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Prevalence of iron deficiency and iron deficiency anemia among university students in Palestine

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Prevalence of iron deficiency and iron deficiency anemia among university students in Palestine

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III

Declaration:

I certify that this thesis submitted for the degree of Master is the result of my own research, except where otherwise acknowledged, and that this study (or any part of the same) has not been submitted for a higher degree to any other university or institution.

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Dedications

This thesis is dedicated to my father Yousef, my mother Marlen,

my brother Khader, my sisters Vicky, Jumana and Hiba and to

Dr. Maher Bazdiki who have supported me all the way since the

beginning of my studies and have a great source of motivation

and inspiration.

Great thanks for your support

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Abstract:

Iron deficiency (ID) is one of the most common nutritional problems worldwide that is considered as the main cause of anemia. Adolescents are vulnerable to ID 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. However, women in general and during their reproductive years are at risk of ID due to blood loss from menstruation. This study aimed to determine the prevalence of iron deficiency and iron deficiency anemia among university students in Palestine.

This is a cross-sectional study conducted among university students in Palestine. Five hundred blood samples were collected from students in different Palestinian universities that covered South, North, West and East of the West-Bank, Palestine. The student's age ranged between 18 to 26 years. The study participants were recruited voluntarily and were asked to fill the study questionnaire. The data collected from the questionnaire covered the socio-demographic aspects of university students such as age, gender, weight, height, BMI, food habits, disease symptoms, dietary and medical history. CBC was measured for all participants (N=500) and iron profile were measured for participants who have MCV< 80 fl (N=43). Data were analyzed statistically by Chi-square test for categorical variables. ANOVA and independent sample *t*- test for continuous variables and Pearson's correlation for testing correlations.

The prevalence of anemia among the study subjects was 4.7% (23 out of 500) judged by WHO definition of anemia, Hb level (Hb < 12 g/dl for females and <13.5 g/dl for males). Based on the analysis of serum ferritin (SF) for participants who have MCV < 80 fl, 20.9% (9 out of 43 subjects) of the study subjects showed depleted iron stores (ID) and 14.0 % (6 out of 43) of the study subjects showed IDA (both Hb and SF

are low). When university students were grouped into three tertile groups and analyzed for to student's habits like smoking water pipe, smoking cigarettes, drinking coffee and tea ($P= 0.031$), no statistically significant difference was observed among Hb tertile groups when compared for Age, BMI, SI, SF, TIBC, students suffering from symptoms of anemia and student's knowledge of anemia. There was a significant correlation between the family income of the students and smoking habit (cigarettes smoking, water pipe).

In conclusion, our data revealed that the prevalence of ID is 1.8% (9 out of 500) and prevalence of IDA is 1.2% (6 out of 500) among university students in Palestine. Our study showed that the level of university student's general knowledge and background about anemia is very good, because 84.4% of students have enough idea about anemia as disease. On other hand, 83.9% and 86.6% of students realize that poor nutrition and ID respectively, were the main cause of anemia. The result of their knowledge regarding poor nutrition and ID as main cause of anemia helps them protect themselves from the distribution of ID and IDA. Our study revealed that 92.4% of the students were medium and high family income, that's mean that the medium and high social-economic level of individuals play a role in reduced figures of ID and IDA.

Table of Contents

List of Tables

No	Table	Page
Table 3.1	Materials used in this study	13
Table 3.2	List of Palestinian universities from which the study samples were collected	15
Table 4.1	Geographic distribution (Urban and Suburban) among different universities in Palestine	19
Table 4.2	General characteristics of university students in Palestine	20
Table 4.3 (a)	Hb status among the university students (N=500).	21
Table 4.3 (b)	Serum ferritin status among the university students (N=43).	21
Table 4.4 (a)	Biochemical status of ID university students (N=9)	21
Table 4.4 (b)	Biochemical status of IDA students (N=6)	22
Table 4.5 (a)	Students characteristics by Hb tertile groups	24
Table 4.5 (b)	Students iron profile characteristics by Hb tertile groups	25
Table 4.6	General characteristics of ID students (N=9)	26
Table 4.7	General characteristics of IDA students (N=6).	27

List of Figures

List of Abbreviations:

AQU	Al-Quds University
BMI	Body Mass Index
Hb	Hemoglobin
Hct	Hematocrit
ID	Iron Deficiency
IDA	Iron Deficiency Anemia
MCHC	Mean Corpuscular Hemoglobin Concentration
MCV	Mean Corpuscular Volume
RBCs	Red Blood Cells
SF	Serum Ferritin
SI	Serum Iron
SPSS	Social Package of Statistical Sciences
TIBC	Total Iron Binding Capacity
TR	Transferrin Receptor
TS	Transferrin Saturation
UNICEF	United Nations Children's Fund
WBC	White Blood Cells
WHO	World Health Organization

XIII

Chapter One

Introduction

1.1 Introduction

Anemia is the most common nutritional deficiency disorder in the world. WHO has estimated that about one third of the global population (over 2 billion) is anemic (Kalaivani, 2009). Globally, the most significant contributor to the onset of anemia is iron deficiency (ID) so that ID and anemia are often used synonymously, and the prevalence of anemia has often been used as a proxy for iron deficiency anemia (IDA). It is generally assumed that 50% of the cases of anemia are due to ID. It occurs at all stages of life cycle, but is more prevalent in pregnant women and young children. In 2002, IDA was considered to be among the most important contributing factors to the global burden of disease. The etiology of IDA is multifactorial, it is typically caused by inadequate intake of iron, chronic loss or a combination of both (Clark, 2009, WHO and CDC, 2008).

Adolescents are vulnerable to ID 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. After menarche, iron needs continue to remain high in females because of menstrual blood loss, which averages about 20 mg of iron per month, but may be as high as 58 mg in some individuals. Oral contraceptives decrease menstrual losses, while some intrauterine devices may increase losses (Beard, 2001).

ID is the predominant nutritional deficiency causing anemia and is present even when other causes of anemia are recognized. The relative proportion of anemia due to ID increases as the prevalence of anemia increases (UNICEF/UNU/WHO, 2001).

The nutrition unit of the WHO's regional office for the Eastern Mediterranean Region showed that the prevalence of anemia in Morocco was 30.1% among women of child bearing age and 9.9% among adult men. While the prevalence of anemia among women of child bearing age in Pakistan was 22.5%. They also found that the prevalence of anemia among women of child bearing age in Syrian Arab Republic and Palestine were 40.8% and 36.2% respectively (Bagchi, 2004).

1.2 Research questions

The investigation was initiated to answer the following questions

- What is the prevalence of ID & IDA among university students in Palestine?
- Is there an association between the socio-economic status of individuals and ID & IDA?
- Role of smoking habits in ID and IDA pathogenesis among study population?

1.3 Objectives

The objectives of this study are:

- To estimate the prevalence of ID & IDA among university students in Palestine.
- To design a questionnaire summarizing social- economic factors, and medical history of individuals and correlates between many factors in the process of ID and IDA pathogenesis.
- To investigate the association between socio-economic factors and ID & IDA.

Chapter Two

Literature Review

2.1 Background

IDA is considered to be one of the top ten contributors to the global burden of disease (WHO and CDC, 2008). It is known to affect the health and cognitive ability of children and adolescents (Abalkhail and Shawky, 2002). The WHO estimates that about one third of the global population (over 2 billion) is anemic (Kalaivani, 2009).

Iron deficiency is defined as a condition in which there are no mobilizable iron stores and in which signs of a compromised supply of iron to tissues, including the erythron, are noted. The more severe stages of iron deficiency are associated with anemia (UNICEF/UNU/WHO, 2001, CDC, 1998)

Anemia pathogenesis is a result of either increased destruction of red blood cell or decreased production of red cell (marrow failure). The peripheral blood loss may be caused by bleeding or hemolysis that include extrinsic or intrinsic red cell defect. The decreased marrow output (Erythropoiesis) includes stem cell defect, erythroid hypo-

proliferation, marrow infiltration (metastasis, lymphoma, myeloma, and fibrosis) and nutritional deficiency like iron, B12 and folate. The general symptoms of anemia are non specific and indicate inadequacy of oxygen transport to tissue or decreased intravascular volume (Rodgers and Young, 2005).

In developing countries, low iron bioavailability of the diet is the primary cause of IDA (Bermejo and Garcia-Lopez,2009); however, decreased iron absorption and blood loss account for the more likely etiologies of ID in developed countries, there are several factors caused decreased iron absorption such as malabsorption syndromes especially celiac disease or atrophic gastritis. Chronic blood loss from genitourinary, gynecological, or gastrointestinal tracts accounts the majority of causes for IDA. IDA is especially prone to occur in those taking aspirin or non steroidal anti-inflammatory drugs chronically (Johnson-Wimbley and Graham, 2011, Bermejo and Garcia-Lopez, 2009).

For development of ID there are some risk factors including; age (infants and postmenopausal are with higher risk than adolescents), gender (increased in women), presence of reproductive and renal disorders like hematuria, presence of gastrointestinal tract bleeding, patient with neoplasm, social, and physiological and drug history also play a role in the development of IDA (UNICEF/UNU/WHO, 2001, Rebecca, 2001).

The total iron content of the health adult human body is about 3.5 to 4 g in women and 4 to 5 g in men. Nearly 70% of this is stored in Hb, 20% in the body's iron depot, 10% in iron containing enzymes and myoglobin, and only 0.1 to 0.2% is bound to transferrin as transport iron (Wick et al., 2011)

The human diet contains two forms of iron: heme iron and nonheme iron. Heme iron is derived from meat and is well absorbed. However, non heme dietary iron, which is found in cereals, beans, and some vegetables, is less well absorbed. Nonheme iron is present as either ferric (Fe^{+2}) or ferrous (Fe^{+3}) iron. (Johnson-Wimbley and Graham, 2011, Bermejo and Garcia-Lopez, 2009).

Several dietary factors can influence iron absorption. Inhibiting factors are plant components in vegetables, tea and coffee (e.g., polyphenols, phytates), and calcium; absorption enhancing factors are ascorbic acid and meat, fish and poultry. The following recommendations are made for people at risk of ID. Increase heme-iron intake (this form of dietary iron present in meat fish and poultry is hardly influenced by other dietary factors with respect to its absorption); increase meal-time ascorbic acid intake; fortify foods with iron. Recommendations with respect to tea consumption include: consume tea between meals instead of during the meal; simultaneously consume ascorbic acid and/or meat, fish and poultry (Zijp, Korver et al. 2000).

2.2 Etiology of IDA

There are many potential causes of ID and IDA and some of them are very relevant. These causes are clearly different in developed and in developing countries. In developed countries, the likeliest cause of anemia in each patient depends on age and sex. In women of childbearing age, excessive menstrual loss is the most frequent etiology, while in males; digestive diseases are the main causes (Bermejo and Garcia-Lopez, 2009).

Digestive disorders, urological diseases, gynecological diseases and other specific situations, such as intravascular hemolysis are main causes of ID or IDA. Focusing on digestive diseases, the etiology of ID and IDA of gastrointestinal origin can be divided into two groups: situations with increased loss of iron (the most common in developed countries), and those with decreased iron absorption (Bermejo and Garcia-Lopez, 2009, Rodgers and Young, 2005).

Gastrointestinal malignancies are uncommon in premenopausal women with ID or IDA, but in men and postmenopausal women with ID or IDA gastrointestinal malignancies are more common than in individuals with normal hemoglobin and iron levels (Bermejo and Garcia-Lopez, 2009, Rodgers and Young, 2005).

2.3 Clinical symptoms of IDA

Several common symptoms of IDA are well defined but individuals may experience these symptoms differently. The symptoms include: fatigue, pallor, (stress-) dyspnea, headache, concentration disorders, chest pain, dizziness, cold hands and feet, sore tongue, brittle nails and enlarged spleen (Rodgers and Young, 2005, Krayenbuehl, Naumann et al., 2007). Rarely, a person with IDA may experience pica, a craving to eat nonfood items such as paint chips, chalk, or dirt. Pica may be caused by a lack of iron in the diet. IDA may also impair temperature regulation and cause pregnant women to feel colder than normal (Pavord, Myers et al., 2012).

2.4 Laboratory tests

2.4.1 Full blood count and red cell indices

ID is usually diagnosed by laboratory tests. Low serum hemoglobin (Hb) in the setting of a reduced MCV is usually the initial finding on a routine CBC. RDW has been proposed as a sensitive indicator for IDA. A significant increase in mean RDW can be used to diagnose IDA. An inverse relationship is also observed between the serum Hb and the RDW in IDA (Zhu, Kaneshiro et al., 2010).

2.4.2 Serum ferritin

Ferritin is a major iron storage protein and is plays an essential role in a wide range of physiologic and pathologic processes and plays also a role in iron homeostasis. In clinical medicine, ferritin is predominantly utilized as a serum marker of total body iron stores (Knovich, Storey et al., 2009)

Serum ferritin (SF) is considered as one of the best laboratory tests for evaluation of iron deficiency as measurement of SF directly related to iron storage. However,

inflammation is major problem seems to be associated with this test; a problem must be taken in consideration when thinking of use of this test. Serum apoferritin is an acute-phase reactant protein and is therefore elevated in response to any infectious or inflammatory process. Consequently, SF in the normal range reflects only iron sufficiency in the absence of these conditions (UNICEF/UNU/WHO,2001; Abu- Hasira, 2007).

2.4.3 Serum iron, Serum transferrin and total iron binding capacity

Serum iron (SI) concentration is a measure of the total amount of iron in the serum. ID results in a reduction in SI levels, an elevation in transferrin (total iron-binding capacity [TIBC]) levels, and hence a net reduction in transferrin saturation (TS). Transferrin saturation is calculated by dividing SI concentration by TIBC and multiplying by 100 to express the result as a percentage:

Transferrin saturation (%) = [SI concentration (µg/dL) / TIBC (µg/dL)] × 100 (UNICEF/UNU/WHO, 2001, CDC, 1998).

An increase in serum transferrin receptors is a sensitive response during the early development of ID. Serum transferrin receptor levels increase progressively as the supply of iron to the tissues becomes progressively more deficient. Major advantages of measuring serum transferrin receptors involve the facts that the assay is not significantly affected by infection or inflammatory processes, and it does not vary with age, gender, or pregnancy. Serum tranferrin is measured by calculating TIBC (ng/dl) / 1.25 (UNICEF/UNU/WHO,2001, Knovich et al., 2009).

TIBC indicates the maximum amount of iron needed to saturate plasma or serum transferrin, which is the primary iron-transport protein. Measurements of TIBC, SI, and the percentage of iron saturation of serum transferin are useful for the clinical diagnosis of IDA. As an alternative to direct measurement methods (Zhu et al.,2010)

2.5 Treatment of IDA

Iron supplements are essential for the rapid treatment of severe IDA in all sex and age groups. In many populations, the amount of iron absorbed from the diet is not sufficient to meet many individuals' requirements. If the amount of absorbable iron in the diet cannot be immediately improved iron supplementation will be a necessary component of programs to control IDA (INACG), (WHO) and (UNICEF) (1998).

Oral iron:

Body stores of iron can be restored in most patients by oral iron therapy. Iron is equally well absorbed from several simple ferrous iron salts, and as ferrous sulphate is the cheapest, this is also the drug of first choice. The side effects of oral iron, such as nausea, epigastric pain, diarrhea and constipation, are related to the amount of available iron they contain (Hoffbrand et al., 2011).

Studies in women and children have shown lower doses of oral iron may be effective and associated with fewer GI side effects (Zhou SJ et al., 2009). In adults, lower doses can be administered through either intermediate-dose tablets (containing around 30–60 mg of elemental iron) or intermittent dosing (e.g., second daily to weekly); the latter approach has been recommended by the WHO for some developing countries. Either approach may be useful in patients with mild IDA who experience GI upset with standard doses of iron, but rapid Hb rise is not essential (Pasricha, Flecknoe-Brown et al. 2010).

Intravenous (i.v.) iron:

The use of i.v. iron has increased dramatically over the last five years. Several i.v. iron preparations are available worldwide include iron dextran, iron dextrin, iron hydoxysaccharate and iron sodium gluconate (Macdougall, 1999)

There are two types of reaction to i.v. iron. The first is a type I IgE- mediated anaphylactic reaction, which is seen exclusively to iron dextran and is due to preformed dextran antibodies whereas the second reaction is anaphylactoid in nature, causing

different symptoms such as wheezing, myalgia, breathlessness, nausea, abdominal or back pain and hypotension (Macdougall, 1999)

Transfusion of packed red blood cells:

Transfusion of red cells remains an overused treatment for IDA. It is also expensive and potentially hazardous. In physiologically compensated patients, transfusion carries unnecessary risks and fails to replenish deficient iron stores (Pasricha, Flecknoe-Brown et al. 2010).

Transfusion is associated with adverse outcomes, including fluid overload (around 1% of patients), and a range of immunological and infectious hazards. Hence, it should be reserved for immediate, targeted management in patients with severe anemia compromising end-organ function (eg, angina pectoris or cardiac failure) or where IDA is complicated by serious, acute ongoing bleeding (Pasricha et al. 2010).

2.6 Prevalence of IDA

IDA is considered to be one of the top ten contributors to the global burden of disease (WHO and CDC, 2008). It is known to affect the health and cognitive ability of children and adolescents (Abalkhail and Shawky, 2002). The WHO estimates that about one third of the global population (over 2 billion) is anemic (Kalaivani, 2009).

A worldwide survey conducted by WHO and CDC and covering the years 1992-2005 found that the prevalence of anemia among non pregnant women aged between 15–50 years is 30.2% where the prevalence of anemia among men (15-50 years) is 12.7% worldwide. The prevalence of anemia ranges widely among developing and developed countries, where the prevalence of anemia among non pregnant women was 21.5% in the Western pacific, 19.0% in Europe, 32.4% in Eastern Mediterranean region which includes most Arabic countries and 17.8% in South East Asia (WHO and CDC, 2008).

In Kavar Urban Area in Southern Iran, Haghpanah et al. (2011) found that 5.8% of adolescent girls had anemia (Hb<12), 8.5% of them had iron deficiency (serum

ferritin< 12) and 1.7% of adolescent girls had iron deficiency anemia (Hb<12 and serum ferritin< 12). Most of the anemic girls (85.7%) were in the mild range of anemia, only three of them had moderate anemia and severe anemia was not seen. There was not significant correlation between hemoglobin concentration and serum ferritin, but a significant negative correlation between hemoglobin concentration and TIBC (Haghpanah et al., 2001).

The Palestinian Ministry of Health (MoH) has protocols for IDA management and prevention that involves free iron supplements. Anemia has been shown to increase with age. In Palestine women aged 40-49 are four times more likely to suffer from anemia than adolescent women. However, the percentage of women aged 15-49 years taking iron was only 7.1 % (PNA, 2005).

Prevalence of IDA among women (non pregnant) in Palestine is 34.8% which is higher than in neighboring countries, such as Lebanon (20%), Egypt (26.3%) and Jordan (28.2%) (PNA,2005).

2.7 Problem statement

Anemia and in particular IDA is a common public health problem worldwide. University students as a target group, some of them are living within refugee campus, and suffering from nutritional insufficiency. Prevalence of ID and IDA among university students in Palestine could be an important public health issue. Once there is no enough published data regarding this issue.

2.8 Justification

IDA is considered to be one of the top ten contributors to the global burden of disease. ID constitutes about 50% of all causes of anemia. The determination of ID and IDA among Palestinian university students should provide primary health care providers and policy makers in health field with necessary data needed for health care assessment.

Identification of risk factors associated with ID and IDA among Palestinian university students and its association with lab tests values should help in developing the intervention to reduce ID and IDA. Additionally, the results of this study can be used as a baseline in monitoring the implementation of a national anemia policy.

Chapter Three

Materials and Methods

3.1 Materials

The materials used in this study are shown Table 3.1.

Table 3.1: Materials used in this study.

#	Item	Manufacture company
1	Needles	
2	Evacuated Tube Blood Collection System	
3	3.5 ml Plain Tubes	
4	3.5 ml EDTA Tubes	
5	Tourniquet	

#	Item	Manufacture company
6	Sterile Gauze Swabs	
7	Cobas Ferritin Reagent Kits, Catalog #	Roche/ Hitachi cobas c systems, Germany
8	Cobas Transferrin Reagents kits, Catalog #	Roche/ Hitachi cobas c systems, Germany
9	Cobas Iron Reagents Kits, Catalog#	Roche/ Hitachi cobas c systems, Germany
10	Cobas Ferritin Controls Catalog #	Roche/ Hitachi cobas c Systems, Germany
11	Cobas Transferrin Controls Catalog #	Roche/ Hitachi cobas c Systems, Germany
12	Cobas Iron Controls Catalog #	Roche/ Hitachi cobas c Systems, Germany

3.2 Methods

3.2.1 Study Design

A cross sectional study was conducted to detect prevalence of ID and IDA among university students in Palestine. The blood samples were collected from different universities that covered South, North, West and East of Palestine. The average age of individuals ranged between 18 to 26 years.

3.2.2 Study Questionnaire

After a detailed review of published and recommended by WHO questionnaires related to ID &IDA. We developed our own questionnaire to match the needs and the parameters of the Palestinian society life style, food habits, social and economic situation. The researcher helped the individuals participating in the study to fill this questionnaire.

The aspects of the questionnaire include personal data (Age, gender, weight, height, BMI, food habits), medical history such as chronic disease, metabolic disorders, and dietary disease), socio-economic and demographic aspects.

3.2.3. Study Sample

Five hundred blood samples were collected from students in different universities in Palestine. The amount of 6 cubic centimeters was collected in Ethylenediaminetetraacetic acid (EDTA) tube and plain tube. The average age of individuals ranged between 18-26 years.

Table 3.2 List of Palestinian universities from which the study samples were collected

Palestinian Universities	Number of Students		
	Males	**Females**	**Total**
Al-Quds Open University- Bethlehem & Ramallah	70	36	106
Palestine Polytechnic University –Hebron	77	23	100
Al- Quds University – Abu Dees	70	65	135
Arab American University- Jenin	33	42	75
Palestine Ahleya University – Bethlehem	56	28	84
Total	**306**	**194**	**500**

3.2.4 Collection of blood samples

Convenient samples were asked to donate a blood sample for the purpose of this study and provide all information required to fill up the questionnaire.

From random university students, 3 ml of whole blood in plain tubes and 3ml of whole blood in EDTA tubes were collected. The EDTA tubes were used within 2- 12 hours for CBC testing. While the blood in plain tube was allowed to clot at room temperature, centrifuged blood and serum were collected and stored at between -18 to -25 ℃ in Caritas Baby Hospital in Bethlehem and used later for determination of Serum iron, Transferrin and Ferritin.

3.2.5 Analysis of blood samples

CBC was the first test that we used to diagnose IDA. CBC was performed for all five hundred participants at Al- Quds University (AQU) laboratory; the CBC machine was calibrated using standard quality assurance. Nihon Kohden 6450 Cell Counter machine was used. The automated hematology analyzer was calibrated using the appropriate calibrators. Reliability of tests was assessed by running appropriate controls.

SI, SF and Transferrin were measured by using Roche Cobas c311 machine. Based on MCV, all individuals with a value less than 80 fl were considered to be at risk for ID and were subjected to SI, SF and Transferrin blood tests.

Blood samples were obtained following standard methods by the researcher in a qualified researcher preventing clot and hemolysis formation, and then blood samples were transferred under optimal temperature and conditions to Caritas Baby Hospital in Bethlehem where SI, transferrin and SF were performed using Roche Cobas c311 machine based on scientific memorandum of cooperation between the department of pathology in AQU and the Caritas baby hospital in Bethlehem.

Iron deficiency is defined as a condition in which there are no mobilizable iron stores and in which signs of a compromised supply of iron to tissues, including the erythron, are noted. The more severe stages of ID are associated with anemia (UNICEF/UNU/WHO, 2001, CDC, 1998)

Anemia is defined as Hb concentration lower than the established cut off defined by WHO, anemia is less than 12g/dl for non pregnant women and less than 13g/dl for adult males. According to CDC and WHO the ID is the number one in nutritional disorder in

world, where 80% of world's population is iron deficient while 30% iron deficient anemia in some form (UNICEF/UNU/WH.O, 2001, CDC, 1998)

According to the WHO/UNICEF/UNI recommendations, IDA for non pregnant women was defined as a situation when Hb is less than 12 g/dl; ferritin is less than 15 ng/ml. However, WHO/UNICEF/UNU recommendations defined ID for non pregnant women as a situation when Hb greater than or equal to 12 g/dl, ferritin is less than 15 ng/ml (WHO/UNICEF/UNU, 2001, Al-Sayes et al., 2011).

3.2.6 Statistical analysis

Data obtained from questionnaires and results of students blood tests were analyzed using software program statistical package for social sciences (SPSS) version 20. Frequencies and percentages were calculated and chi-square test was performed to investigate the significance in the association of the different variables and the prevalence of IDA among university students. A *P*-value <0.05 was considered as statistically significant.

3.2.7 Ethical consideration

A permission to recruit study subjects was obtained from participating universities. All study individuals were briefed of the purpose and objectives of the study and they were asked to sign a consent written to participate in the study by providing all information needed to fill the questionnaire and donate a blood sample.

Chapter Four

Results

Globally, the most significant contributor to the onset of anemia is ID so that ID and anemia are often used synonymously, and the prevalence of anemia has often been used as a proxy for IDA (Clark, 2009, WHO and CDC, 2008). This study was designed to examine the prevalence of ID and IDA among university students in Palestine. Data and blood sample were collected during the period from September 2012 to January 2013. A total of 500 university students who have MCV< 80 fl were included in this study, we helped the students to fill a special questionnaires. Pregnant students, students with MCV>80 fl and students with recent blood transfusion were excluded from this study.

The geographic distribution (Urban and Suburban) of different university students in Palestine is described in table 4.1. The numbers of students from villages, cities and refugee camps were 49.3%, 43.5% and 7.2% respectively.

Table 4.1: Geographic distribution (Urban and Suburban) among different university students in Palestine.

Geographic Distribution (Urban and Suburban)		Male		Female		Total	
		Count	%	Count	%	Count	Total N %
Residence-Palace	Cities	125	25.7%	87	17.9%	212	43.5%
	Villages	164	33.7%	76	15.6%	240	49.3%
	Refugee Camps	26	5.3%	9	1.8%	35	7.2%
	Total	315	64.7%	172	35.3%	487	100%

The general characteristics (age, BMI) and biochemical status (Hb, MCV, Hct, SI, SF, TIBC and serum transferrin) of the study samples are described in table 4.2. The mean age of 500 university students was 21 years (range 18-26 years) and the mean BMI was 23.59 kg/m² (range 14.53-56.34 kg/m²). Where the mean Hb of the students (N= 500) was 15.49 g/dl (range 5.10-20.10 g/dl) and the mean SF measured and serum transferrin for students who have MCV < 80 fl (N=43) were 55.0 and 344.9 respectively.

Table 4.2: General characteristics of university students in Palestine.

General Characteristics				
	N	**Mean ± SD**	**Minimum**	**Maximum**
Age	485	21 ± 3	18	26
BMI (kg/m²)	471	23.6 ± 4.4	14.5	56.3
Biochemical status				
Hb (g/dl)	500	15.5 ± 2.1	5.1	20.1
MCV (fl)	500	87.9 ± 6.2	51.4	100
Hct (%)	500	44.8 ± 5.5	16.2	57.8
SF (ng/ ml)	43	55.0 ± 65.8	2.0	338
TIBC (g/dl)	43	431.0 ± 95.1	269	706
Serum transferrin (mg/dl)	43	344.9 ± 76.0	215	565
Transferrin saturation (%)	43	17.6 ±12.9	2.2	62.8

Table 4.3 (a) shows the Hb status among the university students (N=500). Out of 500 university students, 23 students (4.7%) are anemic based on the recommendation of WHO (WHO, 2001). Table 4.3 (b) shows the serum ferritin status among the university students that have MCV less than 80 fl (N=43). Out of 43 students who have MCV less than 80 fl, the analysis of serum ferritin levels showed that 14.0% (6 out of 43) of students showed IDA (IDA is used when Hb and SF are low) which based on recommendation of the WHO (UNICEF/UNU/WHO, 2001). And 20.9% of students (9 out of 43 students) had ID.

Table 4.3 (a): Hb status among the university students (n=500).

		Frequency (n)	Percentage (%)
Hemoglobin	Anemic *	23	4.7%
	Adequate	477	95.3%

*: WHO definition of Anemia (Anemic has Hb less than 12 for female or 13.5 for male)

Table 4.3 (b): Serum Ferritin status among the university students (n=43).

		Frequency (n)	Percentage (%)
Serum Ferritin	Normal ($\geq$ 15 ng/ml)	28	65.1%
	ID ($\leq$ 15ng/ml)	9	20.9%
	IDA ($\leq$ 15 ng/ml)	6	14.0%

Table 4.4 (a) shows the biochemical status of ID university Students (N=9). The mean Hb of ID students was 13.3 g/dl and mean SI of students was 35.60 µg/dl where the biochemical status of IDA university students (N=6) is also shown in table 4.4 (b), where the mean SF was 5.5 ng/dl and the mean of TIBC was 482.9 g/dl.

Table 4.4 (a): Biochemical status of ID university students (N = 9)

|	N	Mean ± SD
Hb (g/dl)	9	13.3 ± 1.1
MCV (fl)	9	76.1 ±2.0
RDW (%)	9	14.8 ±1.8
SI (µg/dl)	9	35.60 ±26.1
SF (ng/ml)	9	8.20 ±2.5
Serum Transferrin (mg/dl)	9	364.7 ±70
TIBC (g/dl)	9	441.5±67.6

Table 4.4 (b): Biochemical status of IDA students (N = 6)

	N	Mean ± SD
Hb (g/dl)	6	10.6 ± 1.6
MCV (fl)	6	71.3 ±7.20
RDW (%)	6	15.0 ±1.3
SI (µg/dl)	6	24.8 ±11.7
SF (ng/ml)	6	5.5 ±4.0
Serum Transferrin (mg/dl)	6	386.2 ±95.6
TIBC (g/dl)	6	482.9 ± 119.4

Cigarette smoking is a worldwide major cause of preventable morbidity and mortality (Funck-Brentano, Raphael et al. 2006). According to research in Sudan a statistical analysis revealed that SI was significantly higher in smokers compared to non smokers. SI did not change due to age difference. There was insignificant difference between the mean of serum iron in smokers who smoked ≤15 cigarettes per day compared to those who smoked ≥15 cigarettes per day. No correlation found between iron level and the number of cigarettes per day, also no correlation found between iron level and duration of smoking. Table 4.4 (a+b) reveals that none of IDA students smoke cigarette and water pipe. And 1 out of 9 ID students smoke cigarette, our results showed that IDA not related with smoking because none of them smoke cigarette and water pipe.

Smoking can be considered as one of the most dangerous habits that any one individual can have. The WHO estimates that tobacco caused 5.4 million deaths in 2004. The result of our study shows that 54.8% and 63.4% of the Palestinian university student's smoke at all neither water pipe nor regular cigarettes respectively; however 11.1% and 20.2% of them are frequent smokers of water pipe and cigarettes respectively.
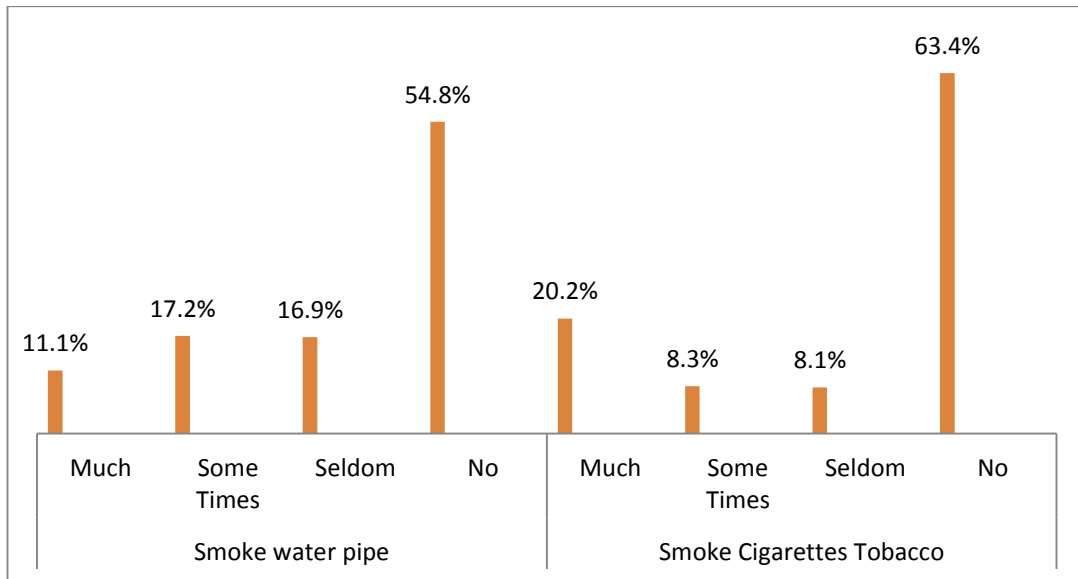
Figure 4.1 Smoking habits among university students

Table 4.5 (a) shows the student's characteristics by Hb tertile groups. As shown in Table 4.5 (a) , a statistically significant difference was observed among the Hb tertile groups when compared with students habits include smoking water pipe, smoking cigarettes tobacco, drinking coffee and tea (P= 0.031). Our study showed that 3 out of 6 students who have IDA are heavy smoker and 4 out of 9 students that have ID are also heavy smoker. No statistically significant difference was observed among Hb tertile groups when compared with Age, students suffering from symptoms of anemia and students knowledge of anemia. As shown in Table 4.5 (b), No statistically significant difference was observed among Hb tertile groups when compared with SI, SF and TIBC.

Table 4.5 (a): Students characteristics by Hb tertile groups. Statistical analysis was performed by One way ANOVA.

	Hb Tertile groups				
	Total	**HbT1 Hb < 11.00 g/dl**	**HbT2 Hb 11.00 - 12.00 g/dl**	**HbT3 Hb >12.0 g/dl**	**P-Values**
	Mean± SD	Mean± SD	Mean± SD	Mean± SD	
Age	21±3	21 ± 3	21 ± 4	21± 3	>0.05
MCV	87.89 ± 6.22	76.93± 13.38	81.26 ± 7.63	88.29±5.62	<0.001
Hct	44.84 ± 5.51	27.33 ± 5.08	34.72 ± 1.52	45.48±4.61	<0.001
Students habits (smoking , drinking coffee and tea	3.75 ± 2.76	1.82 ± 1.66	2.82 ± 1.72	3.82 ± 2.78	0.031
Students suffering from symptoms of anemia	1.83 ±1.81	2.09 ± 1.58	1.00 ± 0.89	1.84 ±1.83	>0.05
Students knowledge of anemia	1.41± 1.58	1.00 ± 1.34	1.91 ± 1.30	1.41 ±1.59	>0.05

Table 4.5 (b): Students iron profile characteristics by Hb tertile groups. Statistical analysis was performed by One way ANOVA

	Hb Tertile groups				P-Values
	Total	**HbT1 Hb < 11.00 g/dl**	**HbT2 Hb 11.00 - 12.00 g/dl**	**HbT3 Hb >12.0 g/dl**	
	Mean± SD	Mean± SD	Mean± SD	Mean± SD	
SI	66.28±45.11	69.83 ± 92.50	45.50 ±30.73	68.15±34.43	>0.05
SF	55.00±65.80	88.20 ± 129.71	17.50 ±20.82	53.52±51.26	>0.05
TIBC	431.98±95.07	516.0± 124.65	434.75± 98.94	416.36± 83.31	>0.05

Table 4.6 (a) shows the general characteristics of ID students (N=9). The mean age and BMI of ID students were 21 Years old and 23.6 kg/m2 respectively. Out of 9 ID students, 7 students (78%) were female. This table shows that 3 of ID students were from Ramallah Refugee camp and 3 of them were from Hebron city. The Distribution of university of ID students showed that 3 out of 9 students were from AAUJ and one of the students was from AQU.

Table 4.6: General characteristics of ID students (N= 9).

Age	Sex	BMI kg/m2	City	Residence	Smoking	University	Family Income
23	Female	23	Ramallah	Refugee Camp	No	Al- Quds Open University	Low
20	Female	23.8	Ramallah	Refugee Camp	No	Al- Quds Open University	Low
19	Female	22	Ramallah	Village	No	Al- Quds Open University	Medium
21	Female	24	Jenin	Refugee Camp	No	AAUJ	Medium
20	Female	27.4	Jenin	Village	No	AAUJ	Medium
21	Male	22.2	Hebron	Village	No	PPU	Low
21	Male	25.1	Hebron	City	No	PPU	Medium
21	Female	22.2	Hebron	City	Yes	PPU	Low
21	Female	22	Abu Dees	City	No	AQU	High

Abbreviations: AAUJ (Arab American University of Jenin, PPU (Palestine Polytechnic University – Hebron), AQU (Al-Quds University – Abu Dees).

The general characteristics of IDA students (N=6) are described in table 4.7. All IDA students were female. The mean age and BMI of IDA students were 20 years old and 21.1 kg/m2 respectively. 2 out of 6 IDA students were from Jenin city and 1 out of 6 students were from refugee camp. 83% of IDA students were from medium family income.

Table 4.7: General characteristics of IDA students (N= 6).

Age	Sex	BMI kg/m2	City	Residence	Smoking	University	Family Income
19	Female	18.8	Jenin	City	No	AAUJ	Medium
19	Female	21	Jenin	City	No	AAUJ	Medium
19	Female	21.3	Hebron	City	No	PPU	Medium
23	Female	21	Hebron	Village	No	AQU	Low
21	Female	22	Bethlehem	Refugee Camp	No	AQU	Medium
19	Female	22.4	Bethlehem	Village	No	AQU	Medium

Chapter Five

Discussion

IDA is the most common nutritional deficiency worldwide, affecting approximately a quarter of the global population, mostly in developing countries (Benoist et al., 2008; Luo et al., 2011b). The prevalence of ID varies greatly according to the host factors like age, gender, physiological causes, pathological causes, nutritional factors, environmental factors and socioeconomic conditions. (WHO and CDC, 2007).

Adolescents are vulnerable to ID 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. However, women in general and during their reproductive years are at risk of ID due to blood loss from menstruation, in particular that 10 % who suffer heavy loss. There are certain contraceptive practices also play a part, the intrauterine devices increase menstrual blood loss by 30 %- 50 % while oral contraceptives have the opposite effect. Furthermore, women in their reproductive years often have a dietary iron intake that is too low to offset losses from menstruation and the increased iron requirement for reproduction (Scholl, 2005).

A worldwide survey conducted by WHO and CDC and covering the years 1992-2005 found that the prevalence of anemia among non pregnant women aged between 15–50 years is 30.2% where the prevalence of anemia among men (15-50 years) is 12.7% worldwide. The prevalence of anemia ranges widely among developing and developed countries, where the prevalence of anemia among non pregnant women was 21.5% in the Western pacific, 19.0% in Europe, 32.4% in Eastern Mediterranean region which includes most Arabic countries and 17.8% in South East Asia (WHO and CDC,2008). Almost the entire population was covered by survey data or regression-based estimates, since all countries except for one had an estimate. The proportion of the population covered by survey data was high in non-pregnant women (73.5%), but lower for men (40.2%), and the elderly (39.1%) (WHO and CDC, 2008).

This study aimed to assess the prevalence of ID and IDA among university students in Palestine and to assess the association between student Hb and SF level. The study subjects were 500 university students. The prevalence of anemia among the study subjects was 4.7% (23 out of 500) judged by Hb level (Hb < 12 g/dl). Based on the analysis of serum ferritin for students who have MCV < 80 fl, 20.9% (9 out of 43 subjects) of the study subjects have depleted iron stores (ID) and 14.0 % (6 out of 43) of the study have IDA. In general, the prevalence of IDA and ID varies according to different conditions.

In Kavar Urban Area in Southern Iran, Haghpanah et al. (2011) found that 5.8% of adolescent girls had anemia (Hb<12), 8.5% of them had ID (serum ferritin< 12) and 1.7% of adolescent girls had IDA (Hb<12 and serum ferritin< 12). Most of the anemic girls (85.7%) were in the mild range of anemia, only three of them had moderate anemia and severe anemia was not seen. There was not significant correlation between Hb concentration and SF, but a significant negative correlation between Hb concentration and TIBC (Haghpanah et.al, 2001).

According to Palestinian Ministry of health, the percentage of women aged 15-49 years taking iron was only 7.1 % (PNA, 2005). When compared prevalence of IDA with neighboring countries, Prevalence of IDA among women (non pregnant) in Palestine is 34.8% is higher than Lebanon (20%) and is better than reported ib Egypt (26.3%) and Jordan (28.2%) (PNA,2005).

In conclusion, our data revealed that the prevalence of ID is 1.8% (9 out of 500) and IDA 1.2% (6 out of 500) among university students in Palestine. A statistically significant difference was observed among the Hb tertile groups when compared with students habits include smoking water pipe, smoking cigarettes tobacco, drinking coffee and tea (P= 0.031). No statistically significant difference was observed among Hb tertile groups when compared with Age, SI, SF, TIBC, students suffering from symptoms of anemia and students knowledge of anemia. Our study revealed that the level of university student's general knowledge and background about anemia is very good, because 84.4% of students have enough knowledge about anemia as disease. On other hand 83.9% and 86.6% of students realize that poor nutrition and ID respectively, were the main cause of anemia. The result of their knowledge regarding poor nutrition and ID as main cause of anemia helps them protect themselves from the distribution of ID and IDA.

Our data revealed that 92.4% of the students were medium and high family income, that's mean that the medium and high social-economic level of individuals play a role in reduced figures of ID and IDA.

Recommendations

Based on the interesting data revealed from the study and discussed, many recommendations could be assumed for the Palestinian Ministry of health, other health providers, community leaders, and students themselves.

- The study highlights the high level of ID and IDA awareness among university students reflected in their knowledge about the disease and the medium economic and social levels through the low incidence of ID and IDA.

- Prophylactic supplementation with iron could prevent the development of ID and IDA in target group and people with high risk.

- Building up a national data base about ID and IDA among different groups in Palestine society such as pregnant women, school girls etc.

- Similar study in Palestinian universities of Gaza in the future could have a comprehensive value and give clear comparative results that contribute to our results.

- To keep the standard level of awareness in the next generation by demonstration of different activities warning from ID and IDA complication by students organizations.

- Enhancement of such research activities in Palestine by Palestinian Ministry of Health and other Health service providers in Palestine to prevent serious diseases by prevention of pathogenesis.

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Appendices

I - Enrollment Questionnaire

جامعة القدس / كلية الدراسات العليا / أبو ديس
نموذج استبيان للمشاركين في بحث حول مرض نقص الحديد و فقر الدم الناتج عنه

رقم العينة: ------------------------------

العمر: ------------------------------------

جنس الطالب/ة : □ ذكر □ أنثى

السنة الدراسية: □ أولى □ ثانية □ ثالثة □ رابعة

الجامعة \ الكلية: ------------------------

الطول: --------------------------------

الوزن: ---------------------------------

مكان الإقامة: □ مدينة □ قرية □ مخيم

اسم المدينة/القرية: ----------------------

الأب: □ يعمل □ لا يعمل

الأم: □ تعمل □ لا تعمل

مستوى الدخل في الأسرة: □ متدني □ متوسط □ عالي
(1000-1900) (2000-2900) (>3000) شيقل

عدد أفراد الأسرة: □ 0-2 □ 3-4 □ 5-6 □ أكثر من6

هل تعرف/ين ما هو فقر الدم؟ □ نعم □ لا

ـ ماذا يعني لك فقر الدم ؟

	لا أعرف	لا	نعم
سوء تغذية			
نقص الحديد			
انخفاض في نسبة الدم			

ـ هل يوجد لديك أي من السلوكيات التالية:

	بكثرة	أحيانا	نادرا	لا
التدخين				
الأرجيلة				
شرب المنبهات (القهوة و الشاي) بعد الأكل مباشرة				
الإمساك المزمن أو الإسهال.				

هل تعاني من أي من الاعراض التالية؟

	لا أعرف	لا	نعم
صعوبة في التنفس			
ضعف عام			
فقدان للشهية			
دوار			
خمول و ارهاق			
شحوب الوجه والشفاه			
تراجع في الذاكرة و الحفظ			

3.هل تعتقد أن أي من الامراض التالية له علاقة بفقر الدم؟

	لا أعرف	لا	نعم	
				قرحــة المعـدة والاثنـى عشر
				المعالجــــة الطويلــــة بالأســــــبرين و المسكنات
				ســــرطان القولـــــون والمعدة.
				اضطرابات في القنـاة الهضــمية كالإســهال والتهاب المعدة

شكرا لمشاركتكم في هذا الاستبيان

الطالبة: تغريد السعدي

الماجستير في العلوم الطبية المخبرية / علم الدم

Prevalence of iron deficiency and iron deficiency anemia among university students in Palestine

<div dir="rtl">

الموافقة المسبقة للطلبة

(الاسم)_____(تاريخ الميلاد)_____

- لقد تلقيت فكرة واضحة عن المشروع البحثي ، والمتعلق بمرض نقص الحديد و فقر الدم الناتج عنه.

- لقد تلقيت معلومات كاملة من الباحث بشأن التفسيرات الممكنة والقيود المفروضة على الاختبارات موضوع البحث.

- ليس لدي المزيد من الأسئلة.

- أقر بأن مشاركتي طوعية تماما. وأنا حر لسحب مشاركتي دون إبداء أي سبب. وفي هذه الحالة ، سيتم تجاهل البيانات الخاصة بي وعيناتي . ولا يشكل هذا الانسحاب أي خسارة في الاستحقاقات بالنسبة لي.

- أنا اوكد الموافقة على سحب عينة الدم الوريدي ، و بالتالي عمل فحوصات نسبة الحديد و متعلقاته في الدم والاختبارات ذات العلاقة

- أوافق على إرسال عينة الدم خاصتي الى مستشفى كاريتاس و مختبرات جامعة القدس لاتمام الفحوصات ضمن مشروع البحث و لتخزينها لاستخدامات بحثية فقط.

وبالإضافة إلى ذلك ، لقد قررت أنه بالإمكان استخدام عينتي كالتالي:

يرجى الإجابة: نعم أو لا

لا	نعم	
☐	☐	أن يتم تخزين عينات الدم الخاصة بي في مختبرات جامعة القدس لاستخدامها في مشاريع أخرى حول نفس الموضوع حتى أعلن انسحابي
☐	☐	أتمنى أن أكون على إطلاع حول النتائج. لقد تم إبلاغي بأن النتائج تستند على مشروع بحثي ولا تلبي معايير التشخيص الروتينية.
☐	☐	أوافق على أن نتائجي سيتم تخزينها مع البيانات لأكثر من 10 سنوات في جامعة القدس.

التلفون \ البريد الألكتروني	اسم الجامعة	تاريخ التوقيع	توقيع المشارك

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انتشار نقص الحديد وفقر الدم الناتج عن نقص الحديد بين طلبة الجامعات في فلسطين.

اعداد: تغريد يوسف السعدي .

اشراف : د. غسان بعلوشة

ملخص

نقص الحديد هي واحدة من أهم المشاكل الغذائية الأكثر شيوعاً في جميع أنحاء العالم التي تعتبر بمثابة السبب الرئيسي لفقر الدم، المراهقين أكثر عرضة لنقص الحديد بسبب زيادة احتياجاتهم للحديد بسبب النمو السريع في هذه المرحلة، احتياجات الذكور للحديد هي أعلى بسبب زيادة حجم الدم ، كتلة العضلات والميوجلوبين، وبشكل عام فان النساء خلال سنوات الإنجاب عرضة لنقص الحديد بسبب فقدان الدم من الدورة الشهرية.

لهذا هدفت هذه الدراسة إلى تحديد مدى انتشار نقص الحديد وفقر الدم الناتج عنه بين شريحة مهمة في المجتمع الفلسطيني وهم طلبة الجامعات في فلسطين ، هذه الدراسة تعتبر دراسة طولية ، حيث شملت هذه الدراسة 500 عينة دم وريدي من طلاب جامعيين تراوحت أعمارهم بين 18-26 سنة وذلك بعد إبدائهم القبول الطوعي للمشاركة في هذه الدراسة، ومن ثم قامت الباحثة بمساعدة هؤلاء الطلبة في تعبئة استبيان قامت بتصميمه مسبقاً بغرض تسليط الضوء على الجوانب الاجتماعية والاقتصادية والصحية للطالب المشارك دون إهمال الجوانب الأخرى مثل التاريخ الطبي، التوزيع الديمغرافي والعادات الغذائية المختلفة إن وجدت، حللت النتائج إحصائياً عن طريق (Chi - square) للمتغيرات الفئوية و (ANOVA) ، (t- test) للمتغيرات المتواصلة و (Pearson's correlation) لفحص العلاقات الإحصائية.

بلغت نسبة انتشار فقر الدم الناتج عن نقص الحديد في هذه الدراسة 4.7% (23 من 500) وذلك بالاعتماد على أن يكون (Hb <12 g/dl للإناث و Hb< 13.5 g/dl للذكور) ، وبالاعتماد على تحليل نسبة مخزون الحديد وجد أن 20.9% (9 من 43) من عينة الدراسة كانوا يعانون من نقص في مخزون الحديد(ID) للطلاب الذي MCV< 80 fl وحيث وجد أن 14.0% (6 من 43) من عينة الدراسة يعانون من IDA .

عندما قمنا بتوزيع طلبة الجامعات في مجموعات ثلاثية بالاعتماد عل نسبة Hb كان هناك اختلافات ذات دلالة إحصائية في نتائج الطلبة بين هذه المجموعات لدى مقارنتها بعادات الطلبة المختلفة (التدخين ، الأرجيلة وشرب المنبهات) (P=0.031) ، لم تكن هناك اختلافات ذات دلالة إحصائية في نتائج الطلبة بين هذه المجموعات لدى مقارنتها مع العمر ، SI ، SF ، TIBC، والطلاب الذين يعانون من أعراض فقر الدم والطلاب ذو معرفة ما هو فقر الدم ، وجدنا أن 85.2٪ من طلاب الجامعات ينحدرون من أسر ذات دخل متوسط في 7.6٪ و 7.2٪ منهم كانوا من ذوي الدخل المنخفض والعالي على التوالي.

وبناء على ما تقدم فإننا نتقدم بتوصيات واضحة وملحّة إلى وزارة الصحة الفلسطينية ، كذلك مقدمي الخدمات الصحية في فلسطين أن يقدموا جانب من الاهتمام بتلك التوصيات لتفادي هذا المرض والحفاظ على معايير الوعي بمخاطره لدى أجيال الشباب عبر تسليط الضوء عليه من خلال المنظمات والنوادي الطلابية المختلفة في الجامعات الفلسطينية وكذلك قادة المجتمع المحلي.