural girls had good intake of vitamin C rich foods. Thus, it can be concluded that majority of urban and rural girls had poor, fair and good intake of vitamin C rich foods.

4.5 Impact of intervention programme

4.5.1 Knowledge intervention

Knowledge intervention is an effective tool for being aware and helps change dietary behavior among community. It brings desirable changes in knowledge level which leads to a beneficial effect on health and over all nutritional status. Knowledge intervention was carried out by lectures, power point presentation and recipe demonstration of various iron rich foods. Lecture was delivered by a Foods and Nutrition expert that included all the facts about anaemia. The literature was prepared in a local language i.e. Gujarati. After lecture, feedback was taken which showed positive impact of the intervention and the girls showed better awareness about the facts related to anaemia .

Power point presentation

Power point presentation included all the basic facts which are responsible for anaemic condition among college girls. It included prevalence and causes of anaemia, effects and symptoms of anaemia and the dietary guidelines for the prevention of anaemia and points which are essential to overcome the presence of anaemic condition.

Plate:4.2 Power point presentation as a part of knowledge intervention

Plate:4.3 College girls at the knowledge intervention programme

Plate:4.4 Power point presentation as a part of knowledge intervention programme

Plate:4.5 College girls at knowledge intervention programme

Plate: 4.6 Power point presentation as a part of knowledge intervention programme

Recipe Demonstration

Recipe demonstration was carried out with the aim to improve the knowledge regarding iron rich foods and its method of preparation. For that different selected iron rich recipes were formulated and demonstrated are as under. The main aim was to create awareness regarding low cost iron rich foods which are locally available and how addition of these foods in recipes in daily diet helps in prevention of anaemia as a long term approach.

- Niger seeds chikki
- Mix sukhadi
- Cow peas dhokali
- Date laddoos.

Niger seeds chikki

Table: 4.5.1 Nutritive value of niger seeds chikki per 100 g.

Ingredients	Amt. (g)	Protein (g)	Energy (Kcal.)	Iron (mg)	Calcium (mg)
Niger seeds	100	23.9	515	56.7	300
Jaggery	100	0.4	383	2.64	80
Ghee	50	-	450	-	-
Total	250	24.3	1348	59.34	380
Per 100 g	100	9.72	539.20	27.74	152

Source: C. Gopalan, NIN, ICMR, Nutritive value of Indian foods (1989)

Plate : 4.7 Demonstrated recipes(Niger seeds chikki and mix sukhadi).

Mix sukhadi

Table: 4.5.2 Nutritive value of mix sukhadi per 100 g.

Ingredients	Amt. (g)	Protein (g)	Energy (Kcal.)	Iron (mg)	Calcium (mg)
GCS Powder	50	12.65	227	50	188.5
Groundnut Powder	50	13.10	285	1.55	38.5
Scrapped Coconut	50	3.4	331	3.9	200
Jaggery	150	0.6	574.5	3.96	7.5
Ghee	50	-	450	-	-
Total	350	29.75	1867.5	59.41	236.5
Per 100 g	100	8.5	533.57	16.97	67.57

Source: C.Gopalan, NIN,ICMR, Nutritive value of Indian foods (1989)

Cow peas dhokali

Table: 4.5.3 Nutritive value of cow peas dhokali per 100 g

Ingredients	Amount (g)	Protein (g)	Energy (Kcal.)	Iron (mg)	Calcium (mg)
Cow peas	50	12.05	173.50	4.3	77
Wheat flour	50	6.05	173	2.65	20.5
Curd	25	0.775	15	0.05	37.25
Tomato	25	0.225	5	0.16	12
Onion	25	0.45	14.75	0.30	10
Coriander leaves	10	0.33	4.4	0.142	18.4
Gingelly seeds	10	1.83	56.3	0.93	145
Oil	20	-	180	-	-
Total	215	21.71	621.95	8.532	320.15
Per 100 g	100	10.12	289.28	3.97	148.91

Source: C. Gopalan, NIN,ICMR, Nutritive value of Indian foods (1989)

Plate:4.8 Demonstrated recipe (Cow peas Dhokali)

Date Laddoos

Table: 4.5.4 Nutritive values of date laddoos per 100 g

Ingredients	Amt. (g)	Protein (g)	Energy (Kcal.)	Calcium (mg)	Iron (mg)
Date	100	2.5	317	120	7.3
Coconut powder	100	6.8	662	400	7.8
Sugar	50	0.05	199	6	0.078
Ghee	50	-	450	-	-
Total	250	9.35	1628	526	15.178
Per 100 g	100	3.74	651.2	210.4	6.071

Source: C. Gopalan, NIN, ICMR, Nutritive value of Indian foods (1989)

Plate:4.9 Demonstrated recipe (Date ladoos)

Thus, it can be concluded that these iron rich recipes aids in reducing anaemic condition and ultimately improving health status by enhancing blood haemoglobin level.

Impact of knowledge intervention programme

Table:4.5.5 Impact of knowledge intervention programme.

Variables	% of knowledge Before	% of knowledge After	% difference
Nutritional knowledge	56.31	75.39	19.08
Anaemia awareness	63.46	85.35	21.89
Overall	59.86	80.37	20.49

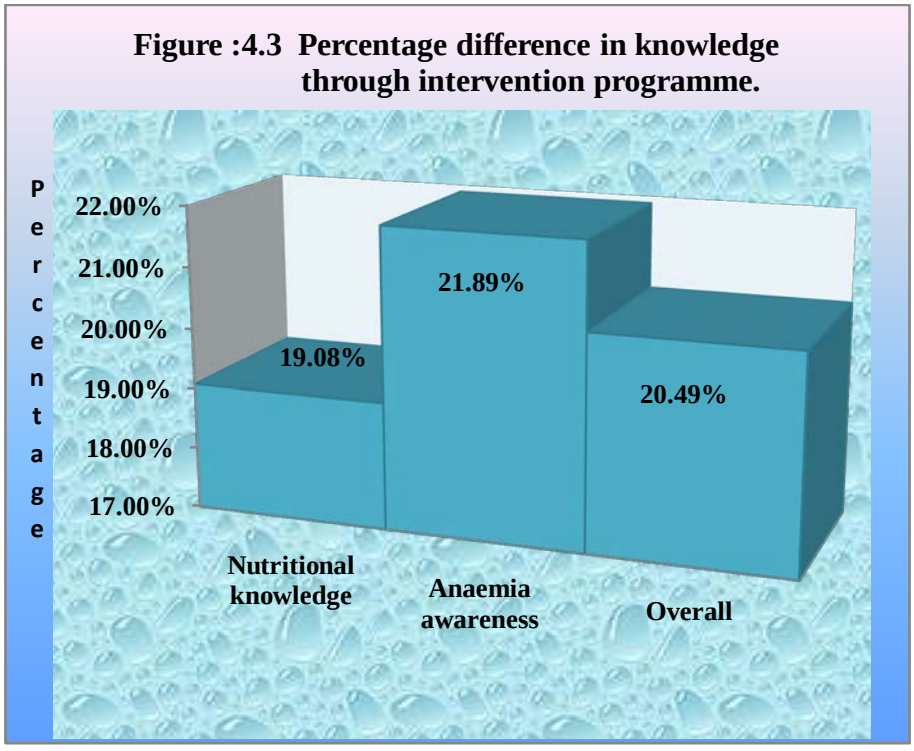


Table : 4.5.5 and Figure:4.3 reveals that before intervention programme, college girls had 56.31 % of nutritional knowledge and 63.40 % of college girls had anaemia awareness and after intervention programme, college girls showed improvement of 75.39 % of nutritional knowledge and 85.35 % of college girls had shown improved anaemia awareness. There was 19.08 % increase in nutritional knowledge and 21.85 % increase in anaemia awareness. Overall, there was 20.49 % increase in overall nutritional knowledge among college girls. Similar observation was found in the study of **Shah and Joshi (2015)**, where there was 32.04 % increase in nutritional knowledge and 37.94 % increase in anaemia awareness among college girls.

4.6 Relational Analysis

4.6.1 Relationship between personal, socio- economic and communicational characteristics of college girls and their nutritional status.

To explore the relationship between independent variables and nutritional status of college girls, the zero order correlation coefficient and multiple regression was applied for each of the independent variable. The value of correlation coefficient (r) and regression coefficient (b) were estimated and then tested for their statistical significance. The observed relationships are discussed with respect to personal, socio-economical, communicational and nutritional variables of college girls.

4.6.2 Correlation analysis

It was hypothesized that there was no relationship between different sets of independent variables like personal, socio-economic, communicational and nutritional characteristics of the college girls and their nutritional status. Zero order correlation was used as a measure for estimating relationship between independent and dependent variables. The data on relationship between selected independent variables with nutritional status of college girls in terms of BMI, clinical signs and symptoms, haemoglobin level, nutritional knowledge, awareness regarding anaemia and overall nutritional knowledge of college girls are presented in Table 4.6.1

Table 4.6.1. reveals that BMI was positively and significantly correlates with blood haemoglobin, iron intake and vitamin C intake. Clinical signs and symptoms positively and significantly correlates with age at menarche and pica. Nutritional knowledge, anaemia awareness and overall, nutritional knowledge positively and significantly correlates with age, and sources of information used by college girls. Haemoglobin was positively and significantly correlated to heavy menstrual bleeding, iron intake and vitamin C intake. Thus, it can be concluded that, in present investigation, age, age at menarche, morbidities, pica, heavy menstrual bleeding, iron and vitamin C intake, nutritional knowledge and awareness regarding anaemia played an important role in association with BMI, clinical signs and symptoms, nutritional knowledge haemoglobin level and nutritional status of college girls.

Table : 4.6.1 Relational analysis of selected variables.

No	Variables	R value	Level of significance
1.	Body Mass Index		
	• Blood Haemoglobin	0.172*	S.
	• Iron Intake	0.213**	H.S
	• Vitamin C intake	0.230**	H.S.
2.	Clinical signs and symptoms		
	• Age at menarche	0.216**	H.S.
	• Pica	0.193**	H.S.
3.	Nutritional knowledge		
	• Age	0.166*	S.
	• Overall knowledge	0.628**	H.S.
4.	Anaemia awareness		
	• Total knowledge	0.526**	H.S.
	• Sources of information	0.271**	H.S.
5.	Total nutritional knowledge		
	• Sources of information	0.372**	H.S.
6.	Blood haemoglobin level		
	• Heavy menstrual bleeding	0.208**	H.S.
	• Iron intake	0.798**	H.S.
	• Vitamin C intake	0.806**	H.S.

4.6.2 Regression analysis.

Extent of variation caused by dependent variables on nutritional status by multiple regression analysis of selected variables. Correlation analysis merely portrays co-existence of relation between any two variables. This does not capture the interaction effect among variables. One variable is associated with or simultaneously depends on several others. Nutritional status of college girls was postulated as linear function of personal, socio-economic, communication, and nutritional variables. It is not by any of these factors taken in isolation but as a part of complex and interacting system. The determination of the rate of change in dependent variable with respect to each independent variable could be seen through multiple regression analysis. The coefficient of determination R^2 reveals the percentage of variation in the dependent variable explained by the selected variables considered. Based on this approach, the multiple regression analysis using linear model was carried out to explore the combined effect of the independent variables in explaining the total variation in the dependent variables. In multiple regression analysis selected variables were fitted to explain the variation in nutritional status of college girls. The results are presented in Table 4.6.2

Table: 4.6.2 Regression analysis of selected variables.

No	Variables	P value	Level of Significance
1.	BMI		
	• Types of diet	0.035	H.S.
	• Types of work	0.05	S.
2.	Clinical signs and symptoms		
	• Heavy menstrual bleeding	0.010	H.S.
	• Morbidities	0.009	H.S.
	• Pica	0.0011	H.S.
	• Sources of information	0.050	S.
3.	Nutritional knowledge		
	• Age	0.004	H.S.
	• Sources of information	0.003	H.S.
4.	Anaemia awareness		
	• Age	0.0004	H.S.
	• Sources of information	0.0035	H.S.
5.	Total nutritional knowledge		
	• Age at menarche	0.019	H.S.
	• Sources of information	0.0021	H.S.
6.	Blood haemoglobin level		
	• Pica	0.0017	H.S.
	• Morbidities	0.0049	H.S.
	• Iron intake	0.0145	H.S.
	• Vitamin C intake	0.00067	H.S.

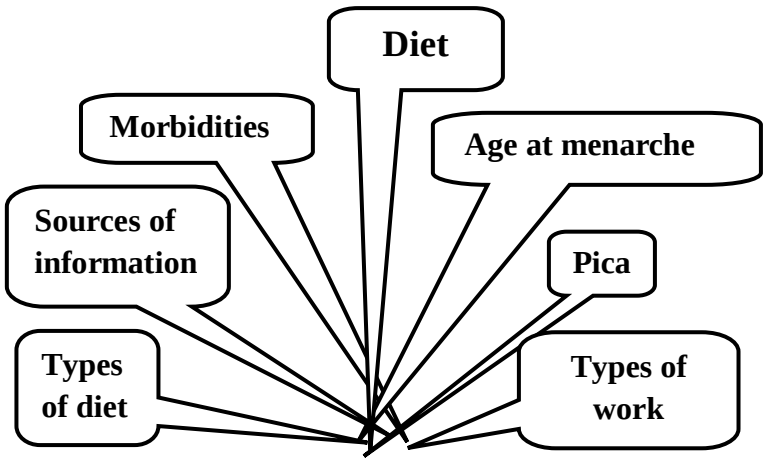
Body Mass Index (BMI)

All the independent variables mentioned in Table 4.6.2 and Figure 4.4 explains that there was as much as 6.80 % total variation in the level of BMI of all college girls. The unexplained variation of 93.2 % may be due to factors outside the scope of the study. The multiple correlation (R) was 0.260 indicating that correlation between BMI of college girls and the level of nutritional status calculated on the basis of independent variable was significant.

It can be revealed that the "P" values of selected variables like types of diet was significant at $p< 0.05$ and types of work was highly significant at $p< 0.01$ level of significance, indicating significant contribution of these two variables in explaining the variation in BMI of all the college girls. Remaining variables had non- significant relationship with BMI of all the college girls.

Clinical signs and symptoms

All the independent variables mentioned in Table 4.6.2 and Figure 4.4 explains that there was as much as 14.19 % total variation in the level of clinical signs and symptoms of college girls. The unexplained variation of 85.81 % may be due to factors outside the scope of the study. The multiple correlation (R) was 0.38 indicating that correlation between clinical signs and symptoms of college girls and the level of nutritional status calculated on the basis of independent variable was significant. It can be revealed that the "P" values of selected variables like heavy menstrual bleeding, morbidities and pica were highly significant at $p<0.01$ level of significance and sources of information was significant at $p<0.05$ level indicating significant contribution of these variables in explaining the variation in clinical signs and symptoms of all the college girls. Remaining variables had non- significant relationship with clinical signs and symptoms of all the college girls.



BMI - R^2- 6.80, Multiple R = 0.26

Clinical signs and symptoms- R^2- 14.19 Multiple R = 0.38

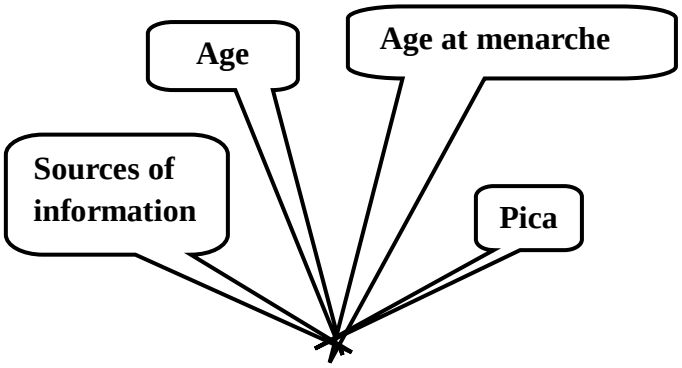
Figure :4.4 Multiple regression analysis of independent variables with BMI and clinical signs and symptoms

Nutritional Knowledge

All the independent variables mentioned in Table 4.6.2 and Figure 4.27 explains that there was as much as 9.90 % total variation in the level of nutritional knowledge of all college girls. The unexplained variation of 90.1 % may be due to factors outside the scope of the study. The multiple correlation (R) was 0.32 indicating that correlation

between nutritional knowledge of all college girls calculated on the basis of independent variable was significant.

It can be revealed that the "P" values of selected variables like age and sources of information were highly significant at $p<0.01$ level of significance, indicating significant contribution of these two variables in explaining the variation in nutritional knowledge of all the college girls. Remaining variables had non- significant relationship with level of nutritional knowledge of all the college girls.



Nutritional knowledge R^2 =9.90, Multiple R =0.32
Anaemia awareness R^2= 9.90 Multiple r =0.315
Total knowledge- R^2 =15.86 %, Multiple r = 0.398

Figure:4.5 Multiple regression of independent variables with nutritional knowledge level

All the independent variables mentioned in Table 4.6.2 and Figure 4.5 explains that there was as much as 9.90 % total variation in the level of awareness regarding anaemia of urban-rural college girls. The unexplained variation of 90.1 % may be due to factors outside the scope of the study. The multiple correlation (R) was 0.315 indicates the correlation between awareness regarding anaemia of all college girls and the level of awareness regarding anaemia calculated on the basis of independent variable was significant.

It can be revealed that the "P" values of selected variables like, age and sources of information were highly significant at $p < 0.01$ level of significance, indicating significant contribution of these two variables in explaining the variation in awareness

regarding anaemia in all the college girls. Remaining variables had non- significant relationship with level of awareness regarding anaemia in all the college girls.

Haemoglobin

All the independent variables mentioned in Table 4.6.2 and Figure 4.6 explained that there was as much as 68.30 % total variation in the level of haemoglobin of all college girls. The unexplained variation of 31.7 % may be due to factors outside the scope of the study. The multiple correlation (R) was 0.826 indicating that correlation between haemoglobin and nutritional status of the all college girls and the level of haemoglobin calculated on the basis of independent variable was significant.

It can be revealed that the "P" values of four variables like pica, morbidities, iron and vitamin C intake were highly significant at $p< 0.01$ level of significance, indicating significant contribution of these four variables in explaining the variation in haemoglobin of all the college girls. Remaining variables had non- significant relationship with level of haemoglobin of all the college girls.

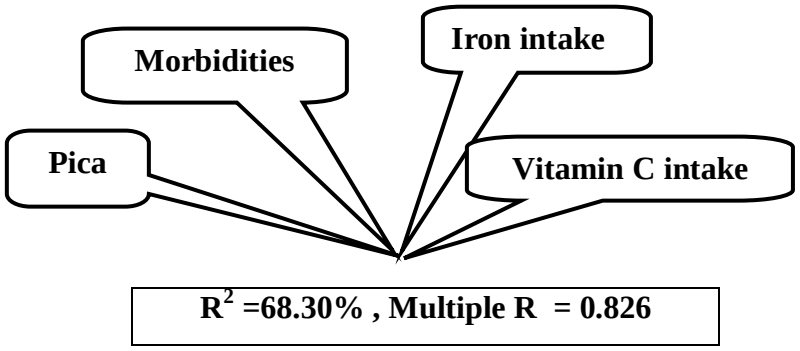


Figure :4.6 Multiple regression of independent variables with blood haemoglobin level.

4.7 Hypothesis testing

4.7.1 Area of residence

Ho 1: ***There will be no significant effect of area of residence on blood haemoglobin and nutritional knowledge level among college girls.***

Table: 4.7.1 Influence of area of residence on blood haemoglobin level and nutritional knowledge level.

Variables	Urban (Mean)	Rural (Mean)	't' calculated	't' tabulated	Level of significance
Blood haemoglobin	10.67	10.66	0.00247	1.95	N.S.
Nutritional knowledge	16.35	16.33	0.518	1.95	N.S

Table 4.7.1 gives information regarding hypothesis testing between urban and rural girls. For testing of hypothesis, 't' analysis was computed and it revealed that there was not any significant difference found between area of residence of college girls and blood haemoglobin level. It expressed that all the selected college girls had a similar haemoglobin level as per urban and rural classification. So the hypothesis was accepted. As per nutritional knowledge, concern, the hypothesis was accepted because there was not any statistical significant difference found. It expressed that there was no difference found in nutritional knowledge level of urban and rural college girls.

4.7.2 Influence of income on blood haemoglobin and nutritional knowledge level

Ho2: There will be no significant influence of income on blood haemoglobin and nutritional knowledge level of college girls.

Table : 4.7.2 Influence of income on blood haemoglobin and nutritional knowledge level

Variables	SOV	SOS	DF	MSS	F Value
Haemoglobin	SS_B	4.18	3	1.39	0.0009 (N.S.)
	SS_W	5869367.4	401	14636.83	
	SS_T	5869371.46	404		
Nutritional knowledge	SS_B	26682.95	03	8894.32	0.210 (N.S.)
	SS_W	17019038	401	42441.49	
	SS_T	1709038.27	404		

Table 4.7.2 reveals that income influences the haemoglobin level and nutritional knowledge. For testing hypothesis ANOVA was computed with different income groups of college girls and result indicated that there was not any significant difference between income group and haemoglobin level. So the hypothesis was accepted and it expressed that in the present investigation income does not affect haemoglobin level, nutritional knowledge.

4.7.3 Age at menarche

Ho3: There will be no significant influence of age at menarche on blood haemoglobin of college girls

Table: 4.7.3 Influence of age at menarche on blood haemoglobin.

Variables	SOV	SOS	DF	MSS	F Value
Haemoglobin	SS_B	239.38	3	119.69	0.0018 (N.S.)
	SS_W	267219.42	402	66491.8	
	SS_T	267299.4	404		

Table 4.7.3 reveals that age at menarche influences the blood haemoglobin. For testing hypothesis ANOVA was computed with different groups of girls for age at menarche data and non significant influence was found in blood haemoglobin. So the hypothesis was accepted and it indicated that there was no significant influence of age at menarche on blood haemoglobin. Thus, it can be concluded that age at menarche does not affect overall health and blood haemoglobin or anaemic status of all the college girls.

4.7.4 Knowledge intervention

Ho4: There will be no significant impact of nutritional knowledge intervention on knowledge level of college girls.

Table:4.7.4 Impact of knowledge intervention programme on knowledge level.

Particular	Before (Mean)	After (Mean)	Calculated 't'	Tabulated 't'	Level of significance
All girls	16.41	22.07	32.06	2.58	H.S.**
(Before)			0.518	1.95	N.S.
Urban	16.34	-			
Rural	16.33	-			
(After)			0.558	1.95	N.S.
Urban	-	22.19			
Rural	-	21.98			
Total knowledge					
Urban	16.35	22.19	19.79	2.58	H.S.**
Rural	16.33	21.98	25.52	2.58	H.S**

H.S.** - Highly significant at $p< 0.001$.

Table 4.7.4 reveals that there was a significant impact found for nutritional knowledge intervention and showed that it had significant impact on nutritional knowledge and awareness regarding anaemia. For testing hypothesis, 't' analysis was carried out for before and after supplementation data and result showed that there was a highly significant difference found in nutritional knowledge intervention at $p< 0.01$ level . So the hypothesis was not accepted and it expressed that intervention greatly affects nutritional knowledge level of selected college girls. Thus it can be concluded that intervention programme had significant influence on overall knowledge level of the selected college girls.

The research carried out showed the positive results and enhancement in knowledge level through the precise intervention programme that was found useful to the respondents who were part of this programme and it will be also useful to the students who may not study the facts related to medical, paramedical or Home science subjects specifically, Foods and Nutrition. The fundamentals ideally required for the maintenance of optimum health of an individual mentioned here will be also useful to particular section of people who wants to prevent the health complications and to help build a good foundation of family health.

Adolescent girls constitute a vulnerable group, particularly in developing countries where they are traditionally married at an early age and exposed to a greater

risk of reproductive morbidity and mortality. Adolescence represents a real opportunity to make a difference in the lifelong patterns. This phase of life is also important due to the ever increasing evidence that control of anemia in girls may be more easily achieved if satisfactory iron status can be ensured during adolescence.

Anaemia is manifested by deficiency of many nutrients and is an escalating problem worldwide. Chronic or recurrent infections also play an important role in promoting deficiency. It is not simply a consequence of the lack of affluence of a population, but rather the result of interactions among social, demographic, genetic, infectious and societal conditions. It is likely always to be a public health problem, since the etiology is so complex. The role of the public health nutritionist involves combined vigilance in wisely monitoring populations and situations. Effective interventions will be needed and particular attention should be paid to applying advances in knowledge with a global perspective, and building partnerships between groups of professionals.

SUMMARY AND CONCLUSION

Anaemia is a worldwide existing nutritional deficiency disease seen in persons of all ages; it is not a diagnosis but rather a sign or symptom of underlying disorder. Anaemia is widely prevalent in all the states of India among all the age group including children, adolescent girls, pregnant and non pregnant women. In India, college girls contribute major portion of population. It has been reported to be a major micronutrient deficiency and its prevalence was reported to be above 80 % in various states of India. Wide prevalence of anaemia, among communities will results in a poor health and economy of any country. It is most silently prevalent deficiency disease all over the world. In India, it was found to have an association with literacy status of mother, occupation of father, structure of family, types of diet, caste, birth order, types of activities etc. Iron deficiency anaemia is the most common form of malnutrition in the world and is the eighth leading cause of disease in girls and women in developing countries. In Indian society, adult girls or college girls are highly anaemic due to poor dietary intake, lack of awareness regarding nutrition and hygiene, taboos, belief, and ignorance. Anaemia results in a poor physical as well as cognitive development of an individual and specially girls are at higher risk because of it. Anaemic condition leads to poor health of a pregnant mother, low birth weight of babies and also poor health of lactating mother and the child.

Anaemia is a condition where there is a reduction in haemoglobin concentration in the red blood cells. Haemoglobin is the iron containing pigment of red blood cells, that carries oxygen from lungs to the tissues, in other words, anaemia is manifested by decrease in the oxygen carrying capacity of blood. Anaemia is a major medical problem, affecting people of all ages all over the world. Anaemia is a serious public health problem and is the commonest one. The goal of anaemia management is to investigate and understand the different stages of anaemia. Identification of the etiology of a nutritional anaemia as the result of inadequate intake, poor absorption, heme and non heme iron in the diet or increased requirement is essential to support the provision of targeted medical nutrition therapy.

Therefore, present study was undertaken to study anaemia prevalence, nutritional status and an effective nutritional knowledge intervention programme for anaemic college girls of Mehsana Taluka with following objectives.

General objective

- An effective nutritional knowledge intervention for anaemic college girls of Mehsana city and taluka.

Specific Objective.

- To study the prevalence of anaemia among selected college girls.
- To study nutritional status by clinical signs and symptoms and anthropometric measurements.
- To study about level of nutritional knowledge among selected college girls.
- To study the effect of knowledge intervention programme.

Review and Literature

In this chapter, an attempt has been made to review the relevant and related literature pertaining to the present study from various research journals, books, websites and other related literature. For developing a conceptual frame work and an appropriate design for the study, a review of past study is necessary. Therefore, a brief account of the work reported by the past researchers was reviewed and presented under the following heads.

2.1 Prevalence of anaemia

2.1.1 Global prevalence of anaemia

2.1.2 National prevalence of anaemia

2.1.3 Prevalence of anaemia in Gujarat

2.2 Etiology of anaemia

2.3 Pica- Eating disorders of non nutritional substances

2.4 Nutritional status

2.5 Intervention strategies for eliminating anaemia

2.4.1 Supplementation

2.4.2 Fortification

2.4.3 Bio availability of dietary iron

2.4.4 Improving bio availability of dietary iron

2.4.5 Nutrition education

2.4.6 Beneficial effects of Garden cress seeds.

Methodology

The scientific study requires adoption of appropriate methods and procedures in order to reach reliable, unbiased and specific conclusions. This chapter mainly deals with the research design, tools and techniques of scientific investigation employed for the collection, tabulation, analysis and interpretation of the data in the light of the objectives of this study. In short, this chapter contains methodology which was adopted for the study and is discussed under the following sub-heads.

Locale of the study

The present study was carried out in Mehsana city of Mehsana taluka located in the northern part of Gujarat.

Selection of city and taluka.

The two different areas viz, urban and rural area were selected from the district. The Mehsana city which is the head quarter of the district was selected as urban area, whereas the girls in the colleges who comes from the nearby villages of Mehsana taluka was selected as rural area.

Research design

Ex-post facto, descriptive and experimental research design was followed.

Variables of the study: It includes independent and dependent variables of college girls.

Independent variables: These are;(1) Personal variables-age, age at menarche, types of diet, types of work, history of heavy menstrual bleeding, morbidities, pica, activities, (2) Socioeconomic variables-caste, income, area (urban and rural)(3) Communicational variables- sources of information and extent of information used by college girls (4) Nutritional variables- dietary pattern and frequency of consumption of iron and vitamin C rich foods.

Dependent variables: These are; (1) Nutritional status (BMI) (2) Clinical signs and symptoms (3) Nutritional knowledge level (4) Awareness regarding anaemia (5) Blood Haemoglobin level.

Operational definition: It includes nutritional status, i.e. assessment of nutritional status by anthropometry, prevalence of anaemia and knowledge intervention.

Sampling technique

Selection of colleges

For this study, the multi-stage random sampling technique was used for the selection of the colleges and college girls. For the selection of the college a list of colleges located in Mehsana city and Mehsana taluka was prepared. Using this list, all the five colleges were selected randomly for the study.

Selection of respondents

At the final stage, the equal allocation random sampling method was applied for the selection of respondents (girls). A list of students was prepared for each selected college in consultation with respective principals and professors. From these lists, total 405 college girls were randomly selected from the localities of Mehsana city and talukas of Mehsana district.

Operationalization of important variables and their measurement

The personal, socio-economic, communicational, and nutritional characteristics of the respondents were selected as independent variables while anaemic condition and nutritional status was considered as a dependent variable. The nutritional status of college girls were assessed by nutritional anthropometry method and clinical examination and blood haemoglobin estimation. Anthropometric measurements, such as body mass index and blood haemoglobin estimation of college girls were taken and then compared with the cut-off values suggested by WHO/NCHS. To know the food consumption pattern of various foods , a diet survey was carried out by using 24 hours dietary recall method.

Tools of study

The well-structured interview schedule was prepared in light of the study and used as tools for collection of data.

Pre-testing of the schedule

The interview schedule was pre-tested with 20 college girls of one college which were not included in present study.

Collection of data

The primary data regarding family background and socio-economic attributes were collected through a personal interview. The present study was conducted with experimental method, descriptive and nutrition survey approach will be adopted for the purpose.

Pre-test Procedure

Phase-I

Anthropometric measurements and clinical observation(N=800).

Phase-II

Haemoglobin estimation by Filter paper method (N=600).

Post- test Procedure

Phase-III

- Hemoglobin estimation of 405 college girls by Cyanmethaemoglobin method.
- Anthropometric measurements were taken i.e. weight, height and body mass index (BMI).
- Knowledge level assessed by nutrition and diet survey.
- Assessment of dietary pattern (i.e. Daily, alternate day, weekly, 15 days interval, monthly, rarely, never)

Pretest study included hemoglobin estimation of 600 respondents, and from the results the anaemic girls with fair and poor knowledge level were selected for the study and knowledge intervention was given to need based college girls.

Statistical analysis of data

The data collected through interview schedule were analyzed and interpreted in order to draw meaningful conclusions in light of objectives of the study. The statistical tools used for analysis of the data were frequency, percentage, arithmetic mean, Standard Deviation (SD), Pearson's coefficient of correlation, multiple regression analysis.

Hypothesis testing: It was conducted by pre decided hypothesis by F test representing by ANOVA and 't' test for the measurement of level of significance.

Ho_1: There will be no significant difference between area of residence of college girls on haemoglobin level and nutritional knowledge level.

Ho_2: There will be no significant influence of age at menarche on haemoglobin level.

Ho_3: There will be no significant influence of income on haemoglobin level and nutritional knowledge level.

Ho_4: There will be no significant difference of intervention on knowledge intervention program on knowledge level.

Results and discussion

Keeping in view the objectives of the study, the data were subjected to the appropriate statistical tests and are presented in the classified and/or categorized forms, tables and diagrams and discussed in this chapter. The results of the various aspects are presented under the following sections.

4.1 Personal, socio-economic and communicational characteristics

The findings related to personal characteristics revealed that the age of college girls were ranged from 18 to 23 years. The age at menarche was ranged from 12 to 16 years and mean age at menarche was 14 years. Majority of girls had started menstrual cycle at 14 years of age. All the selected i.e. 100% girls consumed vegetarian diet. Majority of (72.35 %) girls performed moderate work. Only less than one fourth girls had heavy menstrual bleeding (12.6%)for long time. According to data collected majority had presence of any one morbidity. Overall, 14.57%, 30.12%, 28.64%, 11.11%,3.95%,10.12% and 12.84% of college girls were suffering from fever, sneezing and cough, headache, typhoid, malaria and viral fever respectively. Most common observed morbidities were headache, sneezing and cough. 6.42% and 9.14% of urban and rural college girls had a habit of eating roasted soil i.e. Geophgea.11.36% and 7.90% of urban and rural college girls had a habit of eating ice i.e. Pagophgea. Majority of girls did cooking (93.33 %), dusting and mopping (88.64% and 90.12%), washing clothes (92.24 %) and animal husbandry (20.74 %) among rural girls. Majority i.e. 39.01 % of college girls belonged to OBC followed by SC/ST (22.72 %) and general caste(38.27 %).Majority (37.78%) of girl's family monthly income was Rs.10,001 to 20,000. All the girls used news paper as a source of information and majority (98.83 %) of them had poor and medium level of sources of information used.

4.2 Nutritional status of college girls.

Mean measurements

Nutritional status is the state of our body as a result of the foods consumed and their use by the body. Nutritional status was measured by anthropometry- weight, height

and BMI, clinical signs and symptoms, biochemical parameters i.e. blood haemoglobin level and prevalence of anaemia. The mean weight of urban and rural girls was 46.45 kg and 47.27 kg, respectively, which was lower than the standard weight. The mean BMI of urban and rural girls were 19.71 and 19.93, mean BMI of college girls were normal. There was no statistical difference found in the mean haemoglobin level between urban and rural girls. The mean haemoglobin of urban girl was 10.67g /dl and rural girl was 10.66g/dl.

Body Mass Index

For, BMI classification, data depicts that 18.03 % and 19.75 % of urban and rural college girls were underweight and they had BMI below 18.5. 29.14 %, and 26.67 % of urban and rural college girls had normal BMI i.e. 18.6 to 24.9. 2.46 % and 3.95 % of urban and rural college girls were obese and they had BMI above 25. Overall, 37.78 % of college girls were underweight, 55.80 % had normal BMI and 6.42 % were obese.

Blood heamoglobin

Blood haemoglobin is also health indicator for the study of health and nutritional status. Therefore, in the present study blood haemoglobin of college girls were measured by cyanamethaemoglobin method. In the present investigation, data shows that 3.95 % of urban and rural girls had 13 -14 g/dl of haemoglobin level. 14.82 % and 13.83 % of urban and rural girls had normal haemoglobin i.e. 12 g/dl. 20.99 %, 22.46 % of urban and rural girls were mildly anemic and had 10- 11.9 g/dl of haemoglobin. 7.65% and 9.14 % of urban and rural girls were moderately anemic and had 7 – 9.9 g/dl of haemoglobin. 2.22 % and 0.99 % of urban and rural girls were severely anemic and had haemoglobin 6-6.9 g/dl. Overall, 63.45 % of selected college girls were anemic.

Clinical signs and symptoms

Results of clinical assessment reveals that 14.74% and 16.95 % of urban and rural girls and the mean was 31.69 % of college girls had different hair problems like rough and thin hair, white hair and hair fall. 7%, 8.48% and the mean was 15.48 % of girls had other problems like moon face, acne and paleness of face. 3.95 % and 4.44 % of urban and rural girls had paleness of eyelids. 7.16 % and 8.15 % of urban and rural girls had bleeding gums which is a sign of vitamin C deficiency. 2.71 % and 4.20 % of urban and

rural girls had dental carries. 2.47 % and 3.20 % of urban and rural girls had a redness of tongue which was due to vitamin B complex deficiency. Overall, 4. 69 %, 31.11 % and 10.62 % were suffering from moon face, acne and paleness of face. Thus, it can be concluded that the presence of clinical signs and symptoms related to the deficiency of calorie and protein or poor dietary intake of energy as well as protein. Overall, 8.40 %, 15.31 % , 6.91 % and 5.61 % of girls were suffering from paleness of eyelids, bleeding gums, dental carries and redness of tongue respectively. Thus, it can be concluded that above results of clinical assessment was may be due to presence of energy, protein, iron, vitamin C and B complex vitamin deficiency in the daily diet.

Clinical signs and symptoms of anaemia

Because anaemia is the last manifestation of chronic, long- term iron deficiency, the symptoms reflects a malfunction of variety of body systems. Therefore, clinical findings of anaemia were studied in this investigation. 30.12 % and 33.09 % of urban and rural girls showed decreased work performance. 24.69 % and 25.43 % of urban and rural girls had physical activity intolerance.20.49 % and 25.93 % of urban and rural girls showed less endurance and quick fatigue.9.38 % and 11.35 % of urban and rural girls showed poor concentration level.12.84 % and 15.06 % of urban and rural girls had dullness of skin. 19.51 % and 20.25 % of urban and rural girls showed reduced immunocompetence.8.40% and 10.12% of urban and rural girls had paleness of skin.7.90 % and 10.37 % of urban and rural girls had thin flat nails and 7.41 % and 9.38 % of urban and rural girls had brittle nails.11.11 % and 12.34 % of urban and rural girls experienced burning of tongue and 9.88 % and 11.85 % had redness of tongue.

Menstrual information of college girls

Menstrual bleeding days also affect haemoglobin level of college girls. Because, if menstrual bleeding continues for many days it results in prevalence of anaemia among girls.The data shows that 22.96 % and 23.21 % of urban and rural college girls had three menstrual bleeding days, while 24.44 % and 24.20 % of urban and rural girls had four menstrual bleeding days. 2.22 % and 2.96 % of urban and rural college girls had five menstrual bleeding days. Overall, 46.17 %, 46.64 % and 5.19 % of girls had three, four and five menstrual bleeding days respectively. Thus, it can be concluded that maximum number of menstrual bleeding days were four.

Regularity of menstrual cycle

Regularity of menstrual cycle is also affected by many factors such as food intake, hormones and other physiological activities. Data shows that overall, 47.90 % , 46.43 % and 5.67 % of girls had 28 days of menstrual cycle, 30 days and irregular menstrual cycle. Thus, it can be concluded that majority of college girls had a regular 28 days of menstrual cycle.

Prevalence of menstrual problems

As far as menstrual problems among college girls are concerned, it shows that 35.8 % and 37.53 % of urban and rural college girls had abdominal pain during menstrual cycle. 6.42 % and 7.16 % of urban and rural college girls experienced vomiting.19.26 % and 7.20 % of urban and rural college girls had headache. 9.38 % and 11.55 % of urban and rural college girls had giddiness. 9.63 % and 10.86 % of urban and rural college girls had experienced uneasiness.16.12 % and 19.25 % of urban and rural college girls showed irritation.35.06 % and 37.52 % of urban and rural college girls usually decreased their food intake during menstrual cycle. Thus, it can be concluded that majority of college girls experienced abdominal pain, headache and decreased food intake during menstrual period.

4.3 Nutritional knowledge and awareness regarding anaemia

Nutritional knowledge and nutrition education are also considered as a long term approach to combat anaemia. Nutrition education is equally important as it helps to build up optimum nutritional status, firstly for themselves, then her family and thus the community there by increasing the work output. Therefore, nutritional knowledge measurement was considered for the development of nutritional knowledge intervention program for college girls.

Nutritional knowledge regarding requirements

Results for knowledge regarding nutrient requirements shows that overall, 32.10 % and 23.21 % of girls had a knowledge of energy and protein requirements.11.61 % and 28.89 % of girls had knowledge of calcium and iron requirements. 10.37 %, 8.15 % of girls had a knowledge of vitamin A and vitamin B_1 requirements.8.15 %, 5.32%, 11.60% and 5.68 % of girls had a knowledge of vitamin B_2, B_{12}, C and folic acid requirements respectively. Thus, it can be concluded that 14.97 % had knowledge of nutritional requirement and it was poor among college girls.

Sources of nutrients

Results for knowledge regarding sources of nutrients shows that overall, 72.84 %, 63.70%, 51.85 % , 66.91%, 70.12, and 42.47 % girls had a knowledge regarding sources of energy, fat, protein, vitamin A, vitamin C and iron. Thus, it can be concluded that 61.32 % had knowledge of sources of various nutrients.

Nutrients in foods

Results for knowledge of nutrients present in foods showed that overall, 51.61 %,49.14 %, 47.65 %, 51.60 % , 96.79 % and 39.26 % of girls had knowledge of nutrients present in cereals, pulses, vegetables, fruits, oilseeds, sugar, jaggery and milk respectively. Thus, it can be concluded that 56 % girls had knowledge of nutrients presents in different food groups.

Knowledge regarding deficiency diseases

Knowledge regarding deficiency diseases shows that overall, 75.56 %, 48.40 %, 73.58 %, 45.68 %, 64.44 %, 66.17 % and 59.51 % of girls had knowledge regarding energy, protein, vitamin A, vitamin C, iodine and iron deficiency diseases respectively. Thus, it can be concluded that 31.84 % and 29.14 % of urban and rural college girls and overall, 60.98 % of girls had knowledge of deficiency diseases.

Knowledge regarding awareness of anaemia

Results of knowledge regarding awareness of anaemia shows that 21.73 % and 20.24 % of urban and rural girls and overall, 41.97 % girls had knowledge of foods that makes blood pale like tamarind seeds, soil, junk foods etc. 20 % and 19.75 % of urban and rural girls and overall, 39.75% girls had knowledge of role of iron in the body i.e. for synthesis of haemoglobin. 19.75 % and 19.01 % of urban and rural girls and overall, 38.76 % girls had knowledge of iron rich foods i.e. dates, bajara, GLVs and pulses. 42.47 % and 42.22 % of urban and rural girls and overall, 84.69 % girls knew that there is a harmful effect of drinking excess amount of tea and coffee on the haemoglobin level. Only 6.67 % and 5.92 % of urban and rural girls and overall, 12.59 % girls knew that there is a relation between anaemia and drinking of excess tea and coffee. 21.23% and 20.49 % of urban and rural girls and overall, 41.72 % knew that iron requirements increases during pregnancy. 21.98 % and 21.23 % of urban and rural girls and overall, 43.21 % girls knew that iron is essential for mother and foetus health. 18.52 % and 18.27 % of urban and rural

girls and overall, 36.79 % of girls knew that haemoglobin level decreases after menstrual bleeding. Thus, it can be concluded that 21.48 % and 20.61 % of urban and rural girls and overall, only 42.09 % of college girls had awareness about anaemia.

Knowledge regarding clinical signs and symptoms of anaemia

Results of knowledge regarding clinical signs and symptoms of anaemia shows that 22.47 % and 21.24 % of urban and rural girls and overall, 31.35 % girls had knowledge of fatigue as a sign of anaemia.11.61 % and 10.12 % of urban and rural girls and overall,21.72 % had knowledge of breathlessness as a sign of anaemia.16.54 % and 14.82 % of urban and rural girls and overall, 31.35 % had knowledge of giddiness as a sign of anaemia.29.88% and 28.64 % of urban and rural girls and overall,58.52 % had knowledge of paleness as a sign of anaemia.20.25 % and 18.27 % of urban and rural girls and overall,38.52 % had knowledge of hair fall is a sign of anaemia. 5.19 % and 3.70 % of urban and rural girls and overall, 8.89 % had knowledge of drowsiness as a sign of anaemia. 4.44 % and 2.72 % of urban and rural girls and overall, 7.16 % girls had knowledge of irritability as a sign of anaemia.1.98 % and 0.99 % of urban and rural girls and overall,2.96 % girls had knowledge of poor appetite is a sign of anaemia.4.44% and 3.46 % of urban and rural girls and overall,7.90 % girls had knowledge of poor concentration is a sign of anaemia. Thus, it can be concluded that 12.17 % and 10.87 % of urban and rural girls and overall, 23.04 % girls had knowledge of signs and symptoms of anaemia.

Nutritional knowledge level

Results for nutritional knowledge level shows that 13.33 % and 14.82 % urban and rural girls overall, 28.15 % college girls had poor nutritional knowledge. 7.41 % and 9.87 % of urban and rural girls and overall, 17.28 % college girls had fair nutritional knowledge and 28.89 % and 25.68 % of urban and rural girls and overall, 54.57 % college girls had good nutritional knowledge level. Thus, it can be concluded that majority of college girls had good nutritional knowledge level. Only, 45.43 % had poor and fair nutritional knowledge among college girls.

Nutritional knowledge level as per faculty

Data reveals that the nutritional knowledge level as per faculty wise distribution of college girls shows 20.25 %, 4.44 % and 1.73 % of Arts faculty girls had poor, fair and good nutritional knowledge level respectively. Science faculty girls had 0.49 %, 1.24 % and

11.11 % of poor, fair and good nutritional knowledge level. Computer Science faculty girls had 1.73 %, 2.46 % and 12.82 % of poor, fair and good nutritional knowledge level. Homeopathy faculty girls had 2.47 % and 10.37 % of fair and good nutritional knowledge level. Home Science faculty girls had 0.74 %, 2.47 % and 14.82 % of poor, fair and good nutritional knowledge level. B.Ed. faculty girls had 4.94 %, 4.20 % and 3.70 % of poor, fair and good nutritional knowledge level. Poor and fair knowledge level girls were from Arts and B. Ed. faculty. Good nutritional knowledge level girls were from Science, Home Science, Homeopathy and Computer science faculty. Overall, 28.15 % girls had poor nutritional knowledge. 17.28 % girls had fair nutritional knowledge and 54.56 % girls had good nutritional knowledge. Thus, it can be concluded that half of college girls fall in the category of poor and fair nutritional level.

4.4 Dietary pattern and average intake of college girls

Dietary Pattern

To know the dietary pattern and the actual intakes of various foods, as well as the deficiency of various nutrients in their diet, a survey was carried out by 24 hours dietary recall method. In the present study, food consumption pattern of different foods of college girls was recorded.

Daily food intake

Daily food intake among college girls was recorded as the actual consumption. Fats and oils, wheat and sugar was consumed daily by all urban (49.63%) and rural girls (50.37%).The major cereal consumed by the girls was wheat (49.63% & 50.37 %) for urban and rural girls respectively. Only 25.43 % of urban and 20.73 % rural girls consumed rice daily. It was observed that bajra, rice flakes, puffed rice and bread was consumed frequently. Not a single pulse was consumed by the girls daily. Red gram dhal was consumed daily by urban (26.42%) and by rural girls(25.43%). Coriander was consumed daily by urban (28.15%)and rural girls (26.67%).Lemon was also consumed daily by urban (19.01%) and rural girls (18.52%). Tomato was consumed daily by urban(20%)and rural girls (19.75%) whereas, green gram dhal was consumed daily urban(1.5%) and by rural girls (2.5%) respectively. Only, 28.15% and 26.42 % of urban and rural girls consumed milk daily and majority (urban 40 % and rural- 38.02 %)of girls consumed buttermilk daily. Sugar was consumed daily by all the girls.13.83 % of urban and

24.20 % of rural girls were consuming jaggery daily. Cereal foods were consumed daily whereas food from other food groups was not consumed frequently and daily.

Alternate day intake

Alternate day food intake among college girls shows that rice(urban and rural 13.58%),puffed rice (urban- 7.90 %, rural-7.16 %), red gram dhal(urban -8.40%, rural-7.90%), green gram dhal (urban-4.69%, rural-6.67%)cabbage(urban-24.94%,rural-25.68 %), coriander (urban-10.12%, rural-9.63%),lemon (urban-13.58%,rural-13.09%,)tomato(urban-22.47%,rural-22.71%),grapes(urban-6.91%,rural-.43%),milk (urban-10.37%,rural-12.54%),buttermilk (urban and rural-9.63%) and jaggery (urban-6.9%,rural-7.90%)was consumed by all college girls. Pulses were hardly consumed by all college girls.

Weekly intake

Weekly food intake among college girls shows that they consumed rice(urban-7.65%,rural-7.16%),bajara (urban-1.24%,rural-1.73%), puffed rice (urban-2.96%,rural-44%),Black gram(urban-9.38%, rural- 8.40%),Bengal gram(urban-14.07m%, rural-13.88 %),green gram(urban-2.47%, rural- 1.98 %),red gram dhal(urban-4.69%, rural-5.65 %),green gram dhal(urban-5.43 %, rural- 4.94 %),cabbage(urban-24.94 %, rural-25.68 %), coriander(urban-4.20 %, rural- 4.94 %),fenugreek leaves(urban-11.85 %, rural-10.37 %), apple(urban-7.16 %, rural- 6.67 %), dates(urban-21.24 %, rural-21.48),lemon(urban-3.70%, rural-2.96 %),amla (9.63%),mango (urban-27.40%, rural-26.67%), pineapple (urban-20.25%, rural-20.99%),pomegranate(urban-21.24%,rural-20.99%), sapota (urban-20.49 %, rural-21.24 %),grapes(urban-6.91%, rural-13.83 %),milk(urban-5.68 %, rural-4.20 %), curd (urban-8.15 %, rural-9.63%), buttermilk (rural-2.72%) and jiggery (urban-11.61 %, rural-12.10%).

Other food products

Most of the fruits and vegetables, milk and milk products were consumed half monthly, monthly and rarely by college girls. Some foods were never consumed like lentils, moth beans, rajma etc by some college girls. Other foods like panipuri (urban-49.63 %,rural-50.37 %) was most frequently consumed street food by college girls. Pakodas, vada pav, pavbhaji, dabeli, sandwich were also frequently consumed by girls. Punjabi food

(urban-39.01%,rural-36.30%),Chinese food (urban-39.32 %, rural-30.12 %),and South Indian foods(urban-49.63 %, rural-50.37 %)were also frequently consumed by college girls. Vasana and chavyanprash was also consumed by girls. 49.63 % and 46.91 % of urban and rural college girls consumed iodized salt. No one consumed any kind of non vegetarian foods like egg, meat, fish etc.

Intake level of iron and vitamin C rich foods

In present investigation, 12.84 % and 11.61 % of urban and rural girls had poor intake of iron rich foods whereas, 11.85 % and 14.07 % of urban and rural girls had fair intake of iron rich foods. 24.94 % and 24.69 % of urban and rural girls had good intake of iron rich foods. Overall, 24.44 %, 25.93 % and 49.63 % of college girls had poor, fair and good intake of iron rich foods respectively. In present investigation, 11.85 % and 10.86 % of urban and rural girls had poor intake of vitamin C rich foods whereas, 12.10 % and 13.08 % of urban and rural girls had fair intake of vitamin C rich foods. 25.68 % and 26.42 % of urban and rural girls had good intake of vitamin C rich foods. Overall, 22.72 %, 25.19 % and 52.10 % of college girls had poor, fair and good intake of vitamin C rich foods respectively.

4.5 Knowledge intervention

Nutritional knowledge plays an important role in well being and health status of an individual. Knowledge intervention is an effective tool for improving dietary behavior among communites. It brings desirable changes in knowledge level which leads to a beneficial effect on health and over all nutritional status of an individual. Knowledge intervention was carried out by lectures, power point presentation and recipe demonstration of various iron rich foods.

Lectures were conducted by an expert which included all the myths and facts about anaemia. The literature was prepared in a local language i.e. Gujarati. After lecture, feedback was taken and overall it showed improvement in knowledge level related to anaemia. Power point presentation included all the basic facts which are responsible for anemic condition among college girls. It included prevalence, causes, effects and symptoms of anaemia, dietary guidelines for the prevention of anaemia and points to be considered essential to overcome anemic condition.

Recipe Demonstration

Recipe demonstration was carried out at Smt, A. S. Chaudhary Mahila Arts and Home Science College, Mehsana. The aim of recipe demonstration was to improve the knowledge regarding iron rich foods and its method of preparation. Niger seeds chikki, mix sukhadi, cow peas dhokali and date laddoos were demonstrated to college girls.

The nutritive value of niger seeds chikki per 100 g i.e. 9.72 g of protein, 539.20 Kcal, 27.74mg iron and 152 mg calcium respectively. The nutritive value of mix sukhadi per 100 g i.e 8.5 g of protein, 533.57 Kcal, 16.97 mg iron and 67.57 mg calcium respectively. The nutritive value of cow peas dhokali per 100 g i.e. 10.12 g of protein, 289.28 Kcal, 3.97 mg iron and 148.91 mg calcium respectively. The nutritive value of 100 g of date ladoos was 3.74 g of protein,651.2 kcal energy,210.4 mg calcium and 6.071mg of iron. Niger seeds chikki had highest iron content as compared to other selected recipes. The main aim of recipe demonstration was creating awareness regarding low cost iron rich foods which are locally available and addition of these recipes will help in prevention of anaemia as long term approach. These iron rich recipes aids in reducing anemic condition and ultimately improving health status by enhancing blood haemoglobin level.

Impact of nutritional knowledge intervention program

Before intervention programme, college girls had 56.31 % of nutritional knowledge and 63.40 % of college girls had anaemia awareness and after intervention programme, college girls had 75.39 % of nutritional knowledge and 85.35 % of college girls had anaemia awareness. There was 19.08 % increase in nutritional knowledge and 21.85 % increase in anaemia awareness. Overall, there was 20.49 % increase in overall nutritional knowledge among college girls.

4.6 Relational Analysis

4.6.1 Co relational analysis

It was hypothesized that there was no relationship between different sets of independent variables viz., personal, socio-economic, communicational and nutritional characteristics of the college girls and their nutritional status. Zero order correlation was used as a measure for estimating relationship between independent and dependent variables. The data on relationship between selected independent variables with nutritional status of

college girls was in terms of BMI, clinical signs and symptoms, haemoglobin level, nutritional knowledge, awareness regarding anaemia and overall nutritional knowledge of college girls were studied.

Data shows that **BMI** was positively and significantly correlated with blood haemoglobin, iron intake and vitamin C intake. **Clinical signs and symptoms** were positively and significantly correlated with age at menarche and pica. **Nutritional knowledge, anaemia awareness and overall nutritional knowledge** were positively and significantly correlated with age, and sources of information used. **Haemoglobin** was positively and significantly correlated with heavy menstrual bleeding, iron intake and vitamin C intake. Thus, it can be concluded that, in present investigation, age, age at menarche, morbidities, pica, heavy menstrual bleeding, iron and vitamin C intake, nutritional knowledge and awareness regarding anaemia played an important role in association with BMI, clinical signs and symptoms, knowledge and haemoglobin and nutritional status of college girls.

4.6.2 Multiple regression analysis

The coefficient of determination of R^2 reveals that the percentage of variation in the dependent variable explained by the selected variables were considered. Based on this approach, the multiple regression analysis using linear model was carried out to explore the combined effect of the independent variables in explaining the total variation in the dependent variables. In multiple regression analysis selected variables were analyzed to explain the variation in nutritional status of college girls.

Body Mass Index (BMI)

The data shows that there was as much as 6.80 % total variation in the level of BMI of all college girls. The unexplained variation of 93.2 % may be due to factors outside the scope of the study. The multiple correlation (R) was 0.260 indicating that correlation between BMI of college girls and the level of nutritional status calculated on the basis of independent variable was significant. It can be revealed that the “P” values of selected variables viz., types of diet was significant at $p< 0.05$ and types of work was highly significant at 0.01 level of significance($P<0.01$), indicating significant contribution of these two variables in explaining the variation in BMI of all college girls. Remaining variables had non- significant relationship with BMI of all college girls.

Clinical signs and symptoms

The data shows as much as 14.19 % total variation in the level of clinical signs and symptoms of college girls. The unexplained variation of 85.81 % may be due to factors outside the scope of the study. The multiple correlation (R) was 0.38 indicating that correlation between clinical signs and symptoms of college girls and the level of nutritional status calculated on the basis of independent variable was significant. It can be revealed that the "P" values of selected variables viz., heavy menstrual bleeding, morbidities and pica were highly significant at 0.01 level of significance($P<0.01$) and sources of information was significant at 0.05 level indicating significant contribution of these four variables in explaining the variation in clinical signs and symptoms of all college girls. Remaining variables had non- significant relationship with clinical signs and symptoms of all college girls.

Nutritional Knowledge

The data shows as much as 9.90 % total variation in the level of nutritional knowledge of all college girls. The unexplained variation of 90.1 % may be due to factors outside the scope of the study. The multiple correlation (R) was 0.32 indicating that correlation between nutritional knowledge of all college girls calculated on the basis of independent variable was significant. It can be revealed that the "P" values of selected variables viz., age and sources of information were highly significant at 0.01 level of significance indicating significant contribution of these two variables in explaining the variation in nutritional knowledge of all college girls. Remaining variables had non-significant relationship with level of nutritional knowledge of all college girls.

Awareness regarding anaemia

Data revealed as much as 9.90 % total variation in the level of awareness regarding anaemia of urban and rural college girls. The unexplained variation of 90.1 % may be due to factors outside the scope of the study. The multiple correlation (R) was 0.315 indicates the correlation between awareness regarding anaemia of all college girls and the level of awareness regarding anaemia calculated on the basis of independent variable was significant. It can be revealed that the "P" values of selected variables viz., age and sources of information were highly significant at 0.01 level of significance($P<0.01$), indicating significant contribution of these two variables in explaining the variation in

awareness regarding anaemia in all college girls. Remaining variables had non- significant relationship with level of awareness regarding anaemia in all college girls.

Haemoglobin

The data revealed as much as 68.30 % total variation in the level of haemoglobin of all college girls. The unexplained variation of 31.7 % may be due to factors outside the scope of the study. The multiple correlation (R) was 0.826 indicating that correlation between haemoglobin and nutritional status of all college girls and the level of haemoglobin calculated on the basis of independent variable was significant. It can be revealed that the "P" values of four variables viz., pica, morbidities, iron and vitamin C intake were highly significant at 0.01 level of significance ($P<0.01$), indicating significant contribution of these four variables in explaining the variation in haemoglobin of all college girls. Remaining variables had non- significant relationship with level of haemoglobin of all college girls.

4.7 Testing of hypothesis

Hypothesis testing was carried out between **urban and rural** girls. For testing of hypothesis, 't' analysis was computed and it revealed that there was not any significant difference found between area of residence of college girls on blood haemoglobin level. It expressed that all the selected college girls had a similar haemoglobin level as per urban and rural classification. So the hypothesis was accepted. Similarly, dietary pattern i.e. frequency of iron and vitamin C rich food intake was also found non significant in college girls of both areas. So the formulated hypothesis was accepted. As per nutritional knowledgeis concered, the hypothesis was accepted because there was no statistical significant difference found. It expressed that there was no significant difference found in nutritional knowledge level of urban and rural college girls.

Hypothesis testing shows that **income** does not influence the haemoglobin level and nutritional knowledge. For testing hypothesis ANOVA was computed with different income groups of parents of college girls and result shows that there was no significant difference between income group on haemoglobin level and nutritional knowledge including awareness regarding anaemia. So the hypothesis was accepted and it reveals that

in the present investigation income does not affect haemoglobin level, nutritional knowledge.

Hypothesis testing shows that **age at menarche** does not influence the blood haemoglobin. For testing hypothesis ANOVA was computed with different groups for age at menarche and non significant influence was found in blood haemoglobin. So the hypothesis was accepted and it revealed that there was no influence of age at menarche on blood haemoglobin. Thus, it can be concluded that age at menarche does not affect overall health and blood haemoglobin or anaemic status of all college girls.

Hypothesis testing shows that there will be no significant **impact of intervention programme** and in the study highly significant impact was found for nutritional knowledge intervention and had significant impact in nutritional knowledge and awareness regarding anaemia. For testing hypothesis, 't' analysis was carried out with before and after intervention and result showed that there was a highly significant difference found in nutritional knowledge intervention at $p< 0.01$ level . So the hypothesis was not accepted and it expressed that intervention greatly affects nutritional knowledge level of selected college girls. Thus it can be concluded that intervention program had significant influence on overall knowledge level of selected college girls.

Conclusion

Adolescence is a transitional period from childhood to adulthood, during which certain factors may influence the future health and is considered as the best time to intervene, to assist physical development and to prevent various health related complications. Anaemia in adolescent girls results in reduced physical and mental capacity, diminished concentration in work and educational performance. Data on adolescent girls is scanty and needs attention. Looking at the results obtained from the present study and available literature, anaemia is defined as blood haemoglobin concentration below the established cut –off level, is a major public health problem with major consequences for human health as well as social and economic development. The present study has shown the effectiveness of the nutritional knowledge intervention. The overall study shows the improvement in anaemic condition of the college girls , thus it can be concluded that each area and each community must be tackled at the local level to intervene the existing nutritional deficiency.

The researcher was able to achieve the results through a solid and simplest possible form of knowledge intervention programme for the selected college girls to fulfill the objective. Lack of knowledge can lead to poor health can be proved not only from the present study on anaemia but also for various seasonal illnesses, other deficiency diseases, life style diseases and diseases caused by other concerned factors. By improvement in the knowledge level by creating the awareness implying the practical solutions through simple and fact full information to the community that leads to a healthy family, society and nation.

Implications

On the basis of study results it can be concluded that the prevalence of anaemia was higher among college girls. Underweight, heavy menstrual bleeding and poor dietary intake leads to anaemic condition. To improve dietary behavior, knowledge and awareness, intervention programme should be organized for educating girls. Moreover, the government and NGOs should take lead to improve awareness by providing health and nutrition education to the whole community which in turn leads to better future and healthy life of the citizens.

Recommendations

- On the basis of outcome of the research work the following points can be recommended. The present study was confined to Mehsana city and Mehsana taluka of Mehsana district of North Gujarat. A similar study could be replicated in other parts of the state for the better health and improvement (i.e. anemia) in anaemic condition college girls.
- The study concentrated on nutritional status, anemia prevalence and dietary pattern of college girls. In future studies can be implemented to investigate the socio-economic impact on health and nutritional status and also to change the dietary pattern.
- The variables other than those included in the present investigation might be influencing on nutritional status of college girls. Such variables could be included in future research study.
- During the course of the study, it was felt that college health check up programs need more efforts to disseminate the knowledge of nutrition, care of prevalent

diseases and low cost local food items. A training module can be developed for the same.

- Knowledge intervention program can be conducted more precisely and cover in depth knowledge about health and nutrition not only among the college girls but also to the parents.
- Extensive and persuasive efforts are required to bring behavioural changes in the community for people to adopt dietary diversification. Ultimately, the only sustainable solution to anaemia is to help the communities to consume foods regularly that are rich in iron, to encourage intake of promoters of iron absorption such as vitamin C and to discourage high consumption of inhibitory factors.

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APPENDIX–I

Questionnaire

'An effective nutritional knowledge intervention programme for anaemic college girls of Mehsana taluka'

Principal Investigator

Prafulla U. Shah
Smt.A.S.C.Mahila Arts & Home Science College,
Mehsana- 384001

Personal information:

1. Name of student:
2. Father's name:
3. Mother's name:
4. Name & address of college:
5. Year of study:
6. Local ☐ Up down ☐ Hostel ☐
7. Demographic condition: Rural ☐ Urban ☐
8. Age & birth date:
9. Father's monthly income: Less than Rs.10,000 ☐ Rs.10,001-11000 ☐
   Rs. 20,001 to 21,000 ☐ Above Rs.30,001 ☐
10. Types of work: Sedentary ☐ Moderate ☐ Heavy ☐
11. Types of diet: Vegetarian ☐ Non veg. ☐ Ovo vegetarian ☐
12. List of activities performed in a day:

Animal husbandry:	Yes	☐	No	☐
Sports:	Yes	☐	No	☐
Cooking:	Yes	☐	No	☐
Dusting:	Yes	☐	No	☐
Mopping:	Yes	☐	No	☐
Washing clothes:	Yes	☐	No	☐

13 .Information related to health:

Infectious diseases	Not at present	Current
Fever		
Sneezing & Cough		
Headache		
Diarrhea		
Typhoid		
Malaria		
Chicken guinea		
Viral fever		
Worm		

14. Clinical signs and symptoms:

Signs and symptoms	Yes	No
Hair		
Rough hair		
Very thin hair		
Dull hair		
White hair		
Hair fall		
Face		
Moon face		
Acne		
Paleness		
Eyes		
Poor vision		
Tongue		
Cheilosis and roughness of tongue		
Majenta tongue		
Blisters on tongue		
Teeth		
Dental caries		
Scaly teeth		
Gums		
Bleeding gums		
Pyorrehea		
Nails		
Brittle nails		

15. Reproductive health:
    - Are you menstruating? Yes ☐ No ☐
    - Onset of menarche: ☐
    - Regularity of menstrual cycle: 28 days ☐ 30 days ☐ Irregular ☐
    - Heavy bleeding: Yes ☐ No ☐
    - Days of menstrual bleeding: 3 ☐ 4 ☐ 5 ☐ > 6 ☐

16. Do you have habit of eating non nutritional substances like:

    Roasted soil/ clay: ☐ Chalk and Pen: ☐

    Ice: ☐ Plaster chips: ☐

17. Do you fall ill due to seasonal changes? e.g. rain, cold, heat: Yes ☐ No ☐

18. Do you fall ill on to any occasion? Yes ☐ No ☐

    e.g .Examination, travelling, interview.

19. Anthropometric measurements:

    Weight (kg): BMI:

    Height: Blood Haemoglobin;

20. Dietary pattern (Frequency of iron and vitamin C rich food intake)

Food Stuffs	**Daily**	**Alternately**	**Weekly**	**15th day interval**	**Monthly**	**Rarely**	**Never**
Cereals							
Wheat flour							
Rice							
Bajra							
Puffed rice							
Rice flakes							
Breads							
Legumes and dals							
Blackgram							
Bengal gram							
Green gram							
Lentils							
Moth beans							
Rajma							
Red gram dal							
Bengal gram dal							
Green gram dal							

Black gram dal							
Green leafy vegetables							
Cabbage							
Corriander							
Fenugreek leaves							
Colocasia leaves							
Radish leaves							
Amaranth leaves							
Roots and tubers							
Onion							
Potato							
Radish							
Beet							
Carrot							
Sweet potato							
Other vegetables							
Bottle guard							
Cucumber							
Brinjal							
Drumstick							
Capsicum							
Ladies finger							
Ridge gourd							
Cauliflower							
Onoin stalks							
Cluster beans							
Snake gourd							
Kankoda							
Bitter gourd							
Fruits							
Banana							
Date							
Guava							
Lemon							
Orange							
Papaya							
Tomato							

Amla							
Ripe Mango							
Musk Melon							
Pineapple							
Pomegranate							
Sapota							
Apple							
Custard apple							
Grapes							
Dryfruits							
Tender coconut							
Coconut Water							
Roasted Ground nuts							
Almonds							
Pistachio							
Cashew nuts							
Dry Coconut							
Sesame seeds							
Milk and milk products							
Milk							
Curd							
Butter milk							
Cheese							
Paneer and Khoa							
Sugar and Jaggery							
Sugar							
Jaggery							
Sago							
Honey							
Other products							
Panipuri							
Pakodas							
Vada pav							
Dabeli							
Pav bhaji							
Sandwich							
Punjabi food							
Chinese food							

South Indian							
Vasana							
Chayvanprash							
Iodised salt							
Salt							
Non veg.							
Egg							
Meat							
Fish							

21. Nutritional Knowledge:

1. Do you know your daily requirement of nutrients?

- Calories Yes ☐ No ☐
- Protein Yes ☐ No ☐
- Fat Yes ☐ No ☐
- Calcium Yes ☐ No ☐
- Iron Yes ☐ No ☐
- Vitamin A Yes ☐ No ☐
- Vitamin B_1 Yes ☐ No ☐
- Vitamin B_2 Yes ☐ No ☐
- Vitamin B_{12} Yes ☐ No ☐
- Vitamin C Yes ☐ No ☐
- Folic acid Yes ☐ No ☐

22. Sources of nutrients:

1. Calorie rich foods

   Fat ☐ Sugar & Jaggery ☐ Cereals & Pulses ☐ Don't Know ☐

2. Fat rich foods

   Oils & Fats ☐ Pulses ☐ Cereals ☐ Don't Know ☐

3. Protein rich foods

   Cereals & Pulses ☐ Vegetables & Fruits ☐

   Milk & Milk products ☐ Don't Know ☐

4. Vitamin A rich foods

   Green leafy vegetables ☐ Cereals ☐ Pulses ☐ Don't Know ☐

5. Vitamin C rich foods

   Green leafy vegetables & Fruits ☐ Cereals ☐

Pulses ☐ Don't Know ☐

6. Iron rich foods

Green leafy vegetables & Fruits ☐ Milk ☐

Cereals & Pulses ☐ Don't Know ☐

23. Sources of nutrients of foods.

1. What is obtained from cereals and pulses?

Calorie & Protein ☐ Retinol ☐

Vitamin C ☐ Don't Know ☐

2. What is obtained from vegetables and fruits ?

Vitamins & Minerals ☐ Protein ☐

Fat ☐ Don't Know ☐

3. What is obtained from oil seeds?

Vitamins & Minerals ☐ Vitamin C ☐

Fat & protein ☐ Don't Know ☐

4. What is obtained from sugar and a jaggery ?

Caloreis ☐ Protein ☐ Vitamins ☐ Don't Know ☐

5. What is obtained from milk ?

Vitamin C ☐ Protein & Calcium ☐

Iron ☐ Don't Know ☐

24. Deficiency diseases knowledge:

1. What happens from calorie deficiency ?

Weakness & Fatigue ☐ Don't Know ☐

2. Which disease is caused by protein deficiency?

Kwashiorker ☐ Anemia ☐ Scurvy ☐

3. Which disease is caused by vitamin A deficiency?

Dimness in vision ☐ Skin diseases ☐ Don't Know ☐

4. Which disease is caused by Vitamin D deficiency?

Rickets ☐ Scurvy ☐ Don't Know ☐

5. Which disease is caused by vitamin C deficiency?

Scurvy ☐ Beriberi ☐ Don't Know ☐

6. Which disease is caused by iodine deficiency?

Flourosis ☐ Goitre ☐ Don't Know ☐

7. Which disease is caused by iron deficiency?

Anemia ☐ Rickets ☐ Don't Know

25. Awareness regarding anemia:

1. Which element is lower in blood in anemia ?
   Protein ☐ Iron ☐ Don't Know ☐
2. Is there any relation between menstrual bleeding and anemia?
   Yes ☐ No ☐
3. What is the colour given by dietary iron to blood?
   Red ☐ Pale ☐
4. Which foods that makes blood red?
   Calorie & Protein ☐ GLVs & Fruits ☐
   Milk and animal foods ☐ All ☐
5. Which foods that makes blood pale?
   Junk foods ☐ Soil or clay & Tamarind seeds ☐
   Potatoes ☐ All ☐
6. What is the role of iron in the body?
   For blood ☐ Fights against diseases ☐
   All ☐ Don't Know ☐
7. Is there any harmful effect caused by excess drinking of tea and coffee?
   Yes ☐ No ☐
8. Is there any relation between anemia and excess drinking of tea and coffee?
   Yes ☐ No ☐
9. During pregnancy, iron requirement increases or decreases?
   Increases ☐ Decreases ☐
10. Is iron essential for health of mother and foetus?
    Yes ☐ No ☐
11. After menstrual cycle, haemoglobin increases or decreases?
    Increases ☐ Decreases
12. Which are the signs and symptoms of anemia ?
    Fatigue ☐ Pallor of skin and eye beds ☐
    Breathlessness ☐ Hair fall ☐
    Weakness ☐ Laziness ☐
    Giddiness ☐ Irritability ☐
    Poor appetite ☐ Poor concentration ☐

Don’t Know ☐

26. Do you suffer from any problems during menstrual cycle ?

Abdominal pain	☐	Nausea & vomiting	☐
Uneasiness	☐	Decreased food intake	☐
Headache	☐	Giddiness	☐
Irritabiliy	☐		

27. Sources of information:

1. Do you try to get information related to health and nutrition?

   Yes ☐ No ☐

2. From which sources you get information?

   News paper ☐
   Books and magazines ☐
   Television ☐
   Mobile application ☐
   Government institutes and NGOs ☐
   Government and NGOs programs ☐
   Posters and hoardings ☐
   Personal contacts ☐

APPENDIX - II

લોહતત્વ અને પાંડુરોગ

Knowledge Intervention Programme

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લોહ (IRON)

આપણા શરીરમાં ઓગણીસ જેટલા જુદા-જુદા ક્ષારો જોવા મળે છે. શરીરનો વિકાસ કરવામાં અને શરીરને આરોગ્યમય રાખવામાં ક્ષારો જરૂરી છે. દરરોજના આહારમાથી આ બધા જ ક્ષારો મળી રહેવા જોઈએ. આ તમામ ક્ષારોમાંથી લોહ અત્યંત જરૂરી છે. શરીરમાંના લોહનો કુલ જથ્થો ૩-૪ ગ્રામ છે. શરીરનું મોટા ભાગનું લોહ રક્ત (લોહી) અને યકૃતમાં હોય છે. માનવ શરીરના કુલ વજનના ૭ ટકા ભાગ લોહી હોય છે. લોહીના મુખ્ય બે ભાગ છે. એક પ્રવાહી ભાગ છે. જેને અંગ્રેજીમાં "સીરમ" કહે છે. બીજો જે ઘન ભાગ છે તેને અંગ્રેજીમાં "પ્લાઝમાં" કહે છે. આ બંન્નેનું પ્રમાણ લગભગ પચાસ-પચાસ ટકા હોય છે. ઘન ભાગમાં મોટું પ્રમાણ "રક્તકણો"નું હોય છે. આ "રક્તકણો" માં "હીમોગ્લોબીન" નામનો પદાર્થ રહેલો છે. તેનો રંગ લાલ હોય છે. તેને લીધે લોહીનો રંગ લાલ દેખાય છે. આ હીમોગ્લોબીન માં 'હીમ' અને 'ગ્લોબીન' નામના પદાર્થો હોય છે. 'હીમ' લોહ યુક્ત પદાર્થ છે અને 'ગ્લોબીન' પ્રોટીન છે. હીમોગ્લોબીનનું કામ ફેફ્સાંમાંથી પ્રાણ વાયુ લઈને શરીરના કોષોને આપી દેવાનું અને કોષો પાસેથી ઝેરી વાયુ કાર્બનડાયોક્સાઈડ લઈને ફેફ્સાંમાં તેને છોડી દેવાનું છે. આપણા શરીરમાં 'ગ્લુકોઝ' નું મંદ દહન ક્રિયા રાસાયણક પ્રક્રિયાઓ દ્વારા થઈને શક્તિના નિર્માણનું કાર્ય થાય છે. તેને માટે પ્રાણવાયુ (ઓક્સિજન)ની જરૂર પડે છે. એટલે આપણને જો આપણા આહારમાંથી પૂરતા પ્રમાણમાં લોહ મળે નહીં તો પૂરતા પ્રમાણમાં 'હીમોગ્લોબીન' બને નહીં, પરિણામે કોષોને પૂરતા પ્રમાણમાં પ્રાણવાયુ મળે નહી તેથી પૂરતા પ્રમાણમાં શક્તિ પેદા થાય નહીં અને આપણને અશક્તિનો અનુભવ થાય, નબળાઈ લાગે, હાંફ ચડે.

શરીરમાં લોહનું પ્રમાણ અને તેની વહેંચણી

આપણા શરીરમાં કુલ ૪ ગ્રામ જેટલું લોહ હોય છે. તેમાંનું પોણા ભાગનું એટલે કે ત્રણ ગ્રામ લોહ લોહીમાં હોય છે. બાકીનું આશરે એક ગ્રામ જેટલું લોહ કાળજામાં સંગ્રહ રૂપે રહેલું હોય છે. જે જરૂર પડે તેમ શરીરના ઉપયોગમાં લેવાય છે. રક્તકણોનો જ્યારે નાશ થાય છે ત્યારે તેમાં રહેલું લોહ બરોળમાં જાય છે. એટલે બરોળમાં પણ થોડું લોહ જોવા મળે છે. રક્તકણો બનવાની ક્રિયા હાડકાંનાં માવા (Bone Marrow) માં થાય છે. એટલે ત્યાં પણ થોડું લોહ જોવા મળે છે. રક્તકણો ના ભાગરૂપ ન હોય તેવું લોહ પણ આપણા શરીરમાં હોય છે. શરીરમાં રહેલા કુલ ૪ ગ્રામ લોહ માંથી, ૩ ગ્રામ (૭૫ ટકા) લોહ હીમોગ્લોબીનમાં હોય છે. બાકીનું ૦.૭૫ ગ્રામ (૨૦ ટકા) જેટલું લોહ કલેજામાં અને બરોળમાં હોય છે. તે 'ફેરિટિન' અને 'હિમો સિડેરિન' નામના પદાર્થોમાં રહેલું છે. આશરે ૩ ટકા જેટલું (૦.૧ ગ્રામ) લોહ 'માયોગ્લોબીન' નામના પદાર્થ માં રહેલું હોય છે. આ પદાર્થ સ્નાયુઓમાં હોય છે તેથી તેને 'સ્નાયુ હીમોગ્લોબીન' પણ કહે છે. આ પદાર્થ ઓક્સિજનને પકડી રાખે છે અને જ્યારે લોહી મારફત સ્નાયુઓને ઓક્સિજનનો પૂરતો પુરવઠો ન મળ્યો હોય ત્યારે ઓક્સિજન પૂરો પાડે છે, જે શક્તિના નિર્માણના કાર્યમાં વપરાય છે.

લોહીમાં "ટ્રાન્સફેરિન" નામનો એક પદાર્થ હોય છે. તેમાં પણ લોહ રહેલું છે. આ લોહ શોષણના સ્થાનેથી (આંતરડા આગળથી) સંગ્રહના સ્થાને જતું અથવા તો વપરાશના સ્થાને જતું વહન કરતું લોહ છે. માનવશરીમાં તેનું પ્રમાણ ૩ મિલીગ્રામ (૦.૧%) હોય છે. માંસપેશીઓમાં 'સાયટોક્રોમ' નામનો એક મહત્વનો પદાર્થ હોય છે. તેમાં પણ લોહ હોય છે. આ 'સાયટોક્રોમ' શક્તિના નિર્માણના કાર્યમાં ઘણો મહત્વનો ભાગ ભજવે છે. આ ઉપરાંત કેટલાંક ઉત્સેચકોના કાર્ય સાથે લોહ સંકળાયેલું છે.

લોહનાં પાચન અને શોષણને અસર કરતી બાબતો

લોહ શરીરમાં કેટલા પ્રમાણમાં શોષાય છે તેનો આધાર શરીરને લોહની કેટલા પ્રમાણમાં જરૂર છે તેના પર રહે છે. પ્રયોગમાં એવું જોવા મળ્યું છે કે જ્યારે શરીરને લોહની વધુ જરૂર હોય છે ત્યારે આંતરડામાંથી વધુ પ્રમાણમાં શોષાય છે અને શરીરને જ્યારે લોહની ઓછી જરૂર હોય છે ત્યારે તે આંતરડામાંથી ઓછું શોષાય છે, એટલે લોહના શોષણના પ્રમાણનો આધાર શરીરની જરૂરિયાત પર આધારિત છે એમ કહી શકાય.

- લોહનું સ્વરૂપ. (આહારમાં લોહનું સ્વરૂપ)
- ઓકઝેલિક એસિડ અને ફાયટેટનું પ્રમાણ. (આહારમાં)
- કૃમિ
- કેલ્શિયમનું પ્રમાણ.
- લોહના શોષણ માટે જરૂરી તત્વોનું પ્રમાણ

લોહના સ્વરૂપ

લોહનાં બે સ્વરૂપ હોય છે. 'ફેરસ' અને 'ફેરિક' તેમાં ' ફેરસ' સ્વરૂપે તે સારી રીતે શોષાઈને શરીરનાં ઉપયોગમાં આવે છે. આવા સ્વરૂપે શોષાવામાં આંતરડાની અમ્લતા (Acidity) અને વિટામિન "સી" મદદરૂપ થાય છે. એમ માનવામાં આવે છે. કારણ કે તે બંન્ને લોહને ફેરિક સ્વરૂપમાંથી ફેરસ સ્વરૂપમાં ફેરવવાનું કાર્ય કરે છે. લોહનો શરીરમાં યોગ્ય ઉપયોગમાં થવામાં તાંબુ પણ જરૂરી હોય છે. પ્રાણીજન્ય ખાદ્યોમાં લોહ ફેરસ સ્વરૂપે હોય છે જ્યારે વનસ્પતિજન્ય ખાદ્યોમાં લોહ ફેરિક સ્વરૂપે હોય છે.

આહારમાં ફાઈટેટ્સ અને ફોસ્ફેઈટ અને ઑક્ઝેલેટસનું પ્રમાણ

કેટલાક પદાર્થો આંતરડામાં લોહ સાથે ભળી જઈને તેના અદ્રાવ્ય પદાર્થો બનાવે છે. આવા પદાર્થોમાં ફાઈટેટ્સનો સમાવેશ થાય છે. અનાજના ઉપરના પડમાં તે હોય છે. તેથી અનાજમાં રહેલુ લોહ પૂરતા પ્રમાણમાં શોષાતું ન હોય તેવી એક માન્યતા પ્રવર્તે છે. જ્યારે ખોરાકમાં ચુનાનું પ્રમાણ ઓછું હોય અને ફોસ્ફરસનું પ્રમાણ વધારે હોય ત્યારે વધારે ફોસ્ફરસ આ રીતે લોહ સાથે સંકળાય છે. અનાજમાં ફોસ્ફરસ નું પ્રમાણ વધારે હોય છે અને cuનાનું પ્રમાણ ઓછું હોય છે. તેની સાથે વધુ ચુનો ધરાવતા ભાજી, દૂધ, છાશ જેવા pદાર્થો લેવાથી વધારાનો ફોસ્ફરસ આ ચુના સાથે સંયોજાઈને શરીરના ઉપયોગમાં આવશે, અને લોહ સાથે સંકળાઈને અદ્રાવ્ય પદાર્થો નહીં બનાવે. તેથી લોહનો પણ શરીrમાં ઉપયોગ થશે આ ઉપરાંત આહાર જેમ કે શાકભાજી માં ઑક્ઝેલેટનું પ્રમાણ વધારે હોવાથી તે લોહ સાથે સંયોજાઈને અદ્રાવ્ય પદાર્થો બનાવે છે. પરિણામે આહારમાં લોહ હોવા છતાં પણ શરીરને પુરેપુરું મળી શક્તું નથી.

કૃમિ

શરીરમાં કૃમિ હોય તેવા સંજોગોમાં પણ પૂરતું લોહ શોષાતું નથી. જેમ કે પટ્ટી કૃમિ, અંકુશ કૃમિ, કરમિયા વગેરે જેવા કૃમિના કારણે પણ લોહ શરીરમાં શોષાતું નથી.

આહારમાં કેલ્શિયમનું પ્રમાણ

આંતરડાના દ્રાવણમાં વધુ પડતો ચૂનો (કેલ્શિયમ) હોય તો તે પણ દ્રાવણની અમ્લતા ઘટાડતો હોવાથી લોહના શોષણમાં અવરોધક બને છે. વધુ પડતું દુધ લેતાં બાળકોમાં લોહની ઉણપ જોવા મળે છે કારણ કે દુધમાં સારા પ્રમાણમાં ચૂનો છે અને લોહનું પ્રમાણ ખૂબ જ ઓછું છે તેમજ દુધમાં વિટામીન સી નહીવત પ્રમાણમાં હોય છે.

લોહના શોષણ માટે જરૂરી તત્વોનું પ્રમાણ

લોહ શરીરનાં જે કાર્યો માટે નિર્માયું છે તે બધા કાર્યો બરાબર થાય તે માટે પ્રોટીન (સંપૂર્ણ પ્રકારનું) તાંબુ, ફોલિકએસિડ, વિટામિન B_{12}, વિટામિન B_6, (પાયરી ડૉક્સિન), વિટામિન સી, વિટમિન એ, અને વિટામિન ઈ વગેરે જેવા તત્વો પણ જરૂરી છે. અવશોષણ થતું લોહ યકૃતમાં એકત્ર થાય છે. તેમજ જોઈએ તેટલા પ્રમાણમાં તે હીમોગ્લોબીન સંશ્લેષણ માટે વપરાય છે. હીમ લોહ ધરાવતું સંયોજન છે અને ગ્લોબીન એક પ્રોટીન છે. હીમોગ્લોબીનના સંશ્લેષણ માટે અનેક પોષક તત્વો જરૂરી છે. જો આ પોષકતત્વો ખોરાકમાં ઘટતાં હોય તો હીમોગ્લોબીનનું સંશ્લેષણ ન થાય. આમ એના ઉપર ઘણાં પોષક દ્રવ્યોની અસર થતી હોવાથી રક્તમાં હીમોગ્લોબીનનું માપ પોષણની સ્થિતિ બતાવવા નિર્દેશક તરીકે ઉપયોગી છે. હીમોગ્લોબીનના સંશ્લેષણ માટે જરૂરી પોષક દ્રવ્યોમાંથી કોઈ એક કે વધું દ્રવ્યો અપ્રાપ્ત હોય તો પાંડુરોગ થાય છે.

શરીરમાંથી લોહ નો થતો વ્યય

આપણા શરીરમાંથી લોહ નો વ્યય બહુ જ થોડા પ્રમાણ થાય છે, કારણ કે રક્તકણોના નાશમાંથી મળેલું લોહ ફરી પાછું નવા રક્તકણો બનાવવામાં વપરાય છે. થોડું લોહ પેશાબ અને પરસેવા વાટે શરીરમાંથી બહાર જાય છે. આ ઉપરાંત જ્યારે વાળ અને નખ કાપવામાં આવે છે ત્યારે તેની સાથે પણ થોડું લોહ જતું હોય છે. ચામડીના ઉપરના ભાગના કોષો જ્યારે નાશ પામે અને ચામડી પરથી નીકળી જાય ત્યારે તેની સાથે પણ થોડું લોહ જતું હોય છે. આંતરડા દ્વારા થોડું લોહ શરીરમાંથી બહાર જાય છે. સ્ત્રીઓમાં માસિક વખતે શરીરમાંથી લોહ જતું હોય છે. પુખ્ત વયની વ્યક્તિના શરીરમાંથી થતા લોહના વ્યયનું પ્રમાણ નીચે પ્રમાણે અંદાજવામાં આવે છે.

- ✓ પેશાબ દ્વારા - ૦.૨૫ મિલીગ્રામ
- ✓ આંતરડા દ્વારા - ૦.૨ – ૦.૯ મિલીગ્રામ

- ✓ ચામડી દ્વારા - ૦.૫ મિલીગ્રામ
- ✓ પરસેવા દ્વારા - ૦.૪ મિલીગ્રામ
- ✓ સ્ત્રીઓમાં માસિક દ્વારા - ૦.૬ મિલીગ્રામ

લોહની દૈનિક જરૂરિયાત

લોહનો વ્યય ખૂબ જ ઓછો થતો હોવાથી તેની દૈનિક જરૂરિયાત પણ ઓછી રહે છે. પ્રયોગમાં એવું જોવા મળ્યું છે કે રોજનું ફક્ત ૬ મિલીગ્રામ લોહ મળે તો તે પૂરતું થાય. સ્ત્રીઓને રોજનું ૧૦ મિલીગ્રામ લોહ મળે તો તે પૂરતું થઈ રહે પરંતુ જુદા જુદા ખાદ્ય પદાર્થોમાંથી પ્રાપ્ત થતા લોહનું પ્રમાણ ૧૦ થી ૩૩ ટકા હોવાથી પુરૂષોને દૈનિક આહારમાં ૧૫ થી ૨૦ મિલીગ્રામ અને સ્ત્રીઓને રોજનું ૩૦ મિલીગ્રામ લોહ લેવાની ભલામણ આહારશાસ્ત્રીઓએ કરેલી છે. જુદા જુદા વય જૂથ પ્રમાણે લોહની દૈનિક જરૂરિયાત નીચે પ્રમાણે છે.

વય જૂથ	**લોહનું પ્રમાણ (મિલીગ્રામ)**
જન્મથી ૧ વર્ષ	૧ મિલીગ્રામ/ ૧ કિલો શરીરના વજન પ્રમાણે
૧ – ૬ વર્ષ	૧૫ – ૨૦ મિલીગ્રામ
૬ – ૧૨ વર્ષ	૧૫ – ૨૦ મિલીગ્રામ
૧૩ – ૧૮ વર્ષ છોકરાઓ છોકરીઓ	૨૫ મિલીગ્રામ ૩૫ મિલીગ્રામ
પુખ્ત પુરૂષો	૨૦ મિલીગ્રામ
સ્ત્રીઓ	૩૨ મિલીગ્રામ
સગર્ભા સ્ત્રીઓ	૪૦ મિલીગ્રામ
ધાત્રી માતા	૩૨ મિલીગ્રામ

સગર્ભા સ્ત્રીઓની લોહની જરૂરિયાત

સગર્ભાવસ્થા દરમ્યાન રક્તકણોના જથ્થામાં ૧૫ થી ૨૦ ટકાનો વધારો થાય છે. આ વધારાનો રક્તકણોની રચના માટે લગભગ ૩૦૦ મિલીગ્રામ જેટલા લોહની જરૂર પડે છે તે માટે આહારમાં વધારે લોહ લેવાની જરૂર પડે છે.સગર્ભાવસ્થાના છેલ્લા ત્રણ માસ દરમ્યાન ગર્ભસ્થ શિશુના કાળજામાં લોહનો સંગ્રહ સારા પ્રમાણમાં થાય છે. આ લોહ બાળક માતા પાસેથી મેળવે છે. જન્મ સમયે બાળકના કલેજામાં આશરે ૩૫ મિલીગ્રામ જેટલો લોહનો સંગ્રહ થયેલો હોય છે. બાળક એક વર્ષનું થાય ત્યાં સુધી માં આ સંગ્રહ ઘટતાં ઘટતાં ૧૫ મિલીગ્રામ

જેટલો થઈ જાય છે. આનું કારણ એ છે કે માતાના દુધમાં લોહનું પ્રમાણ બહુ જ ઓછું હોય છે એટલે બાળકના શરીરની જરૂરિયાત માટેનું લોહ બાળકના કલેજાના સંગ્રહમાંથી વપરાય છે માતાને સગર્ભાવસ્થામાં પૂરતું લોહ મળી રહે તેવો ખોરાક ન મળે તો માતાનાં લોહીમાંથી લોહ ઓછું થઈને બાળકના કલેજામાં સંગ્રહ થાય છે. આને કારણે સગર્ભા સ્ત્રીઓમાં લોહીની ફીકાશનો રોગ- પાંડુરોગ જોવા મળે છે. આવી સ્ત્રીઓનું બાળક પણ લોહનો પૂરતો પુરવઠો લઈને જન્મતું નથી. આવું બાળક જન્મથી જ નબળું રહેતુ જોવા મળે છે. આવું ન બને તે માટે સગર્ભા સ્ત્રીઓના આહારમાં કાળજીપૂર્વક ધ્યાન રાખવાની જરૂર છે.

શિશુની અને માતાની લોહની જરૂરિયાત

બાળક લગભગ છ માસ સુધી માતાના દુધ પર જ નભતું હોય છે તે પછી માતાના દુધ ઉપરાંત અન્ય દુધ કે ગાયનું દુધ તેને આપવામાં આવે છે. માતાના ૧૦૦ મિલી લિટર દુધમાં ફક્ત ૦.૧૫ મિલીગ્રામ જેટલું જ લોહ હોય છે. માતાના ૮૫૦ મિલી લિટર દુધમાંથી બાળકને ૧.૩ મિલીગ્રામ લોહ મળે છે. જે છ માસ સુધી તો પૂરતું થાય, કારણ કે કલેજામાં લોહનો સંગ્રહ હોય છે. પરંતુ છ માસ પછી આટલું લોહ બાળકને પૂરતું ન થાય. આ માટે બાળકને ફળોના રસ, સૂપ અને વીટામીન સી અને લોહથી ભરપૂર ખાદ્યો આપવા જોઈએ.

લોહીના રક્તકણોની રચના માટે તાંબુ પણ લોહની જેમ જરૂરી જણાયું છે. એટલે લોહીની ફીકાશ ના રોગમાં લોહની સાથે તાંબુ પણ આપવામાં આવે છે. તેની દૈનિક જરૂરિયાત ૧ થી ૩ મિલીગ્રામની અંદાજવામાં આવી છે. આપણા આહારમાં જરૂરિયાત મુજબનું તાંબુ મળી રહે છે, એટલે માનવ આહારમાં તાંબા ની કમી ના કિસ્સા જોવા મળતા નથી. શરીરમાં ચાલતી અનેક રાસાયણિક પ્રક્રિયાઓમાં ઉત્પ્રેરક તરીકે કાર્યો કરતાં અનેક ઉત્સેચકોમાં તાંબુ રહેલું હોય છે. તે પ્રોટીન સાથે જોડાયેલું જોવા મળે છે. ખોરાકમાં રહેલું તાંબુ કલેજામાં જાય છે ત્યાં તેમાંથી " સેરુલોપ્લાઝમિન " નામનો હીમોગ્લોબીન જેવો પ્રોટીનયુક્ત પદાર્થ બને છે જે લોહી મારફતે કોષોને મળે છે. આ પદાર્થ ની હીમોગ્લોબીન બનાવવમાં જરૂર પડતી હોય છે. તાંબુ તેમજ લોહની જેમ જ કોબાલ્ટ પણ પાંડુરોગીને લોહીની ફીકાશ દૂર કરવા માટે લોહ, તાંબા સાથે કોબાલ્ટ પણ અલ્પ માત્રામાં આપવામાં આવે છે.

રક્તના રક્તાણું જેમાં હીમોગ્લોબિન હોય છે તેમનું સંયોજન અસ્થિમજ્જામાં થાય છે. શરૂઆત માં તે મોટા અને ઘાટ વગરના હોય છે તથા તેમાં હીમોગ્લોબીન હોતું નથી. (મેગાલોબ્લાસ્ટસ) તેમનો વિકાસ થતા તેઓ નાના તેમજ ગોળ બને છે અને તેમાં હીમોગ્લોબીન હોય છે. આ

તબક્કે તેમાં નાભિક હોય છે. તેમાંથી નાભિક ચાલ્યું જાય છે. ત્યાર પછી પૂર્ણ વિકસિત રક્તાણું બને છે. તે રક્તાણું એરિથ્રોસાઇટ કહેવાય છે. નીરોગી વ્યક્તિના પરિભ્રમણ કરતાં રક્તમાં મહદંશે રક્તાણું હોય છે કારણ કે અસ્થિમજ્જામાંથી તેઓ પરિપક્વ થઈને જ બહાર નીકળે છે પરંતુ કેટલાક પ્રકારના પાંડુરોગમાં રક્તાણુપ્રસુ (નૉમોબ્લાસ્ટ) અને મૂળ રક્તાણુ પ્રસુ (મેગાલોબ્લાસ્ટસ) ઓછું હોય છે તેઓ કદમાં નાના હોય છે અને તેમાં હીમોગ્લોબીન ઓછુ હોય છે. કેટલીક વાર કોષમાં તેઓ બરડ અને અલ્પ જીવી હોય છે.

નીરોગી વ્યક્તિના રક્તમાં દર ૧૦૦ મિ.લી. માં ૧૨-૧૬ ગ્રામ હીમોગ્લોબીન હોય છે. ઊણપ હોય અથવા રોગ થાય તો આ માત્રા ઘટીને ૧૦૦ મિ.લી માં ૫ ગ્રામ થઈ જાય છે. રક્ત માં હીમોગ્લોબિન ઓછું હોય તો તે રોગને પાંડુરોગ કહે છે. હીમોગ્લોબિનના સંશ્લેષણ માટે જરૂરી પોષક દ્રવ્યો માંના એક અથવા વધુ પોષકતત્વો ની આહારમાં ઊણપ હોય તો પાંડુરોગ થાય છે. રોગીનો આહાર દેખીતી રીતે પૂરતા પ્રમાણમાં હોવા છતાં પણ તેમાં ચેપી અને બીજા રોગો તેનામાં જણાતા હોય છે. કેટલીક વાર અસ્થિમજ્જાની રક્તાણું સર્જવાની કાર્ય ક્ષમતા પર અસર થાય છે. પ્રતિ જૈવિક પદાર્થો અને સલ્ફા ઔષધો અનહદ પ્રમાણમાં લેવાથી પણ કેટલીકવાર આવું બને છે. કેટલાક સંજોગમાં રક્તાણું ઝડપથી નાશ પામે છે. આ પરિસ્થિતિમાં હીમગ્લોબિન સંશ્લેષણ માટે જરૂરી પોષક દ્રવ્યો વધુ પ્રમાણમાં આપવામાં આવે છે. અત્યંત ખરાબ પરિસ્થિતિમાં પોષક દ્રવ્યો વિપુલ પ્રમાણમાં આપતા પણ હીમોગ્લોબિન સંશ્લેષણ પ્રમાણિત સ્તરે આવતું નથી. જૂના રક્તાણુંનું વિઘટન અને નવા રક્તાણુંનું સંશ્લેષણ સતત ચાલુ રહે છે. પહેલા માંથી છૂટું પડતું લોહ બરોળમાં એકત્ર થાય છે અને હીમોગ્લોબિન સંશ્લેષણમાં પુનઃ વપરાય છે.

પાંડુરોગ

રક્ત ના હીમોગ્લોબિનના સંશ્લેષણ માટે જરૂરી પોષક દ્રવ્યો માંના એક અથવા વધુ પોષકતત્વોની આહારનાં ઉણપ હોય તો પાંડુરોગ થાય છે. પાંડુરોગમાં કાં તો રક્તમાં રહેલા રક્તાણુંના કદ અને સંખ્યા ઘટે તેથી હીમોગ્લોબીન ઘટે અથવા તેઓના પૂર્ણ વિકાસમાં ઊણપ રહેતી હોય છે.

પાંડુરોગના પ્રકાર

(૧) આહારમાં પોષક દ્રવ્યોની ઊણપથી થતો પાંડુરોગ

- ✓ ઈરિથ્રોપોએટીનની અપૂરતી બનાવટ

- ✓ ફોલિકએસિડ અને વીટામિન B_{12} ની ઊણપ. (મેગાલોબ્લાસ્ટીક એનિમિયા)
- ✓ લોહની ઊણપથી થતો પાંડુરોગ
- ✓ વીટામીન સી, પિરિડોક્સિન અને કેટલાક અંત:સ્ત્રાવો ની ઊણપથી થતો પાંડુરોગ

(૨) જનીનિક ખામીથી થતો પાંડુરોગ (હિમોલાઈટિક એનિમિયા)

- ✓ જનીનની બનાવટમાં ખામીથી થતો પાંડુરોગ
- ✓ રક્તાણુંની બનાવટમાં ખામીથી થતો પાંડુરોગ
- ✓ ગ્લોબિનની બનાવટમાં ખામીથી (થેલેસિમીયા) થતો પાંડુરોગ
- ✓ રક્તાણું માં કેટલાક ઉત્સેચકોની ઊણપના કારણે થતી ખામીથી થતો પાંડુરોગ

(૩) **અન્ય કારણો થી થતો પાંડુરોગ**

- ✓ દવાઓના સેવનથી (સલ્ફા અને પ્રતિજૈવિકો)
- ✓ ઝેરી રસાયણોના સેવનથી (સીસુ , આર્સેનિક)
- ✓ ચેપ અને પ્રતિજનથી
- ✓ પેશીઓમાં સંગ્રહાયેલા લોહનો ઉપયોગ ન થવાના કારણે થતો પાંડુરોગ (સીડીરોબ્લાસ્ટીક એનિમિયા)

જો લોહ કે પિરિડોક્સિનની ઊણપને કારણે પાંડુરોગ થયો હોય તો તેના રક્તાણું કદમાં નાના (માઈક્રોસાઈટિક) હોય છે, અને તેમાં ઓછું હીમોગ્લોબિન (હાઈપોક્રોમિક) હોય છે. આવા પાંડુરોગને માઈક્રોસાઈટિક હાઈપોક્રોમિક પાંડુરોગ કહેવાય છે. જ્યારે કેલરી અને પ્રોટીનની ઊણપથી પાંડુરોગ થાય ત્યારે રક્તાણુંના કદ અને તેમાંના હીમોગ્લોબિનમાં તફાવત પડતો નથી. પરંતુ તેઓની સંખ્યા ઘટી જાય છે અને રક્તમાં અપક્વ રક્તાણુંઓ દેખાય છે. આવા પાંડુરોગને નોર્મોસાઈટિક નોર્મોક્રોમિક પાંડુરોગ કહેવાય છે.વિટામીન બી૧૨, ફોલિકએસિડ કે વિટામીન ઈ ની ઊણપમાં રક્તાણુંની સંખ્યા ઘટે છે. અને તે કદમાં મોટા (મેક્રોસાઇટિક) હોય છે. જો રક્તમાં મેગાલોબ્લાસ્ટસ હોય ત્યારે તેને મેક્રોસાયટિક મેગાલોબ્લાસ્ટીક પાંડુરોગ કહેવાય છે.

વિભિન્ન પ્રકારના પાંડુરોગનું વર્ગીકરણ

નિમિત્ત	લક્ષણો	વર્ણન અને ઉપચાર
લોહની ઉણપ	રકતાણુંનુ કદ અને તેમાંના હિમોગ્લોબિનમાં ઘટાડો.	માઇક્રોસાયટિક, હાઇપોક્રોમિક લોહ xક્ષાર, આપવાથી સુધારી શકાય.
કેલરી – પ્રોટીન ઉણપ	રકતાણુંની સંખ્યામાં ઘટાડો, અપકવ રકતકણોની હાજરી	નોર્મોસાયટિક, નોર્મોક્રોમીક , આહાર સુધારવાથી ફાયદો
ફોલિક એસિડ વીટામીન B_{12} વિટામીન ઇ ની ઉણપ	રકતાણુંની સંખ્યામાં ઘટાડો, મોટા અપકવ રકતકણો (મેગાલોબ્લાસ્ટસ) ની હાજરી	મેક્રોસાયટિક, મેગાલોબ્લાસ્ટિક યોગ્ય વિટામીન અને જરૂરી તત્વો આપવાથી સુધારો.
પિરિડોક્સિન	રકતાણુંના કદ અને હીમોગ્લોબિનમાં ઘટાડો	મેક્રોસાયટિક, હાઇપોક્રોમિક લોહ-ક્ષાર થી ફાયદો નથી પરંતુ પિરિડોક્સિન આપવાથી ફાયદો.
વિટામીન સી	રકતાણુંની સંખ્યામાં ઘટાડો, નોર્મોબ્લાસ્ટસ અને મેગાલોબ્લાસ્ટસ ની હાજરી	નોર્મોસાયટિક અથવા મેક્રોસાયટિક અને નોર્મોક્રોમિક વિટામીન સી થી ફાયદો

આહાર સિવાયના પરિબળો

નિજીતત્વની ઉણપ	વીટામીન B_{12} ની ઉણપ પ્રમાણે	ઉગ્ર પાંડુરોગમાં વીટામીન B_{12} નું અંત:શિરાઇ (**Intravenous**) ઇન્જેકશન અથવા નિજીતત્વ આપવું.
વિષમય ઘટકો (પ્રતિજૈવિકો અને સલ્ફા ઔષધો)	રકતાણું સંશ્લેષણમાં ઘટાડો	એપ્લાસ્ટિક, પોષક દ્રવ્યો થી સામાન્ય રીતે સુધારો હંમેશા નહી.
રકતસ્રાવ	ઇજા, વાઢકપ કે અંત:રકતસ્રાવમાં લોહી વહી જવાથી રકતાણું, શ્વેતકણમાં	અનુરકત સ્રાવ સામાન્ય રીતે પોષક આહાર સારા પ્રમાણમાં આપવો હમેશા

	ઘટાડો.	ફાયદો નહી.
સીસું આર્સેનિક વગેરે થી લાંબા ગાળાના ઝેરી તત્વોના સેવનથી	રકતાણું નું ઝડપથી વિઘટન અને અલ્પજીવન	રુધિરાલયી
અંકુશ કૃમિ જેવા આંતરડામાં કૃમિ	લોહની ઉણપ પ્રમાણે	માઇક્રોસાયટિક, હાઇપોક્રોમિક કૃમિઓના નિકાલ કરવાથી ફાયદો થાય.

ખાદ્ય પદાર્થમાં લોહનું પ્રમાણ

આપણા દૈનિક આહારમાં જુદા-જુદા ખાદ્ય પદાર્થોમાં લોહ હોય છે જે નીચે મુજબ છે.

- કેટલાક ખાદ્ય પદાર્થોમાં લોહનું પ્રમાણ (મિલીગ્રામ/ ૧૦૦ ગ્રામ)

નામ	**પ્રમાણ (મિલીગ્રામ/ ૧૦૦ ગ્રામ)**
અનાજ	
બાજરી	૮.૦
જુવાર	૪.૧
મકાઇ (સૂકી)	૨.૩
ચોખા	૧.૦
ઘંઉનો લોટ	૪.૯
રાગી	૩.૯
પૌંઆ	૨૦.૦
મમરા	૬.૬
કઠોળ	
ચણા	૪.૬
ચણાદાળ	૫.૩
અડદ	૩.૮
અડદ દાળ	૩.૮
ચોળા	૮.૬
મગની દાળ	૩.૦
મગ	૪.૪

મઠ	૯.૫
સુકા વટાણા	૭.૦૫
તુવેર દાળ	૨.૭
સોયાબીન	૧૦.૪
મસૂર	૭.૫૮
શાકભાજી	
તાંદળજો	૩.૪૯
અળવીના પાન	૨૮.૦
કોથમીર	૧.૪૨
મીઠો લીમડો	૦.૯૩
સરગવાનાં પાન	૦.૮૫
મેથીની ભાજી	૧૯.૩
કુદીનો	૧૫.૬
મૂળાનાં પાન	૧૮.૦
કરેલાં (નાના)	૨.૦
એશીળીયાની ભાજી	૨૮.૬
સવાની ભાજી	૧૭.૪
લીલી ડુંગળી	૭.૪૩
સુકો મેવો અને મરી મસાલા	
તલ	૯.૩
રાઇ	૭.૯
પિસ્તાં	૭.૭
હિંગ	૩૯.૪
ધાણા	૭.૧
જીરૂ	૧૧.૭
મેથી	૬.૫
કાળામરી	૧૨.૪
આંબલી	૧૭.૦
હળદર	૬૭.૮
કાળી દ્રાક્ષ	૮.૫

બદામ	૫.૦૫
કાજુ	૫.૮૧
સુકુ ટોપરૂ	૭.૮
કાળાતલ	૫૬.૭
માવો	૫.૮

પાંડુરોગ અટકાવતા ના ખાદ્ય પદાર્થો (દર ૧૦૦ ગ્રામ)

આયર્ન – લોહતત્વ	**વીટામીન B_{12} (માઇક્રોગ્રામ)**	**ફોલિક એસિડ (માઇક્રોગ્રામ)**
પૌઆ – ૨૦.૦	ગાયનું દહીં – ૦.૧૩	ચણા- ૧૮૬
મૂળાની ભાજી- ૧૮.૦		તાંદળજો- ૧૪૯
ફૂદીનો – ૧૫.૬		ચણાદાળ- ૧૪૭.૫
શેકેલા ચણા - ૯.૫		ગવાર- ૧૪૪
બાજરી – ૮.૦		તલ – ૧૩૪
		અડદ દાળ- ૧૩૨
		પાલખ – ૧૨૩
		કુદીનો – ૧૧૪
		ભીડાં – ૧૦૫.૧

APPENDIX-III

Permission Letter

To,

The Principal

Subject: Permission for nutritional assessment of college girls.

Respected Sir,

I, Dr. P.U.Shah, Associate professor, Department of Home Science, Smt.A.S.C.Mahila Arts and Home Science College, Mehsana, affiliated to H. N. G. University, Patan, doing UGC 12th plan Minor Research Project on prevalence of anemia, assessment of nutritional status and impact of intervention programme on knowledge level of college girls. We would like to assess the nutritional status of college girls in your esteemed institution. For this purpose, I request you to allow her to do the following work.

- To fill up a questionnaire regarding health and nutrition.
- To find out prevalence of anemia among college girls.

We assure you that the data collection will be solely used for the research purpose. Kindly grant us permission for the same.

Thanks and regards,

(Dr.P.U.Shah)
Principal Investigator
UGC, MRP.