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Prevalence of Iron Deficiency Anemia among School Children in Salfeet District

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Dedication

To My Beloved Wife, Parents for their Patience and Encouragements with Love and Respect

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Abstract

A cross-sectional study conducted in the second semester of the academic year 2005 to investigate the prevalence of iron deficiency anemia in school children aged 6 to 18 years, who live in the district of Salfeet in the West Bank area of Palestine. The study sample consisted of 144(49.7 %) male students, and 146 (50.3 %) female students. Complete blood count (CBC) was performed and blood samples with main corpuscular volume (MCV) value less than 80um^3(FL) were subjected to serum iron test. The prevalence of iron deficiency was 26.7% (12.7% with anemia, and 14% without anemia). The prevalence of iron deficiency among females was 30.5%, and among males was (21.6%). Iron deficiency was apparent in all studied age groups. The prevalence of 32.4% was observed among the age group 6- 8 years, 35.3% among age group 9-11 years, 25.9% among 12-14 years and 12.1% among 15-18 years old. Differences in prevalence rates were statistically significant (***P***= 0.01 at α = 0.05). According to place of residency, there was statistically significant difference between the overall prevalence of iron deficiency among children living in villages compared to children living in the city (22.8% versus 32.6% respectively, $P < 0.01$). There was no clear link between family size and iron deficiency. With respect to prevalence of iron deficiency and family income, no significant difference was observed (24.9% low income; 28.1% with medium and 30.2% with high income). In general, improper daily healthy practices and poor knowledge regarding

iron rich nutrients and its absorption found. Previous history of other diseases seems to contribute to the highly observed prevelance rate of IDA.

To effectively face these deficiencies it is necessary to think about the possibilities and cost effectiveness of fortifying foodstuffs (floor, salt, milk) and it is essential to carry out nutritional education activities to improve children and parents awareness and knowledge regarding iron deficiency anemia and its consequence.

Chapter One

Introduction

1.1 General background

Iron deficiency is the most prevalent and common micronutrient deficiency in the developing world today (Tatala *et al.*, 1998; Asobayire *et al.*, 2001; Abalkhail and Shawky, 2002; Hashizume *et al.*, 2003). The public health effects of iron deficiency include anemia, decreased intellectual and work performance as well as functional alterations of the small bowel (Oski, 1993). Beside other vulnerable age groups, such as infancy and early childhood, adolescence is placed at a high risk level for developing iron deficiency, due to a combination of menstrual iron losses in girls and a rapid physical growth, especially in boys (Fomon *et al.*, 2003).

Poor diet quality and low dietary iron bioavailability are the principal factors that contribute to the increased incidence of iron deficiency (Tatala *et al.*, 1998). The bioavailability of haem iron, present in animal products, is high with absorption rates of 20−30%, whereas the bioavailability of nonhaem iron is determined by the presence of enhancing or inhibiting factors (Hurrell, 1997). The main enhancers of nonhaem iron absorption are meat (haem iron) and vitamin C (Cook & Reddy, 2001). Inhibitors include phytate (nuts, bran and oat products, whole-wheat and brown flour), polyphenols (tea, coffee, cocoa, some spices and vegetables), calcium (milk products) and Phosphorous (Reddy *et al.*, 2000).

In developing countries, low standards of living, low socio-economic conditions, restricted access to food and lack of knowledge for good dietary practices and personal hygiene contribute even more to a high occurrence of iron deficiency and hence anemia (Hall *et al.*, 2001; Islam *et al.*, 2001; Soekarjo *et al.*, 2001). Intestinal parasitic infection, due to poor hygienic conditions also interferes with iron absorption, thus expanding the prevalence of iron deficiency anemia in the developing world (Olivares *et al.*, 1999; Musaiger, 2002).

1.2 Definition

Iron deficiency anemia is a decrease in the total hemoglobin levels caused by a lack of sufficient iron (Goldenring, 2003). It is the most common cause of anemia worldwide. Iron is needed to form hemoglobin and is mostly stored in the body in the form of ferritin and hemosiderin. About 30% of iron is stored as ferritin and hemosiderin in the bone marrow, spleen, and liver. Iron-deficiency anemia does not develop immediately. Instead, a person progresses through stages of iron deficiency, beginning with iron depletion, in which the amount of iron in the body reduced but the amount of iron in the red blood cells remains constant. If iron depletion not corrected, it progresses to iron deficiency, eventually leading to iron-deficiency anemia.

1.3 Pathophysiology

Iron is vital for all living organisms because it is essential for multiple metabolic processes, including oxygen transport, DNA synthesis, and electron transport. Iron equilibrium in the body regulated carefully to ensure that sufficient iron is absorbed in order to compensate for body losses of iron. While body loss of iron quantitatively is as important as absorption in terms of maintaining iron equilibrium, it is a more passive process than absorption. Consistent errors in maintaining this equilibrium lead to either iron deficiency or iron overload (Conrad, 2000).

Iron balance usually achieved by regulation of iron absorption in the proximal small intestine. Either diminished absorbable dietary iron or excessive loss of body iron can cause iron deficiency. Diminished absorption is usually due to an insufficient intake of dietary iron in the absorbable form.

Iron uptake in the proximal small bowel occurs by three separate pathways. These are the heme pathway, the ferric pathway and the ferrous pathway. Heme iron not chelated and precipitated by numerous constituents of the diet that renders nonheme iron nonabsorbable. Examples are phytates, phosphates, tannates, oxalates, and carbonates. Heme is maintained soluble and available for absorption by globin degradation products produced by pancreatic enzymes. Heme iron and nonheme iron are absorbed into the enterocyte noncompetitively. Heme enters the cell as an intact metalloporphyrin, presumably by a vesicular mechanism, degraded within the enterocyte by heme oxygenase with release of iron so that it traverses the basolateral cell membrane in competition with nonheme iron to bind transferrin in the plasma (Marcel, 2005).

Ferric iron utilizes a different pathway to enter cells than ferrous iron. This shown by competitive inhibition studies, the use of blocking antibodies against divalent metal transporter-1 (DMT-1) and beta3-integrin, and transfection experiments using DMT-1 DNA. This indicated that ferric iron utilizes beta3-integrin and mobilferrin, while ferrous iron uses DMT-1 to enter cells (Lee, 1999). Which pathway transports most nonheme iron in humans is not known. Most non-heme dietary iron is the ferric iron. Iron absorption in mice and rats may involve more ferrous iron because they excrete moderate quantities of ascorbate in intestinal secretions. On the contrary, humans are a scorbutic species and are unable to synthesize a scorbate to reduce body ferric iron (Marcel, 2005).

There are other proteins, which appear to be involved in iron absorption. These are stimulators of iron transport (SFT), which are reported to increase the absorption of both ferric and ferrous iron, and hephaestin, which is postulated to be important in the transfer of iron from enterocytes into the plasma (Marcel,2005).

The iron concentration within enterocytes varies directly with the body's requirement for iron. Absorptive cells in iron-deficient humans and animals contain little stainable iron, whereas this increased significantly in subjects who are replete in iron (Marcel, 2005). Untreated phenotypic hemochromatosis creates little stainable iron in the enterocyte, similar to iron deficiency. Iron within the enterocyte may operate by up-regulation of a receptor, saturation of an iron-binding protein, or both. In contrast to findings in iron deficiency, enhanced erythropoiesis, or hypoxia, endotoxin rapidly diminishes iron absorption without altering enterocyte iron concentration. This suggests that endotoxin and, perhaps, cytokines alter iron absorption by a different mechanism (Marcel, 2005).

Most iron delivered to nonintestinal cells is bound to transferrin. Transferrin iron is delivered into nonintestinal cells via 2 pathways, the classical transferrin receptor pathway (high affinity, low capacity) and the pathway independent of the transferrin receptor (low affinity, high capacity) (Marcel, 2005). Otherwise, the non-saturability of transferrin binding to cells cannot be explained. In the classical transferrin pathway, the transferrin receptor complex enters the cell within an endosome. Acidification of the endosome releases iron from transferrin so that it can enter the cell. The apotransferrin is recycled back to plasma for reutilization. The method by which the transferrin receptor–independent pathway delivers iron to the cell is not known (Marcel, 2005). Nonintestinal cells also possess the mobilferrin integrin and DMT-1 pathways. Their function in the absence of an iron-saturated transferrin is uncertain; however, their presence in nonintestinal cells suggests they may participate in intracellular functions in addition to their ability to facilitate cellular uptake of iron (Marcel, 2005).

1.4 Iron needs during infancy and childhood

To meet the needs of iron for growth and to replace normal losses, iron intake must supplement the approximately 75 mg of iron per kilogram of body weight that is present at birth (Widdowson, Spray, 1951). Iron losses from the body are small and relatively constant except during episodes of diarrhea or during the feeding of whole cow's milk, when iron losses may be increased. About two thirds of iron losses in infancy occur when cells are extruded from the intestinal mucosa and the remainder when cells are shed from the skin and urinary tract. In the normal infant, these losses average approximately 20µg per kilogram per day. An infant who weighs 3kg at birth and 10kg at one year of age will require approximately 270 to 280mg of additional iron during the first year of life to maintain normal iron stores (Widdowson, 1951).

After one year of age, the diet becomes more varied and there is less information from studies on which to base dietary recommendations. The recommended dietary allowance decreases to 10mg per day for children between 4 and 10 years of age and then increases to 18mg per day at the age of 11 to provide for the accelerated growth that take place during adolescence (Elk, 1985).

There are two broad types of dietary iron; about 90% of iron from food is in the form of iron salts and referred to as non-heme iron. The extent to which this type of iron is absorbed is highly variable and depends both on the person's iron status and on the other components of the diet. The other 10% of dietary iron is in the form of heme iron, which derived primarily from the hemoglobin and myoglobin of meat. Heme iron is well absorbed, and its absorption less strongly influenced by the person's iron stores or the other constituents of the diet. There is little meat in the diet of most infants; therefore, most of their dietary iron is non-heme, and their intake is highly influenced by other dietary factors. Ascorbic acid enhances the absorption of non-heme iron, as do meat, fish, and poultry (Derman *et al.*, 1980). Inhibitors of absorption include bran, polyphenols, oxalates, phytates, vegetable fiber, the tannins in tea, and phosphates (Charlton and Bothwell, 1989). Heme iron itself promotes the absorption of non-heme iron. For example, adults absorb approximately four times as much non-heme iron from a mixed meal when the principal protein source is meat, fish, or chicken than when it is milk, cheese, other dairy products, or eggs. The beverage is also important.

Breast milk and cow's milk both contain about 0.5 to 1.0mg of iron per liter, but its bioavailability differs markedly. The absorption of iron from breast milk is uniquely high, about 50 percent on average, and tends to compensate for its low concentration. In contrast, only about 10% of the iron in whole cow's milk is absorbed. About 4% of iron is absorbed from iron-fortified cow's-milk formulas that contain 12mg of iron per liter (Saarinen, 1977; McMillan *et al.*, 1977). The reasons for the high bioavailability of iron in breast milk are unknown, although it appears that the high concentrations of calcium, phosphorus, and protein, in conjunction with the low concentration of ascorbic acid, are responsible, in part, for the poor absorption of iron from cow's milk.

1.5 Causes of iron deficiency anemia

Iron-deficiency anemia can be the consequence of several factors, including:

- Insufficient iron in the diet
- Poor absorption of iron by the body
- Ongoing blood loss, most commonly from menstruation or from gradual blood loss in the intestinal tract
- Periods of rapid growth
- Damage of intestines
- Infection and disturbance of mucosa
- Elevation of pancreatic secretions

A diet low in iron is most often behind iron-deficiency anemia in infants, toddlers, and teens. Children who do not eat enough or who eat foods that are poor sources of iron are at risk for developing iron-deficiency anemia. Poverty is a contributing factor to iron-deficiency anemia because families living at or below the poverty level usually do not get enough iron-rich foods. Iron deficiency can also lead to better absorption of lead, which increases the risk of lead poisoning in children, especially those living in older homes. The combination of iron-deficiency anemia and lead poisoning can make children very ill and can put them at risk for learning and behavioral problems. During infancy and adolescence, the body demands more iron. Children are at higher risk for iron-deficiency anemia during periods of rapid growth when iron in their diet is not sufficient to make up for the increased needs.

In infants, discontinuing iron-fortified formula and introducing cow's milk before 12 months can lead to iron-deficiency anemia. Cow's milk is low in iron necessary for the infant growth and development when it replaces the consumption of iron-rich foods. Milk decreases the absorption of iron and can irritate the lining of the intestine, causing small amounts of bleeding. This slow, gradual loss of blood in the stool combined with low iron intake may eventually result in iron deficiency and anemia. Prematurity and low birth weights are other factors that put an infant at risk for iron-deficiency anemia. Before birth, full-term, normal-weight babies have developed iron stores that can last them 4 to 6 months. Because premature babies do not spend enough time in the uterus getting nutrients from the mother's diet, their iron stores are not as great and are often depleted in just 2 months (Christopher, 2003).

Children between 1 and 3 years of age are at risk of iron deficiency and iron-deficiency anemia, even though it is not a period of exceptional growth. Most toddlers are no longer consuming iron-fortified formula and infant cereal, and they are not eating enough iron-rich foods to make up for the difference. Toddlers also tend to drink a lot of cow's milk, often more than 24 ounces a day. During the first stages of puberty, when a lot of growth occurs, boys are at risk of iron-deficiency anemia. Adolescent girls are at higher risk because of menstrual blood loss and smaller iron stores compared with boys (Christopher, 2003).

1.6 Symptoms of iron deficiency anemia

Many people with iron deficiency anemia will not suffer from additional symptoms, however several common symptoms of iron-deficiency anemia are well defined but individuals may experience these symptoms differently. The symptoms include:

- Headache
- Abnormal pallor or lack of color of the skin
- Irritability
- Lack of energy or tiring easily (fatigue)
- Increased heart rate (tachycardia)
- Sore or swollen tongue
- Enlarged spleen
- A desire to eat peculiar substances such as dirt or ice in large amounts (a condition called pica).

1.7 Diagnosis of iron deficiency anemia

Iron-deficiency anemia develops as end result of a series of steps that begins with depletion of stored iron. First, iron disappears from the bone marrow, and the red-cell distribution width becomes abnormal. Next, there is a loss of transport iron, reflected by a reduced serum iron level. Then erythropoiesis becomes iron-deficient, as indicated by a reduced mean corpuscular volume and an increased concentration of red-cell protoporphyrin. The result is overt anemia.

Diagnosis of moderately or severe iron-deficiency anemia is easy. The disease is characterized by low MCV, reduced serum ferritin level, reduced serum iron level, increased serum iron-binding capacity, increased red-cell protoporphyrin level, and increased red-cell distribution width. The diagnosis of mild forms of iron-deficiency anemia may present a greater challenge. The laboratory tests may be less reliable, and the values of iron-deficient and iron-sufficient persons overlap considerably (Charlton, 1983; Yip, 1984). The following represent general considerations:

- A complete blood count (CBC) may reveal low hemoglobin levels and low hematocrit (the percentage of red blood cells in whole blood). The CBC also gives information about the size of the red blood cells (RBCs). RBCs with low hemoglobin tend to be smaller and less pigmented (Microcytic and hypochromic).

- Serum iron directly measures the amount of iron in blood, but may not accurately reflect iron concentrations in cells

- Serum ferritin reflects total body iron stores. It is one of the earliest indicators of depleted iron levels, especially when used in conjunction with other tests, such as (CBC).

The most useful single laboratory value for the diagnosis of iron deficiency may be plasma ferritin. Ferritin is the cellular storage protein for iron. Plasma ferritin differs from its cellular counterpart in several respects, and appears to be a secreted protein of different origin (Arosio, *et al*., 1977). Plasma ferritin values often falls under 10% of its baseline levels with significant iron deficiency. The normal values for age-matched red cell indexes and serum iron listed in Table 1-1.

Table 1.1 Normal values for age-matched red cell indexes and serum iron.

Age	**Hemoglobin g/dl**	**MCV Um^3(FL)**	**Serum iron µg/dl**
7-12 yrs	11.5-15.5	80-100	
12-18 y		80-100	50-100
Male	12.5-15.5		70-160
Female	12-16		

Adopted from: Siberry and Iannone, 2000; Rodger, 1993 / MCV= mean corpuscular volume

1.8 Treatment

The response of iron deficiency anemia to adequate amounts of iron supplements is an important diagnostic and therapeutic feature. Oral administration of simple ferrous salts (sulfate, gluconate, and fumarate) provides inexpensive and satisfactory therapy. No evidence that addition of any trace metal, vitamin, or other hemantic substance significantly increases the response to simple ferrous salts. The therapeutic dose calculated in terms of elemental iron; ferrous sulfate is 20% elemental iron by weight. A daily intake of 4-6 mg/kg of elemental iron in three divided doses provides an optimal amount of iron for the stimulated bone marrow. Intolerance to oral iron is uncommon in young children, although older children and adolescents sometimes have gastrointestinal complaints. A parenteral iron preparation (iron dextran) is an effective form of iron and is usually safe when given in a properly calculated dose, but the response to parenteral iron is no more rapid or complete than that obtained with proper oral administration of iron, unless malabsorption is a factor (Richard *et al.*, 2004).

While adequate iron medication is given, reconsideration of patient's diet is essential, and the consumption of milk should be limited to a reasonable quantity, preferably 500ml/24 hours or less. This reduction has a dual effect. The amounts of iron-rich foods is increased, and blood loss from intolerance to cow's milk proteins is reduced. When re-education of child and parents is not successful, parenteral iron medication may be indicated (Richard *et al.*, 2004).

Eating a diet with iron-rich foods can help treat iron-deficiency anemia. Good sources of iron include the following (UMMC, 2004):

- Meats - beef, lamb, liver, and other organ meats
- Poultry - chicken, duck, turkey, liver (especially dark meat)
- Fish - shellfish, including clams, mussels, sardines and anchovies
- Leafy greens of the cabbage family and collards
- Legumes and Yeast-leavened whole-wheat bread and rolls
- Iron-enriched white bread, pasta, rice, and cereals

1.9 Patient education

Public health officials in geographic regions where iron deficiency is prevalent need to be aware of the significance of iron deficiency, its effect on work performance, and the importance of providing iron during pregnancy and childhood. Addition of iron to basic foodstuffs usually employed to solve this problem (Hoffman etal, 1998).

1.10 Complications of iron deficiency

Iron deficiency anemia diminishes work performance by forcing muscles to depend mostly on anaerobic metabolism. This believed to be due to deficiency in iron-containing respiratory enzymes in addition to anemia. Severe anemia due to any cause may produce hypoxemia and enhances the occurrence of coronary insufficiency and myocardial ischemia. Likewise, it can worsen the pulmonary status of patients with chronic pulmonary disease (Marcel, 2005).

Defective structure and function of epithelial tissues usually observed in severe iron deficiency. Fingernails may become brittle or longitudinally ridged with the development of spoon-shaped nails. The tongue may show atrophy of the lingual papillae and develop a glossy appearance. Angular stomatitis may occur with fissures at the corners of the mouth. Dysphagia may occur with solid foods, with webbing of the mucosa at the junction of the hypopharynx and the esophagus; this has been associated with squamous cell carcinoma of the cricoid area. Atrophic gastritis occurs in iron deficiency with progressive loss of acid secretion, pepsin, and intrinsic factor and development of an antibody to gastric parietal cells (Marcel, 2005).

Cold intolerance develops in one fifth of patients with chronic iron deficiency anemia and is manifested by vasomotor disturbances, neurologic pain, or numbness and tingling. Rarely, severe iron deficiency anemia is associated with papilledema, increased intracranial pressure, and the clinical picture of pseudotumor cerebri. These manifestations corrected with iron therapy. Impaired immune function reported in subjects, who are iron deficient, and there are reports that these patients are prone to infection; however, evidence that this is directly due to iron deficiency is not convincing because of the presence of other factors. Children deficient in iron may exhibit behavioral disturbances. Neurologic development is impaired in infants and scholastic performance reduced in children of school age. The IQ of schoolchildren deficient in iron reported as significantly less than non-anemic peers in addition to behavioral disturbances and growth impairment. All these manifestations improve following iron therapy (Marcel, 2005).

1.11 Prevention

Eating foods rich in iron can help prevent iron deficiency anemia, as part of a balanced diet. Eating plenty of iron-containing foods is particularly important for people who have higher iron requirements. The child's diet is the most important way to prevent and treat iron deficiency. If the diet is deficient in iron, iron should be taken orally during periods of increased requirements, such as during pregnancy and lactation to increase dietary intake or using iron supplements.

1.12 The prevalence and distribution of iron deficiency worldwide

The prevalence of iron deficiency varies widely depending on the criteria used to establish the diagnosis. Variables include age, socioeconomic status, family size, nutritional status, and total income of the family. According to UNICEF report two billion people suffer from anemia worldwide and most of them have iron deficiency anemia, especially in underdeveloped and developing countries, where 40-50% of children are iron deficient (UNICEF, 1998). According to world health organization (WHO), there are no current global figures for iron deficiency anemia, but using anemia as an indirect indicator 39-48% children in non-industrialized countries compared to 6-20% in industrialized countries are iron deficient as shown in table 1.2 (WHO, 2001).

Table 1.2 Estimated percentage of anemia prevalence (1990-1995) based on blood hemoglobin concentration

Percentage of affected population		
Age group/y	**Industrialized countries**	**Non-industrialized Countries**
0-4 years	20.1	39
5-14 years	5.9	48.1
Females 15-59 y	10.3	42.3
Males 15-59 y	4.3	30

Data presented in table 1.3 shows regions with the numbers of anemic cases in these regions as reported by WHO (WHO, 2001).

Table 1.3 Estimated prevalence of anemia (1990-1995) by WHO regions based on blood hemoglobin concentration

Total affected population in thousands				
WHO regions	**Children 0-4 years**	**Children 5-14 years**	**Females 15-59 years**	**Males 15-59 years**
Africa	45228	85212	57780	41925
Americas	14200	40633	53787	19443
South-East Asia	11426	207802	214991	184752
Europe	12475	12867	27119	13318
Eastern Mediterranean	33264	37931	60196	41462
Western Pacific	29793	156839	158667	174400
Overall	245386	541284	572540	475300

1.13 Iron deficiency anemia in Palestine

Iron deficiency anemia recognized as an important health problem in Palestine. Relatively, large number of children (50%) has iron deficiency anemia (Hopkins-Al-Quds University, 2002). This survey reveals that the nutritional status of the Palestinian children in the West Bank and Gaza is seriously deteriorating due to the prevailing political situation in the area. They suggested that impaired psychomotor development, coordination, scholastic achievement, and decreased physical activity could be the result of the deteriorating nutritional status. The authors developed a program with the ministry of health and ministry of education to offer iron and vitamins supplementation for schoolchildren. The results also indicated that 60% of Palestinian families face various difficulties in acquiring sufficient food including closure (60%), curfews (31%), and loss of income (56%). In addition, 61% of families reported borrowing money to secure food, 43% reported using savings, and 32% relying on food aid. Meat consumption decreased by 68% and anemia prevalence reached 50%. The constant restriction, closure, curfews reduce the availability or economical access to fresh fruits and vegetables, as well as micronutrient dens foods, such as poultry, meat, fish, and milk. Reduction in the consumption of such food commodities puts the population at risk to suffer from iron, Vit A, Folate, Zinc, Calcium, Vit B2, Vit B12, and Vit C deficiencies (John Hopkins, 2002).

The Palestinian Ministry of health, WHO, and UNICEF conducted a comprehensive review of nutrition situation among schoolchildren in the West Bank and Gaza Strip in 2005. The findings of this study showed that there is little information on the nutritional status and dietary habits of schoolchildren. Moreover, it appears that food sold at some school canteens are of low nutritional value and all regulations on the quality of food available to students are not forced (WHO, 2005).

In Jenin district, 5% of secondary school children reported to suffer from iron deficiency anemia (Khrewish, 2003). This study showed that 16% of the anemic students were males, and 84% were females. The study indicates that the main risk factors of iron deficiency anemia were age, gender, type of diet and economic status.

1.14 Study objectives

1. To estimate the prevalence of iron deficiency among school aged children in Salfeet district.

2. To evaluate the level of knowledge, awareness and practices of parents of the study population concerning the significance of iron for children health.

3. To identify the possible risk factors of iron deficiency among the study population

Chapter Two
Methodology

2.1 Study sample

Out of 5761 students in Salfeet district, two hundred ninety students randomly chosen in order to evaluate the prevalence of iron deficiency in this group. The sample represents school children of all educational levels and age ranged between 6-18 years. This cross sectional study represents the total population through the used parameters of sample selection. The study sample was collected through two stage stratified random sample from seven towns and villages (Salfeet, Kafr-Aldeek, Bruqin, Farkhah, Khirbet- Kais, Yasouf, and Skaka) having in mind educational level and gender variations. Table 2.1 shows the distribution of the study sample based on population size in each locality. For each town or village students selected using the odd numbers from the students list and students were selected from different schools within each village. Students number for each village based on total population size.

Table 2.1 Distribution of the study sample

Living Area	Student No.	Study Level				Total
		Elementary		Secondary		
		Male	Female	Male	Female	
Salfeet	2447	29	29	34	31	123
Kafr-Aldeek	1196	14	11	14	20	59
Bruqin	936	16	11	8	12	47
Farkhah	391	6	9	2	4	21
Khirbet- Kais	35	1	1	0	0	2
Yasouf	409	4	4	7	5	20
Skaka	347	3	5	6	4	18
Total	5761	73	70	71	76	290

The study sample consisted of 144(49.7 %) male students, and 146 (50.3%) female students. Elementary level was represented by 143 (49.3%) students (73M/ 70F) with an age range between 6-12 years, while

147 (50.7%) of students (71M/ 76F) were in the secondary level with an age ranged between 12-18 years.

2.2 Tools of study

2.2.1 Questionnaire

A specially designed questionnaire was prepared for this purpose [Appendix 1]. The questionnaire included personal demographic data, a set of questions used to measure the level of awareness, knowledge, practices and health profile.

2.2.2 Blood tests

Complete blood count (CBC) conducted for all participants. Based on main corpuscular volume, all samples with a value less than 80um^3(FL) were considered to be at risk and were subjected to serum iron test. Blood sample collection and blood tests performed as described later in the procedure section. Table 2.2 represents the internationally adopted cutoff values for the used blood tests.

Table 2.2 Cutoff values for iron deficiency and anemia

Age (Years)	Hemoglobin g/dl	MCV um^3(FL)	Serum iron µg/dl
7-12 yrs	11.5-15.5	80-100	50-100
12-18 y		80-100	
Male	12.5-16		70-160
Female	12-15.5		

MCV= mean corpuscular volume.

2.3 Procedure

Permission from the Ministry of education obtained to carry out the survey study [Appendix 2]. A consent form for blood collection obtained from the parents [Appendix 3]. Data collected through home visits and direct interview with the parents.

Samples collection and handling

1. Blood samples were obtained following standard methods by well-trained nurses to prevent hemolysis and clot formation

2. Blood samples were then transferred under appropriate conditions, avoiding exposure to high or low temperature, to Al-Watani Hospital laboratory where blood tests were performed

3. CBC and Serum Iron tests were performed on the collected samples within 17 hours, CBC done using Cell Dyne 1700 (Auto analyzer) and S. iron was done using Kerawell 2900 (Diasystem).

4. All samples with MCV less than 80 femtoliter (Siberry and Iannone, 2000; Rodger, 1993) were processed for serum Iron evaluation

5. Samples with hemoglobin less than 11.5g/dl, MCV below 80 um^3(FL), and serum iron less than 50µg/dl were considered iron deficiency anemia. Samples with MCV below 80 um^3 (FL), serum iron below 50µg/dl, and hemoglobin within normal value were considered iron deficiency (Siberry and Iannone, 2000; Rodger, 1993).

2.4 Data analysis

Data of the questionnaire and blood test were analyzed using SPSS software (Statistical Package for Social Sciences). Descriptive studies and Chi-Square used. Calculated weighted mean were used to measure the means as un weighted mean to avoid bias.

Chapter Three

Results and Discussion

3.1 Prevalence of iron deficiency and iron deficiency anemia

Iron deficiency is a global nutritional problem, which mainly affects infants, children, and women of childbearing age. Using anemia as an indicator of iron deficiency, an estimated 30-60% of women and children in developing countries are iron deficient. Even in developed countries, iron deficiency warrants significant public health concern (Halileh and Gordon, 2006). In developing countries, the main cause of iron deficiency is low iron bioavailability in diet. The consequences of iron deficiency are many and serious, affecting not only individuals' health but also the development of societies and countries. Prevention and control of iron deficiency and IDA in all age groups within societies with different iron requirements, necessitates coordination of various intervention programs (Halileh and Gordon, 2006).

In Palestine, studies on iron deficiency anemia are limited and none directed mainly to school students. In addition, most of these studies depended on complete blood count as a major diagnostic tool. The present study represents is the first to focus on school-aged children at the various educational levels in Salfeet locality using the most commonly adopted diagnostic procedures for the determination of iron deficiency with or without anemia (see Table 2.2).

Among the 5761 schoolchildren between 6 and 18 years, 26.7% were with iron deficiency (12.7% ID, and 14% IDA). Other types of anemia and students with transient infections or chronic inflammatory process excluded as infections known to induce secondary iron deficiency anemia (Yip and Dallman, 1988). Our findings with respect to prevalence of iron deficiency anemia are much higher than that reported by Khrewish among secondary school children (5% for those aged 14-18 years) in Jenin district (Khrewish, 2003). It is important to note that Khrewish study was limited to secondary school children and used CBC as the main diagnostic tool for IDA. However, our findings are consistent with the results obtained among first and ninth grade schoolchildren in which, an overall prevalence of 23.9% in Gaza and 14.7% in the West Bank was reported by UNRWA (UNRWA, 2005). The UNRWA study also showed that the prevalence of iron deficiency anemia in some pockets higher than others. Alarming rates were reported among first grade schoolchildren (Khan Younis, 59.9%; Jabalia, 52.3% and Rafah, 30.4%). Similar findings among first and ninth grades students reported by the WHO in the West Bank area (15%), and much higher rates reported in Gaza 29.5% (WHO, 2005).

The results of other studies that focused on pregnant women, infants, and preschool children; showed that anemia is a common problem among children aged 6-59 months (West Bank, 21%; Gaza, 19%) as reported by Halileh and Gordon (Halileh and Gordon, 2006). Another study conducted by Care committee reflects that despite the levels of malnutrition, the prevalence of anemia among children 6-59 months of age varies little between the West Bank (43.8%) and the Gaza Strip (44%). Four of every five children in both areas have inadequate serum iron levels (Lucy, 2003).

Another study by UNRWA in 2004 on the prevalence of iron deficiency anemia among children 6 to 36 months of age, pregnant women and nursing mothers, revealed that anemia in Gaza Strip was fairly high (54.7% among children, 35.7% among pregnant women and 45.7% among nursing mothers. The corresponding rates in the West Bank were 34.3% among children, 29.5% among pregnant women and 23.1% among nursing mothers). The high prevalence of anemia for many children may cause permanent negative effects on their physical and mental development. It is worth mentioning that the prevalence of anemia among infants 6 to 12 months of age reached 75% in Gaza (WHO, 2004).

After reviewing the results of previous studies, it is clearly evident that there is no programs are adopted to prevent or decrease the prevalence of iron deficiency anemia like those taken in the neighboring countries. In Jordan, a successful iodized salt program has helped to address iodine deficiency and goiter. Moreover, in response to recent data indicating iron deficiency anemia (22% for women and 10% for pre-school aged children), a multi-sectoral effort based on lessons learned from the iodized salt program led to the design of a iron flour fortification program. Fortification estimated to cost 0.03 JD per capita per year, compared to 4.49J.D per capita per year to treat anemia (Mram project, 2004). A multi-sectoral national committee involving representatives of the Ministries of Health and Interior the Jordanian Royal Medical Society, flour millers and food industry helped to ensure the program's success (Maram project, 2004). On the other hand, there was a noticeable improvement in the prevalence of iron deficiency anemia in Israel. The prevalence of IDA in Jewish infants declined from 68% in 1946 to 50% in 1985 at an average annual rate of 71.43% (Nitzan Kaluski1 *et al.,* 2001). Following iron supplementation directives, the average annual rate of decline increased to 74.0% and reached about 11% in 1996. IDA rates in Arab infants declined by an annual average of 73.7%, and were consistently almost twice as high as for Jewish infants (Nitzan Kaluski1 *et al.,* 2001). Despite the contribution of iron supplementation program to reduce IDA, the persistently high rates indicate inadequate iron content in the diet. This emphasizes the important role of a national food fortification program, using staple foods commonly consumed (Nitzan *et al.,* 2001).

Although there have been significant variations in the approaches and findings of different nutrition studies conducted in the West Bank and Gaza Strip, there is consensus that malnutrition and anemia pose significant health threats to Palestinians, especially pregnant women and children, and serious challenges to the health sector. Research results have been limited, and had to limited influence on policy and program development. Standardizing approaches, definitions, and reference points within the nutrition research sector could improve that situation (Maram project, 2004).

Using the criteria in Table 2.2 to define iron deficiency and anemia, the prevalence of iron deficiency with and without anemia was determined for children with different age, gender, and demographic characteristics (Table 3.1). For most groups considered, iron deficiency without anemia was more prevalent than was iron deficiency with anemia. This is an expected observation as young age groups represent periods of rapid growth and depletion of blood iron, which deposited in bone tissue (Looker, *et al*., 1997). On the other hand, adolescent girls also are more susceptible to iron deficiency because of poor dietary intake in conjunction with high iron requirements related to rapid growth and menstrual blood loss. Our findings are consistent with that reported by (Looker, *et al*., 1997). Iron deficiency in this case is most likely due to the fact that adolescence may not be getting enough iron in their diet to make up for the increased needs during these stages of life.

Iron deficiency was relatively common in all studied age groups. The prevalence rates were (32.4%, 35.3%, 25.9%, and 12.1%) for children 6- 8 years old, 9 to 11 years old, 12 to 14 years old and above 15 years, respectively. Differences in prevalence rates were statistically significant (***P*** = 0.01 at α = 0.05). These results clearly demonstrate the poor iron dietary intake by these children.

Female's population had iron deficiency prevalence of 30.5%, which is higher than that found among male population (21.6%). Again, one should expect such variations between males and females due to poor food consumption and blood loss during menstruation in old females.

Adolescents are vulnerable to iron deficiency because of increased iron requirements related to rapid growth. Iron needs are highest in males during peak pubertal development because of a greater increase in blood volume, muscle mass and myoglobin (CDC, 1998; Provan, 1999; Beard, 2001). Iron needs continue to remain high in females because of menstrual blood loss, which averages about 20mg of iron per month, but may be as high as 58 mg in some individuals (CDC, 1998; Wharton, 1999).

According to place of residency, there was statistically significant difference between the overall prevalence rate of iron deficiency in children living in rural areas or villages compared to children in city (22.8% versus 32.6%, ***P*** <0.01). This finding strongly indicates that children living in rural areas and villages are getting more iron-rich foods compared to residence of urban regions. This expected, as rural communities are more self-dependent on their food supplies and their eating habits and social beliefs may also contribute to this comparatively lower prevalence of iron deficiency compared to city inhabitance. Our finding (22.8% versus 32.6%, P <0.01) in this respect is inconsistent with that of Zhonghua in which rural children in China reported to be more prone to development of iron deficiency than urban (42.0% versus 39.5%, ***P*** < 0.01) due to lower socioeconomic status of their families, poor hygienic conditions, and poor family conditions (Zhonghua, 2004). It is important to note that our comparison with such settings and communities just to give a general idea about prevalence, which affected by several other factors including social and behavioral believes.

With respect to family size, the prevalence of iron deficiency was 20.1%, 33.2%, 23.2% and 19.6% among families with 1-3 members, 4-6 members, 7-9 members and more than 10 members, respectively. Clearly no link could be established between family size and iron deficiency as one might speculate that increased prevalence of iron deficiency would correlate with increased family size due to the fact that large families require more income to support nutritional needs.

Interestingly, the findings in table 3.1 showed higher prevalence of iron deficiency associated with increased family income. Our findings with respect to prevalence of iron deficiency and family income (24.9% low; 28.1% medium and 30.2% high income) are contradictory to the believe that poverty is a contributing factor to iron-deficiency anemia because families living at or below the poverty level may not be getting enough iron-rich foods. Again, one should mention that family behavior and social habits regarding eating and food types might contribute to these differences.

In fact previous studies in this field showed that socio-economic status constitute an important factor in the development of iron deficiency among children in other societies including Japan (Oski, 1993) and the USA (Sargent, 1996).

Table 3.1 Prevalence of iron deficiency by demographic patient characteristics

Demographic Characteristic	*N*	ID (%)	IDA (%)	ID total (%)	Normal Total (%)
Age group					
6-8	439	23.6	8.8	32.4	68.6
9-11	420	21.9	13.4	35.3	64.7
12-14	360	10.1	15.8	25.9	74.1
15 and more	138	5	7.1	12.1	87.9
Gender					
Female	845	16	14.5	30.5	69.5
Male	610	13.3	8.3	21.6	78.4
P. Residence					
Village	738	14.2	8.6	22.8	77.2
City	816	16.7	15.9	32.6	67.4
Family Size					
1-3	60	13.4	6.7	20.1	79.9
4-6	938	20.5	12.7	33.2	66.8
7-9	578	12.1	11.2	23.2	76.8
10 and more	77	5.1	14.5	19.6	80.4
F. Income					
High	60	20.1	10.1	30.2	69.8
Medium	1096	14.3	13.8	28.1	71.9
Low	399	17.5	7.4	24.9	75.1

* P, place; F, family

3.2 Knowledge, awareness and practices of study population towards iron deficiency

In the current study, we tried to search for factors that may contribute to iron deficiency through measuring the level of knowledge, awareness and practices of parents with respect to diets, daily habits and behaviors that may improve or worsen the state of iron deficiency among their children. Table 3.2 shows the various variables used to test knowledge and awareness of the study population regarding ID. The numbers used in this table represent the views of parents of ID children only.

For instant the habit of providing children with breakfast as one of the main factors that maintain good health and improve the behavior of children in school (Carroll, 1993), only 27.7% of the iron deficient students' parents were aware that breakfast is responsible to improve their children concentration and attention in school, while 22.4% of them have no idea about the importance of breakfast and its effect on the health of their children. This could be due to lack of knowledge reflected by low level of education or due to limited time available for parents to pay attention to their children.

Lack of knowledge is also clear from the effect of tea on iron absorption since 31.5% of parents of iron deficient students' believed that drinking tea with meals increase iron absorption, thus, reflecting poor knowledge concerning the negative role of tea (tannin) to the pathogenesis of iron deficiency especially with none heme diets (Disler *et al.,* 1975). Although, the adverse effects of tea especially among iron deficient children well documented (Hamdauoui *et al*., 1995), our findings on the effect of tea being consumed after meals also indicates the poor knowledge of the study population as 33.8% of the parents of iron deficient students believe that tea consumption dose not affect iron absorption and 18.2% of them have no idea about the role of tea on iron absorption.

Poor knowledge with respect to iron rich foodstuff is also evident from the findings among parents of iron deficient children, as 51.3% of them do not know if green leafy plants generally are rich source of iron. It may be important to know that spinach, although it contains some iron, is not a rich choice for an iron boost. In fact, this is one of the most common misconceptions. Rather, spinach tends to block the absorption of iron such as do some substances found in coffee, chocolate, tea, and soy products. Therefore, the consumption of these foods in hopes of obtaining iron is not advisable and should be limited (Logan, 1997). Knowledge concerning fruits and other vegetables as a non-heme source of iron that helps with other heme products to compensate iron level in blood (TargetWoman.com, 2004-2006) was also limited. Evidently, 28.6% of the respondent parents disagree with this fact and 33.5% do not know if carrots and apples are rich sources for iron. The fact that, 100% of parents of students (iron deficiency without anemia) believed that tea is a rich food source of iron is another strong indication about the lack of knowledge concerning rich iron food sources.

On the other hand, milk and other diary products constitute major food sources in our area. These food items are poor in iron and may lead to iron deficiency in infants and children (TargetWoman.com, 2004-2006). Milk is low in iron (anemic children used to be called milk babies), it neither enhances nor blocks iron absorption from other foods (McKesson Health Solutions LLC, 2003). Our findings strongly indicates lack of knowledge among the study population with respect to milk and its products as 25.3% believed that milk is a rich source of iron and 16.9% have no idea about iron contents in milk.

Liver is one of the most animal products that are very rich in heme iron. For instant, liver from beef or chicken contains 3-8mg of iron per ounce (BloodBook.com, 2000-2006). In our study only 25.8% of parents agreed that liver is rich in iron, while 33.7% of them suggested that liver is not rich in iron and 23.9% don't know if it is rich or not.

Similar findings found with respect to eggs since only 30.5% of parents realize that eggs are rich source of iron and the rest either disagree or do not know. Iron in egg yolk is poorly absorbed. In fact, unless you have some vitamin C at the same time you eat an egg, egg yolk will keep iron from being absorbed from other foods (McKesson Health Solutions LLC, 2003).

Legumes, more commonly known as beans, are good sources of protein and fiber and known for their relatively high content of iron. Legumes are common diet components in the area used in soups, salads and popular Middle Eastern dishes (Foul and Hummus). Chickpeas contain about 2mg of iron in each ounce (Center for Young Women's Health, Children's Hospital Boston, 1999-2006). However, knowledge concerning legumes and their iron content seems to be limited as 54.6% of the study population reported that they do not know.

Although, soft drinks known for their lack of iron and their inhibitory role of iron absorption they are consumed in large quantities in our area. This fact is well documented by the World Health Organization (WHO) through its scientific group on nutritional anemia's which states that "Certain foods have been found to interfere with iron absorption in the gastrointestinal tract, and these foods should be avoided, including tea, coffee, wheat bran, rhubarb, chocolate, soft drinks, red wine, ice cream (WHO, 1998). In our study 29% of iron deficient students' parents indicated that soft drinks are rich in iron, and 30% of them don't know if it is rich or not, and only 26.9% of them answered that it is not rich in iron.

Natural fruit juice is not rich in iron, but is an important factor that contains Vitamin C, which increases and improves the absorption of iron

(MCkinley, 2004-2006). Marked differences in enhancement of iron absorption seen in the presence of ascorbic acid. Ascorbic acid promotes iron absorption from the diet by reducing the negative effect on iron absorption of certain ligands such as phytates and tannins present in the diet. This interpretation is supported by observations that the most pronounced effects of ascorbic acid were found in meals with a high content of ligands known to inhibit iron absorption (Hallberg, Brune, and Rossander, 1997). Our findings showed that 25.7% of the students' parents do believe that fruit juice is rich in iron, 29.5% of them didn't agree, and 36% didn't know if it has iron or not.

Food habits of people deeply influenced by their culture, behavior and life style. Some habits responsible for specific types of nutritional disorders reported in different populations. In the current study, most school children reported that they prefer to eat chips (poor source of iron) from the school canteen. Such practice may affect their appetite for proper food that improves their health and decrease the possibility of getting diseases like iron deficiency. Clearly, 38.8% of iron deficient students' parents indicated that chips is a rich in iron, 27% suggested that it is not rich in iron, and 21% didn't know if it is rich or not. Moreover, 24.7% of iron deficient students' parents answered that fish and sardines are rich in iron, while 35.4% answered that they are not rich in iron, and 29.5% didn't know if it is rich or not. These results again indicate poor knowledge concerning fish and seafood as a rich source of heme iron, which contains about 0.7-1mg/ounce (MCkinley, 2004-2006).

Finally, the parents suggested that biscuits are rich in iron with a percentage of 26.2% of iron deficient students, 25.8% of iron deficient students' parents suggested that it is not rich in iron, and 31.6% of them didn't know if biscuits are rich in iron or not. Biscuits are produced from wheat which is rich in iron, and according to other studies whole wheat, biscuits have 1.9mg of iron in 6.5 inch of them (BloodBook.com, 2000-2006).

In general we can evidently conclude that there is poor knowledge in our population about the proper sources of iron and its absorption, an area which needs special attention. Improvement in knowledge and life-style can be enhanced through especially educational programs the curriculum and through the media.

Table 3.2 Prevalence of iron deficiency according to family awareness regarding diet maintaining iron levels

Meals	Answers	*n*	ID (%)	IDA (%)	ID % Total
Breakfast increases ability to concentrate and be alert	Yes	1513	15.7	12	27.7
	No	0	0	0	0
	Don't know	40	11.2	11.2	22.4
Tea with meals increases iron absorption	Yes	934	16.1	15.4	31.5
	No	600	14.9	8.5	23.4
	Don't Know	0	0	0	0
Tea one hour after meal deceases iron absorption	Yes	856	12.1	11.9	24
	No	538	20.1	13.7	33.8
	Don't Know	120	15.2	3	18.2
The following types of food are rich in iron					
Spinach	Yes	1514	14.7	11.9	26.6
	No	20	100	0	100
	Don't know	20	51.3	0	51.3
Carrots / Apples	Yes	714	12.1	12.1	24.2
	No	461	17.5	11.1	28.6
	Don't Know	360	20.5	13	33.5
Tea	Yes	20	100	0	100
	No	1372	14.1	12.2	26.3
	Don't know	80	13.9	13.2	27.1
Milk and milk products	Yes	977	17.1	8.2	25.3
	No	477	12.2	20.3	32.5
	Don't know	60	0	16.9	16.9
Foul / hommus	Yes	1273	14.7	12.8	27.5
	No	139	23.4	0	23.4

	Don't Know	142	13.2	18	31.2
Liver	Yes	1192	13.8	12	25.8
	No	141	28.9	4.8	33.7
	Don't Know	142	10.3	13.6	23.9
Eggs	Yes	837	14.2	11.8	26
	No	557	18.6	11.9	30.5
	Don't Know	121	10.6	10.4	21
Soft drinks	Yes	40	29	0	29
	No	1414	14.4	12.5	26.9
	Don't Know	100	24	6	30
Natural fruit juice	Yes	1253	14.3	11.4	25.7
	No	141	25.3	4.2	29.5
	Don't Know	122	18	18	36
Chips	Yes	100	31	7.8	38.8
	No	1354	14.7	12.3	27
	Don't Know	100	12.6	8.4	21
Fish /Sardines	Yes	1339	16.6	8.1	24.7
	No	236	9	26.4	35.4
	Don't Know	140	8.4	21.1	29.5
Biscuits	Yes	140	22.6	3.6	26.2
	No	1114	13.4	12.4	25.8
	Don't Know	220	20.1	11.5	31.6

3.3 Healthy practices and iron deficiency

Daily healthy practices that ensure rich sources of dietary iron studied in order to evaluate the effect of such practices on iron deficiency anemia. Data presented in table 3.3 shows the various tested variables used to measure such healthy practices. The numbers used in this table represent the views of parents of ID children only. Although breakfast is considered as the most important meal of the day as it improve children health, behavior, and school achievement (Carroll, 1993), only 50% of iron deficient student's parents provide this meal. This reflects a poor practice concerning their responsibilities towards the health of their children and might be one of the reasons for their susceptibility to iron deficiency anemia. Moreover, it is important to give children suitable type of food in breakfast either to prevent iron deficiency or improve their iron level status.

The Center for Young Women's Health, Children's Hospital at Boston showed that breakfast with cereals; whole wheat breads and legumes contain iron, however this is non-heme iron which is not easily absorbed. To increase iron absorption from these food sources, the center recommends the addition of Vitamin C such as the introduction of orange juice or other fruits (Center for Young Women's Health, Children's Hospital Boston, 1999-2006). As we mentioned earlier non-hem sources of iron such as legumes constitute a major source of iron and inclusion of enough amounts of vitamin C is essential to insure a proper absorption of iron. The observed practices of the parents do not reflect this attitude as only 24.8% of the iron deficient students seems to take fruit juice.

Children also must have at least three regular meals through the day to meet their needs of daily allowances of iron either from heme or non-heme resources. So they must eat foods high in non heme iron and combine them with heme iron foods to help absorption. In general, males need 12mg of iron per day, while females need 15mg (Herbert, Victor and Genell, 1995). Our findings showed that only 27% of the iron deficient students take three meals, indicating bad practice that might contribute to their ID status.

Fruits and vegetables are one of the main available sources of non-heme iron in our area; however, it must be taken with heme iron to compensate the iron requirement for the children. Salads have different types of vegetables, which are rich in iron or Vit C like tomato, so it is important to involve these products in the main meals of children (Whitney and Rolfes, 1996). In our study, we found that only 28.1% of the iron deficient students are ingesting vegetables and salads, and 16.7% do not take them regularly. We also found that 28.5% of the iron deficient students do not always take fruits, and only 26.1% of them ingest these products regularly. Despite the availability of fruits and vegetables (reasonably cheap), it seems that parents were not aware of the importance of such commodities as a non-heme rich source of iron. On the other hand, the difficult economic situation constitute a major obstacle in maintaining the proper health standard at all levels.

Tea influences the absorption of non-heme iron as heme iron is relatively unaffected by tea (Doyle *et al.,* 1999). Many studies reflect that there is a higher risk of anemia amongst tea drinkers compared to none tea drinkers (Gibson, 1999). On the contrary, other studies concluded that tea consumption does not influence iron status in healthy individuals who are eating a well balanced diet and have adequate iron stores. Only in populations with marginal iron status seems to be a negative association between tea consumption and iron status (Hamdauoui *et al.*, 1995). Our findings are consistent with these conclusions since 39.7% of iron deficient students drink too much tea, and 24.3% of them drink it in moderate amount, which make them more susceptible to iron deficiency.

Animal products mainly meat are rich sources of heme iron that is absorbed more efficiently than nonheme iron, so eating red meat 2-3 times/ week ensures the absorption of adequate heme iron. Red meat also has a special effect on iron absorption, when eaten together with the vegetables it can boost the absorption of non-heme iron by up to four times (Denise, 2004**).** In our study, the fact that 26.8% and 28.2% of the iron deficient students respectively eat animal product in little and middle amounts strongly indicates the negative effects of these situations on IDA. Again, one should emphasize the serious effects of the poor economic situation and the burden on parents to provide the adequate amounts of such expensive commodities to their growing children.

Table 3.3 The prevalence of iron deficiency related to the practice (health profiles) of the study population

Practice	**Answers**	***n***	**ID (%)**	**IDA (%)**	**ID Total (%)**
Make sure that children have breakfast daily	Yes	1331	14.3	12.2	26.5
	No	152	18.8	7.6	26.4
Children provided with three regular meal daily	Yes	1255	14.6	12.4	27
	No	199	10.3	10.2	20.5
Fruit juice provided for children	Yes	975	13.7	11.1	24.8
	No	518	16.4	13.9	30.3
Vegetables provided as salads	Yes	1353	15.3	12.8	28.1
	No	139	9.6	7.1	16.7
Fresh fruits provided for children	Yes	1175	14.6	11.5	26.1
	No	338	15.3	13.2	28.5
Tea consumption	Much	336	23.5	16.2	39.7
	Medium	617	11.7	12.6	24.3
	Little	601	16.3	9.3	25.6
Availability of animal products (meat, eggs, milk,…etc) too	Much	418	14	10.7	24.7
	Medium	999	16.4	11.8	28.2
	Little	137	11.7	15.1	26.8

Much = more than tow cups daily; Medium = up to tow cups daily; Little = less than tow cups per week

3.4 Consequences of iron deficiency

Data presented in table 3.4 shows the different variables used in order to evaluate the consequences of iron deficiency anemia on students physical and or cognitive development. The numbers used in this table represent the views of parents of ID children only. In our study, the finding of 35.6% of IDA study population with previous history of other disease especially gastrointestinal diseases which may contribute to the high prevelance of IDA as the parents mentioned. A clear association between IDA and other disease mainly gastrointestinal disease is well documented

(UMMC, 2005). These studies revealed that gastrointestinal tract abnormalities can lead to iron deficiency, because any abnormalities in the gastrointestinal tract could alter iron absorption and result in iron deficiency. These abnormalities include, GI bleeding, and celiac disease which is a part of the differential diagnosis in evaluating patients with iron deficiency anemia (Audain, 1997). Other disease may be side by side with iron deficiency like, blood disorders, hematuria, and hookwarm or parasite diseases.

Poor study or school acheivement is one of the results of iron deficiency in school children. Previous studies focused on this issue through measuring the intellectual and cognitive performance and most of these studies concentrated on test scores to study the effect of iron deficiency on cognitive performance among school-aged children. The majority of these studies raised the possibility that iron deficiency affects academic performance (Webb and Oski, 1993). The finding of 23.8% of iron deficiency students with low study achievements, as evaluated by the parents, and 32.8% of them with low growth rates is consistent with these studies. Childhood growth is often difficult to separate from overall nutritional deficiency. The high prevalence of childhood iron deficiency among less affluent people has linked deficiencies of iron and general nutrients. When the two factors separated, correction of iron deficiency improves growth independently of nutritional status. Iron deficiency, with or without concomitant anemia, commonly impairs growth and intellectual development in children. Studies of cognitive development in the setting of iron deficiency produced disparate results for a time (Lozoff *et al.,* 1991).

Around 25% of ID total deficiency reported to be under medication. This reflects poor health status that might be affected by iron deficiency or other diseases. On the other hand, 25.2% of the iron deficient students reported history of bleeding disorders, which is most likely accused as a main cause of iron deficiency. Bleeding reported to take place in different sites including hematuria, hematemesis, hemoptysis and gastrointestinal bleeding. One should also mention excessive menstrual losses that may be overlooked. Two thirds of body iron is present in circulating red blood cells as hemoglobin. Each gram of hemoglobin contains 3.47 mg of iron; thus, each ml of blood lost from the body (hemoglobin 15 g/dl) results in a loss of 0.5 mg of iron (Conrad, 2005). Hookworms also reported as other causative bleeding agents as 35% of ID total reported to suffer from hookworm infections. *Necator americanus* or *Ancylostoma duodenale* are the most common parasitic species involved in bleeding, however, further investigation is required for the identification of such parasites, which known for their microscopic blood loss, which usually lead to iron deficiency among children (Hopkins *et al.*, 1997).

Regarding the symptoms of iron deficiency, definite signs and symptoms were reported among the affected study population which is consistent with iron deficiency. 12.5% were reported for headache, 37.6% for tiredness and restlessness, 36.5% for drowsiness and fainting, 45.5% for vision disturbances, and 19.4% for low concentration and attention, respectively. The majority of these signs and symptoms are considered common among students suffering from iron deficiency and iron supplementation seems effective in relieve of symptoms (Mansson, 2005).

Table 3.4 Prevalence of iron deficiency according to consequences of the disease

Consequences	Answers	*n*	ID (%)	IDA (%)	ID Total (%)
Is child complaining of any disease?	Yes	172	22.4	13.2	35.6
	No	1393	14.8	11.7	26.5
Do you think that your child study achievement is low?	Yes	377	13.7	10.1	23.8
	No	1158	16	12	28
Do you think growth level of your child is low?	Yes	222	18.2	14.6	32.8
	No	1231	14.8	10.7	25.5
Did your child or /family members suffer from the following disorders?					
Thalassemia	Yes	39	0	49.4	49.4
	No	1494	15.6	11	27.6
Sickle Cell Anemia	Yes	62	16.4	34.4	50.8
	No	1473	15.4	11	26.4
G6PD	Yes	20	0	16.7	16.7
	No	1514	15.8	11.4	27.2
Does the child take any kind of medication?	Yes	80	18.9	6.3	25.2
	No	1393	14.3	12	26.3
Did your child suffer from bleeding disorders before?	Yes	81	18.9	6.3	25.2
	No	1433	14.3	12	26.3
Did the child complain from worms disorders?	Yes	341	20.6	14.4	35
	No	1193	14.4	11	25.4
Is the child complaining from the following symptoms?					
Headache	Much	80	5.6	16.9	12.5
	Little	618	12.6	11.7	24.3
	No	856	19	11.3	30.3
Tiredness and Restlessness	Much	120	18.8	18.8	37.6
	Little	541	12.5	13.5	26
	No	854	16.6	9.8	26.4
Drowsiness and Fainting	Much	81	27.5	9	36.5
	Little	260	13.1	11.2	25.3
	No	1193	15.4	11.8	27.2
Vision Disturbances	Much	100	18.2	27.3	45.5
	Little	321	20.9	9.4	30.3
	No	1113	13.9	11.2	25.1
Low concentration and follow up	Much	99	15.5	3.9	19.4
	Little	621	14.2	19.4	33.6
	No	794	16.1	7.8	23.9

3.5 Recommendations and concluding remarks

The effects of iron-deficiency anemia will depend on the duration and severity of the situation. If left untreated, iron-deficiency anemia may lead to behavioral or learning problems. These may not be reversible, even with later iron supplementation in severe prolonged cases. However, in most cases, iron-deficiency anemia is preventable by following some basic recommendations. These include iron supplementation programs that might include fortification of foodstuff; especially designed educational programs through curriculum; other educational programs targeted both children and parents and this might involve various media or channels. Most of these activities can be run by both the Ministry of Education in collaboration with the Ministry of Health or under the supervision of various governmental and non-governmental organizations. Such programs should focus on the needs of infants younger than 1 year (breast milk or an infant formula supplemented with iron); the needs of children under 2 years (requirements of cow's milk/day) and older age groups.

Finally, one should keep in mind that proper nutrition is not the only factor that might affect the general health of young population. In our community, emotional and psychological disturbances due to the prevailing political situation are major factors influencing normal child development at all levels and one should take these in consideration when planning nutritional or educational programs concerning health and development of young generations.

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Appendices

Appendix 1

بسم الله الرحمن الرحيم

Iron Deficiency Anemia Questionnaire

رقم العينة: ---------------

الفئة العمرية: □ 6-9 سنوات □ 9-12 سنة □ 12-15 سنة □ 15-18 سنة

جنس الطالب: □ ذكر □ أنثى

اسم المدرسة: -------------------

الصف: --------------------

مكان الإقامة: □ مدينة □ قرية

تعليم الأب: □ توجيهي أو أقل □ دبلوم □ بكالوريوس □ ماجستير □ دكتوراه

تعليم الأم: □ توجيهي أو أقل □ دبلوم □ بكالوريوس □ ماجستير □ دكتوراه

عمل الأب: --------------

عمل الأم: ----------------

عدد أفراد الأسرة: □1-3 □ 4-6 □7-10 □ 10 فأكثر

الدخل الشهري للعائلة: □متدني □متوسط □عالي

أجب عن الأسئلة التالية بوضع إشارة × لاختيار الإجابة التي تعبر عن رأيك مقابل كل سؤال من الأسئلة.

-1	تناول الفطور يزيد من قدرة الطالب/ة على الانتباه والتركيز في الصف	□نعم	□لا	□لا أعرف
-2	تناول الشاي مع الوجبات يزيد من امتصاص الحديد	□نعم	□لا	□لا أعرف
-3	تناول الشاي خلال ساعة بعد الوجبة يقلل من امتصاص الجسم للحديد	□نعم	□لا	□لا أعرف
-4	تحتوي المواد التالية على نسبة عالية من الحديد(غنية بالحديد)	الخيارات		
	4-1 سبانخ/ خس	□نعم	□لا	□لا أعرف
	4-2 جزر/ تفاح	□نعم	□لا	□لا أعرف
	4-3 الشاي	□نعم	□لا	□لا أعرف
	4-4 مشتقات الحليب: حليب، لبن، لبنة، جبن.	□نعم	□لا	□لا أعرف
	4-5 فول/ حمص	□نعم	□لا	□لا أعرف
	4-6 الكبد	□نعم	□لا	□لا أعرف
	4-7 البيض	□نعم	□لا	□لا أعرف
	4-8 المشروبات الغازية (كولا،صودا،	□نعم	□لا	□لا أعرف

	سفن أب....)	
	9-4 عصائر الفواكه الطبيعية	□نعم □لا □لا أعرف
	10-4 الشيبس والبامبا	□نعم □لا □لا أعرف
	11-4 السمك/ السردين	□نعم □لا □لا أعرف
	12-2 البسكويت	□نعم □لا □لا أعرف
-5	أحرص على أن يتناول الأطفال الفطور يوميا	□نعم □لا
-6	يتناول الأطفال ثلاث وجبات منتظمة	□نعم □لا
-7	أعمل على تقديم العصائر للأطفال باستمرار	□نعم □لا
-8	أعمل على تقديم الخضروات باستمرار - سلطات	□نعم □لا
-9	يتناول الأطفال الفواكه باستمرار	□نعم □لا
-10	كيف يشرب الأطفال الشاي بشكل:	□كبير □متوسط □قليل
-11	كيف يتناول الأطفال المنتجات الحيوانية مثل (اللحم، البيض، والحليب) بشكل:	□كبير □متوسط □قليل

-12	هل يعاني الطفل من مرض ما؟	□نعم □لا
-13	هل تعتقد أن مستوى تحصيل طفلك العلمي متدني	□نعم □لا
-14	هل تعتقد أن مستوى النمو عند طفلك متدني	□نعم □لا
-15	هل سبق وأن عانى طفلك أو أي من أفراد الأسرة من الأمراض التالية:	
	(1) أنيميا البحر الأبيض المتوسط (Thalassemia) (2) فقر الدم المنجلي (Sickle Cell Anemia) (3) التفول (G6PD)	□نعم □لا □نعم □لا □نعم □لا
-16	هل يتناول الطفل أدوية معينة؟	□نعم □لا
-17	إذا كانت الإجابة نعم، أذكر نوع العلاج(الدواء):	
-18	هل سبق حدوث أي نزيف عند الطفل؟	□نعم □لا
-19	هل عانى الطفل من الإصابة بأمراض الديدان؟	□نعم □لا
-20	هل يعاني الطفل من:	
	وجع رأس (صداع)	□كثيرا □قليلا □لا
	التعب والإرهاق	□كثيرا □قليلا □لا
	الدوار والدوخة	□كثيرا □قليلا □لا
	عدم وضوح الرؤيا	□كثيرا □قليلا □لا
	عدم القدرة على التركيز والمتابعة	□كثيرا □قليلا □لا

شكرا لحسن تعاونكم

Appendix 2

بسم الله الرحمن الرحيم

جامعة النجاح الوطنية / كلية الدراسات العليا– نابلس

أهالي الطلبة المحترمون

أنا الطالب محمد محمود عوده من سلفيت ومن طلبة الدراسات العليا / قسم الصحة العامة في جامعة النجاح الوطنية، وأعمل على دراسة مدى انتشار مرض فقر الدم الناجم عن نقص الحديد بين طلبة المدارس في محافظة سلفيت، وهي الأكثر عرضة للإصابة بهذا المرض.

تنطوي هذه الدراسة تحت إطار البحث العلمي، والمعلومات الموجودة في هذا الاستبيان سوف تبقى سرية وسيتم استخدامها لأغراض البحث العلمي فقط.

يرجى الإجابة على الأسئلة الموجودة في الاستبيان مع مراعاة الدقة والأمانة، كما يرجى الموافقة على سحب عينات دم من أبنائكم لتحليلها مخبريا، وذلك بالتوقيع أسفل هذه الصفحة.

شكرا لحسن تعاونكم

محمد عوده

توقيع ولي الأمر

Appendix 3

بسم الله الرحمن الرحيم

السلطة الوطنية الفلسطينية
وزارة التربية والتعليم العالي
مديرية التربية والتعليم – سلفيت

Palestinian National Authority
Ministry of Education & Higher Education
Directorate of Education - Salfit

الرقم:م.ت/6/

التاريخ:2006/3/21م

الموافق:21/صفر/1427 هـ

حضرات مديري ومديرات المدارس المحترمين

تحية طيبة وبعد،،،،،

الموضوع:تنفيذ دراسة حول نقص الحديد لدى طلبة المدارس في محافظة سلفيت
للدارس "محمد محمود عوده"

لا مانع لدينا من توزيع استبانة الدارس "محمد محمود عوده" أحد طلبة الدراسات العليا /قسم الصحة العامة في جامعة النجاح الوطنية على طلبة المدارس ، وأخذ عينات من دم الطلبة لتحليلها مخبريا وتطبيقها على دراسته والتي تحمل عنوان (نقص الحديد لدى طلبة المدارس في محافظة سلفيت) ، شريطة أخذ الموافقة الخطية لأولياء أمور الطلبة قبل البدء بأخذ عينات الدم من الطلبة .

واقبلوا الاحترام،،،

مدير التربية والتعليم

وجيه الأمين

نسخة: / النائبان المحترمان

/ رئيس قسم الصحة المدرسية المحترم .

خ.م/خ.م

سلفيت – هاتف 09/2515661 – 09/2515665 فاكس 2515664 – 9 – 972

Salfit – Tel. 09/2515661 – 2515665 Fax 972 – 9 – 2515664

جامعة النجاح الوطنية
كلية الدراسات العليا

دراسة حول انتشار مرض فقر الدم الناجم عن نقص الحديد بين طلبة المدارس في محافظة سلفيت

إعداد
محمد محمود محمد عوده

إشراف
د. نائل صدقي أبو الحسن
مشرف مساعد
د. رياض احمد عمار

قدمت هذه الأطروحة استكمالا لمتطلبات درجة الماجستير في الصحة العامة بكلية الدراسات العليا في جامعة النجاح الوطنية في نابلس، فلسطين.

2006

دراسة حول انتشار مرض فقر الدم الناجم عن نقص الحديد بين طلبة المدارس في محافظة سلفيت

إعداد

محمد محمود محمد عوده

إشراف

د. نائل صدقي أبو الحسن

د. رياض احمد عمار

الملخص

لقد تم إجراء الدراسة الحالية بهدف تشخيص نسبة الإصابة بنقص الحديد وفقر الدم الحاد الناتج عن هذا النقص لدى أطفال المدارس ومن الفئة العمرية 6–18 سنة في محافظة سلفيت. تألفت العينة من 290 طالبا وطالبة كعينة عشوائية ممثلة للمجتمع السكاني في المحافظة (144 من الذكور، 146 من الإناث). وتم إجراء فحوصات شاملة للدم لجميع أفراد العينة ومن ثم تم استخدام حجم الكريات الدموية الحمراء كمؤشر لفقر الدم حيث ان العينات والتي كانت فيها القيمة اقل من 80 وحدة تم استخدامها لدراسة تركيز الحديد في الدم. وكانت نسبة نقص الحديد لدى العينة 26.7% كان فيها 12.7% يعانون من فقر الدم الحاد نتيجة لنقص الحديد. وكانت نسبة الإصابة لدى الإناث 30.5% في حين بلغت هذه النسبة 21.6% لدى الذكور. وكانت النسب المتدنية شائعة لدى جميع الفئات العمرية المدروسة حيث كانت الفروق بين هذه الفئات ذات قيمة إحصائية هامة (P= 0.01). أما فيما يتعلق بمكان الإقامة ومتوسط الدخل الأسري فقد تبين أن نسب الإصابة تزداد مع ازدياد الدخل (24.9% عند ذوي الدخل المتدني، 30.2% عند ذوي الدخل المرتفع) وأنها كذلك أكثر انتشارا لدى سكان المدينة (32.6%) بالمقارنة مع سكان الريف (22.8%) وكانت الفروقات ذات قيم إحصائية هامة (P=0.01). وقد لوحظ كذلك تدني كبير في مستوى المعرفة حول المواد الغذائية والمصادر الغنية بالحديد والمساعدة في امتصاصه ولوحظ كذلك غياب الممارسات الغذائية الجيدة. أما فيما يتعلق بتاريخ الإصابة بالأمراض ذات العلاقة فقد لوحظ ارتفاع في نسبة الإصابة بمثل هذه الأمراض لدى أفراد عائلات الأشخاص المصبين بفقر الدم. أما فيما يتعلق بتدني التحصيل العلمي والنمو لدى فئة المصابين بفقر الدم فقد لوحظ وجود علاقة واضحة كمؤشر ونتيجة متوقعة لفقر الدم الناتج عن نقص الحديد.

للحد من هذه المشكلة لا بد من استخدام الأغذية والمزودة بعنصر الحديد وكذلك لا بد من إعداد برامج تثقيفية تتعلق بموضوع التغذية لتحسين نمط امتصاص عنصر الحديد.