# Nutritional program based on dietary pattern and iron deficiency anemia–related knowledge among Egyptian preparatory school girls.

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**Abstract:** The adolescent development is a fairly recent concept corresponding to the 2nd decade of life. For many decades, this short phase in the human life cycle was neglected by parents and society. Anemia is one of the most widespread public health problems and has important health and welfare, social, and economic consequences. **Aim of study are** to study the nutritional practices and iron deficiency-related knowledge of preparatory school girls and the effect of nutritional educational program on adolescent girls with iron deficiency anemia. **Material and Methods:** Interventional design, using an interviewing questionnaire was conducted in El-Behira Governorates. **Results:** Of the total studied subject, the mean age was 12.89 ± 0.80 years and ranged from twelve to more than fourteen years. More than one-third of them had satisfactory school achievement. Headache was the first problem mentioned by 26.0% of girls. It was found that 34.0% of girls had anemia and 79.4% received iron supplementation as treatment. Concerning total scores of students' dietary practice and knowledge; 68.18% of non-anemic girls and 86.4% for those anemic one had poor dietary practices' scores and the majority of girls had poor knowledge scores. Regarding the impact of the nutritional educational program on the total scores of students' knowledge about iron deficiency anemia; the total mean scores of knowledge for the experimental group were increased from 41.34±8.05 at the pre intervention phase to be 62.59±11.53 at the post-intervention phase. A highly statistically significant differences were found among the control and experimental groups at the post-intervention evaluation (t test= 18.796, p<0.001). **Conclusions and Recommendations:** Success in combating anemia depends on understanding its associated factors. Greater efforts and creative solutions are needed to develop and implement programs both to prevent and control anemia.

## INTRODUCTION

Adolescence, the period of transition from childhood to adulthood, is a key phase of human development. It is characterized by rapid changes – physical, sexual, psychological, emotional, cognitive, and social. (1) During this stage in the life cycle, a young person's social, economic, legal and political status is transformed. Adolescence is a time of preparation for the adult roles of worker, citizen and community participant, spouse, parent, and household manager. It is a period of capacity development and one of increased vulnerability and risk, especially for girls.(2)

WHO defines it as the period between 10 and 19 years old. It may be divided into three developmental stages based on physical, psychological and social changes; early adolescence occurs roughly between ages 10 and 14, middle adolescence between ages 14 and 17, and late adolescence between ages 17 and 19.(3) Adolescents constitute a large and important segment of the population worldwide. Globally there are one in every five people in the world is an adolescent. Out of 1.2 billion adolescents worldwide, about 85% live in developing countries and the remainder lives in the industrialized world (United Nations 1997). (4,5)

Adolescents represent 22% of the Egyptian population. This means that nearly one in four Egyptians is an adolescent. They expected to grow from 13.8 million in 2000 to an estimated 16.5 million in 2020. (6,7)

Adolescents are considered to be a nutritionally vulnerable segment of the population. Due to enhanced growth during adolescence, the requirement of some minerals is of paramount important. A rapid growth rate combined with a marginal nutrient intake increases the risk of nutritional deficiencies in this population. Micronutrients such as iron and zinc are essential trace elements involved in the high growth rates of adolescents. [8]

Poor nutritional status during adolescent is an important determinant of health outcomes at a later stage of life. Therefore, attention should be given to adolescent health and nutrition. Studies confirmed the higher prevalence of anemia and iron deficiency along with some other micronutrient deficiencies. [8,9]

Although few studies characterized the dietary pattern and nutritional status of adolescent school girls, we are not aware of any systematic report that has characterized the dietary pattern, nutritional status and prevalence of anemia in adolescent girls. Their health and nutritional status have great impact on the quality of the next generation and consequently the future of the country. [8]

Iron deficiency is the most common form of malnutrition in the world, affecting more than 2 billion people globally. Iron deficiency anemia (inadequate amount of red blood cells caused by lack of iron) is highly prevalent in less-developed countries but also remains a problem in developed countries where other forms of malnutrition have already been virtually eliminated. Iron deficiency is not the only cause of anemia, but where anemia is prevalent; iron deficiency is usually the most common cause. The prevalence of anemia, defined by low hemoglobin or hematocrit, is commonly used to assess the severity of iron deficiency in a population. [10.11]

Iron deficiency anemia (IDA) is most prevalent and severe in young children and women of reproductive age, but is often found in older children and adolescents and may be found in adult men and the elderly. Even today nearly 1.5 billion people all over the world are affected by IDA. [5, 12] Iron deficiency anemia occurs when iron stores are exhausted and the supply of iron to the tissues is compromised. Iron deficiency anemia is a severe stage of iron deficiency in which hemoglobin (or hematocrit) falls below the above cutoffs. Iron deficiency anemia is defined as anemia with biochemical evidence of iron deficiency. [12]

Serum ferritin, transferrin saturation, transferrin receptor, and erythrocyte protoporphyrin are indicators used as biochemical evidence of iron deficiency. Iron deficiency generally develops slowly and is not clinically apparent until anemia is severe even though functional consequences already exist. Where iron deficiency anemia is prevalent, effective control programs may yield benefits to human health.[12]

Poor diet quality and low dietary iron bioavailability are the principal factors that contribute to the increased incidence of iron deficiency. 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. The main enhancers of nonhaem iron absorption are meat (haem iron) and vitamins C. Inhibitors include phytate (nuts, bran and oat products, whole-wheat and brown flour), polyphenols (tea, coffee, cocoa, some spices and vegetables) and calcium (milk products). [13, 14]

In developing countries, low standards of living, low socio-economic conditions, restricted access to food and a lack of knowledge for good dietary practices and personal hygiene contribute even more to a high occurrence of iron deficiency and hence anemia. Intestinal parasitic infection, due to poor hygienic conditions, interferes with iron absorption by reducing it, thus expanding the prevalence of iron deficiency anemia in the developing world. [13, 14]

Adolescents' nutritional problems may represent a heavy health burden. Furthermore, the deleterious effects of deficiencies in adolescents are ignored. Promoting the healthy development of adolescents is one of the most important investments that any society can make.[15, 16] A better understanding of adolescents' diets and eating behaviors is essential for the design and development of relevant education and other intervention programmes. Thus, this research was conducted to study the nutritional practices and assess iron deficiency-related knowledge of preparatory school girls and study the effect of nutritional educational program on adolescent girls with iron deficiency anemia.

**Hypothesis of this interventional study was:**

1. Students have wrong dietary practices and knowledge regarding iron deficiency anemia or not?
2. Is there an impact of a nutritional educational program on adolescent girls with iron deficiency anemia or not?

## MATERIAL AND METHODS

**Research design:** Interventional study designs were adopted to carry out this study.

**The study involved the following:**

A cross-sectional study was conducted in the first phase to assess the nutritional practices and knowledge regarding iron deficiency anemia. Then experimental research design was carried out to assess the impact of the nutritional educational program on students' knowledge about anaemia, their hemoglobin level and serum iron.

**Study settings:** This study was conducted in governmental preparatory schools in El-Beheira Governorate, which composed of 18 educational administrative departments (648 preparatory governmental schools). By 15% proportional allocation, three educational administrative departments (Damanhour, Kom-Hamada and El-Nobaria) were randomly selected using lottery to be the place of study; one school was selected randomly from each educational administrative department. Students of first grades from the chosen schools were included in the study and all classes of first grades were enrolled in the study.

**Subjects:**

All students of the first grade in the mentioned educational administrative departments were included in the sample, they reached 1042, 42 students refuse to participate in the study. So, the total sample was 1000.

**Inclusion criteria:**

The study sample was selected according to the following criteria:

- Having mild (10 – 11.9 g /dl) or moderate (7 – 9.9 g /dl) degree of anemia. [17]
- Having abnormal serum iron level.
- Free from chronic diseases such as diabetes, rheumatic fever, epilepsy or parasitic infestation.
- Not menstruating at the time of hemoglobin test.
- Hadn't any recent surgery at least six months prior to hemoglobin test.

**Tool for data collection:**

One tool was developed and used by the researchers in order to collect the necessary information from students at selected schools after reviewing the literatures.

**This tool includes:**

**Part I: Students' personal data:**

- Socio-demographic characteristics as: age, residence, family income, parents education, and occupation.
- Students' achievement in classroom.
- Menstrual history e.g. regularity of menstrual period, duration of menstruation and number of pads daily used.
- Medical health status; past and present complaints.

**Part II:**

- Students' dietary practices as number of meals daily, snacks intake, fruits and vegetables intake.
- Students' knowledge about iron deficiency anemia, nutrients important to prevent anemia and its management.

**Part III:**

- Laboratory investigations as stool analysis, blood investigation for hemoglobin concentration and serum iron.

**Methods**

1. Using stratified random sampling technique, by choose representative schools from the three educational administrative departments at El-Beheira Governorate.
2. All students enrolled at preparatory school at the first grade and accept to be participated (48 classes with average 21 students per class) were included in the study; their total number was 1000 students. First grade students were routinely screened for hemoglobin level and stool analysis by school health insurance clinic at the beginning of the academic year as pre-determined appointment and during the presence of the researcher.
3. According to the results of hemoglobin and serum iron screening performed also at school health insurance clinic to confirm iron deficiency anemia; 340 students were found to have iron deficiency anemia.
4. The study sample was selected according to the pre-determined inclusion criteria.
5. Accordingly, 120 students were incongruent with the criteria of selection and excluded from the sample.
6. The 220 students with anemia were divided into two matched groups (experimental and control). Then, they were referred to the health insurance clinic to receive appropriate treatment. The treatment and follow up study was performed on all anemic students (220 student girls of both groups).
7. Nutritional educational program was done on the experimental group (110 students).
8. Finally, the control group was assessed to determine the effect of iron supplementation only on students' hemoglobin and serum iron level. While, the experimental group was assessed to determine the impact of both nutritional educational program and iron supplementation on students' hemoglobin and serum iron level.
9. Data collection methodology:

- Approvals were obtained from the headmistresses of the selected schools and school health insurance directors after explaining the purpose of the study to gain their cooperation.
- Tool of data collection was designed based on recent relevant literature.
- Tool was checked from jury consist of 3 experts at the same field to assess contents validity.
- Pilot study was carried out in order to ensure the clarity of the tool. After the development of the tool, a pilot study was carried out on 100 students randomly selected from another preparatory school which was not included in the study sample. The questionnaire included students' achievement in classroom, medical health status, menstrual history, dietary practices and knowledge about iron deficiency anemia.
- Data collection: Data was collected during the academic years 2011 – 2012.
    - This started at September/2011 till November 2011 to assess practice and knowledge of students.

- December/2011 till March/2012 to implement the nutritional educational program over a period of three months.
- Evaluation of the program was conducted until May/2012.
- An extra trainee (co-worker) used in order to help the researchers in data collection phase only.

**1- Preparation and organization of nutritional educational program's sessions:**

**1- Preparation of sessions**

Nutritional educational program's sessions were prepared by the researcher for the experimental group. The content of the sessions was based on review of literature, results of assessment as well as characteristics of adolescent students and their needs.

**The aims of the sessions are to:**

- Help students to follow the proper nutritional regimen to prevent further complication of iron deficiency anemia.
- Improve student's nutritional status in relation to anemia.

**2- Nutritional educational program strategies**

**A. Nutritional educational program methods:**

Different methods of instructions were adopted as brain storming, group discussion, case study and role play.

**B- Teaching aids:**

Different aids were used to facilitate and illustrate teaching such as posters, handouts, food models and real natural food stuffs.

**3- Implementation of sessions:**

This phase included the implementation of the planned nutritional educational program. The experimental group (110 students) was divided into small groups (10 groups) based on the needs and problems of each student. Therefore, nutritional educational program were implemented through three sessions for each group. Each session lasted approximately 60 minutes. Firstly, discussion of the session objectives and content were dedicated. Then, time was available for student's participation and interaction. Different methods of instructions and teaching aids mentioned before were used.

**Follow up:**

a- Iron supplementation was given to the two comparative groups (experimental and control group) by school health insurance clinic over a period of three months. The dose was one capsule taken daily after the main meal as prescribed by the physician.

b- Check of students' compliance with medication during the implementation phase of the program.

**4- Evaluation phase:**

Reassessment was done immediately for both groups after the completion of the nutritional educational program and treatment and it last three months for its completion.

1. Students were referred to the health insurance clinic for screening of hemoglobin level and serum iron after completion of the educational program.
2. Control group was assessed to determine the effect of iron supplementation only on students' hemoglobin and serum iron level.
3. Experimental group was assessed to determine the impact of nutritional educational program on students' knowledge about anemia. In addition, assess the effect of iron supplementation on students' hemoglobin and serum iron level.

**Ethical consideration:**

Verbal consent was obtained from the students after explanation of the aim of the study. Privacy was maintained during process of data collection. Confidentiality and anonymity of students' response were guaranteed.

**Statistical analysis:**

After data were collected, they were coded and transferred into especially designed formats to be suitable for computer feeding. Following data entry, checking and verifying processes were carried out to avoid any errors during data entry. Frequency analysis, cross tabulation and manual revision were all used to detect any errors.

 Data was analyzed using PC with Statistical Package for Social Sciences (SPSS) version 16.0.

 The level of significance selected for this study was p equal to or less than 0.05.

 **The following statistical measures were used:**

**A- Descriptive statistics:** Count and percentage: Used for describing and summarizing quantitative data, Arithmetic means Standard deviation (SD) and range: They were used as measures of central tendency and dispersion respectively to summarize quantitative data. Paired t-test was used to compare between sample means for quantitative data with normal distribution.

**B- Scoring system**

- **Section 1: students' practices regarding consumption of food rich iron:**

This section of the questionnaire includes ten items composed of foods which alter the iron level at the body. The items were scoring as following: A score "3" was given to daily eat item. While, score "2" was given to weekly eat item, a score "1" was given to monthly eat food item and a score "0" was given to never eat food item. The total practice score was obtained for each student (0-30). Percent total practice score was calculated as follows; poor practice <15 (less than 50%), fair practice 15-<22.5 (50-<75%) and good practice ≥22.5 (≥75%)

- **Section 2: Knowledge about anemia:**

This section of the questionnaire consists of 10 items includes general knowledge about different types of anemia, definition of iron deficiency anemia, degree of iron deficiency anemia, reasons of iron deficiency anemia, manifestation associated with and management of iron deficiency anemia.

**A scoring system for assessing the student's knowledge regarding iron deficiency anemia;**

The correct answers were pre-determined according to the literature. A score of (2) was given to the correct complete answer, a score of (1) for correct but incomplete answer and a score of (0) for the wrong or missed answers. The total knowledge score was obtained for each student (0-20). Percent total knowledge score was calculated as follows;

- Poor knowledge < 10 (< 50%)
- Satisfactory 10 - < 15 (50 - < 60%)
- Good ≥ 15 (≥ 60%)

**RESULTS**

**Regarding characteristics of the studied sample, table (1)** shows that students' age ranged from twelve years to more than fourteen, with a mean of 12.89 ± 0.80 years. With respect to place of residence the majority of them (97%) were from urban areas and only 3% were from rural ones. Highest percent of students were observed to be either first or second child order.

Concerning the students' achievement as reported by teachers; it was evident that more than one third of the students had satisfactory achievement. **Table (1)** also shows the monthly family income was ranged from 200 to less than 400 pounds as stated by nearly one fifth of the students (18%) compared to 82% who had 600 to 1200 pounds. As regards crowding index, it was observed that more than half (57%) had a crowding index of four to less than seven persons per room.

**Table (1): Distribution of the students according to their socio-demographic characteristics**

| Items | No. (n= 1000) | % |
|---|---|---|
| **Age (year):** 12 - | 770 | 77.0 |
| ≥14 | 230 | 23.0 |
| **Mean ± S.D.** | **12.89 ± 0.80** | |
| **Place of residence** | | |
| Rural | 30 | 3.0 |
| Urban | 970 | 97.0 |
| **Student's birth order** | | |
| First | 360 | 36.0 |
| Second | 350 | 35.0 |
| Third | 220 | 22.0 |
| Fourth or more | 70 | 7.0 |
| **Income** | | |
| 200- L.E | 40 | 4.0 |
| 400- L.E | 140 | 14.0 |
| 600- < 1200 L.E | 820 | 82.0 |
| **Crowding index: person/room** | | |
| Less than 3 person / room | 10 | 1.0 |
| 3- persons / room | 370 | 37.0 |
| 5- persons / room | 570 | 57.0 |
| 7 persons or more / room | 50 | 5.0 |
| **Student's absenteeism** | | |
| No | 530 | 53.0 |
| 1-3 day/month | 320 | 32.0 |
| 4 day/m or more | 150 | 15.0 |
| **Students' achievement in classroom** | | |
| Poor | 260 | 26.0 |
| Satisfactory | 339 | 33.9 |
| Good | 401 | 40.1 |

Concerning parents' education, nearly two thirds (63.6% and 67%) of student's fathers and mothers respectively had university education (**figure 1)**. Regarding parents' occupation, more than three quarter (75%) of fathers were working in professional jobs compared to 49% of mothers (**figure 2)**.

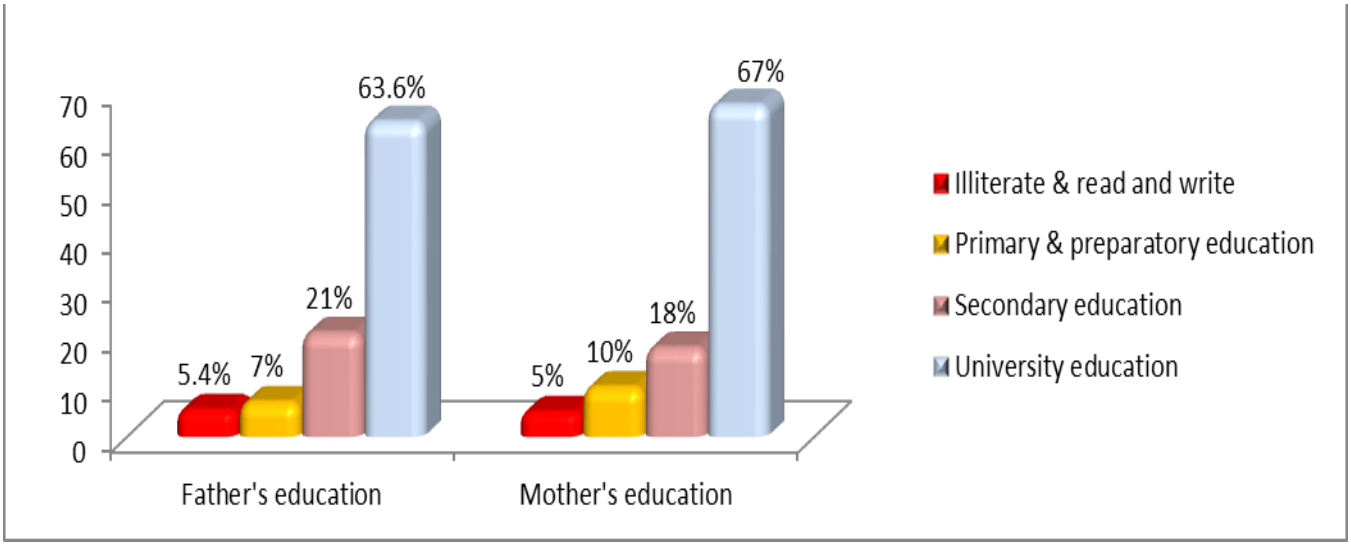


**Figure 1: Distribution of the students according to their parents' educational level**

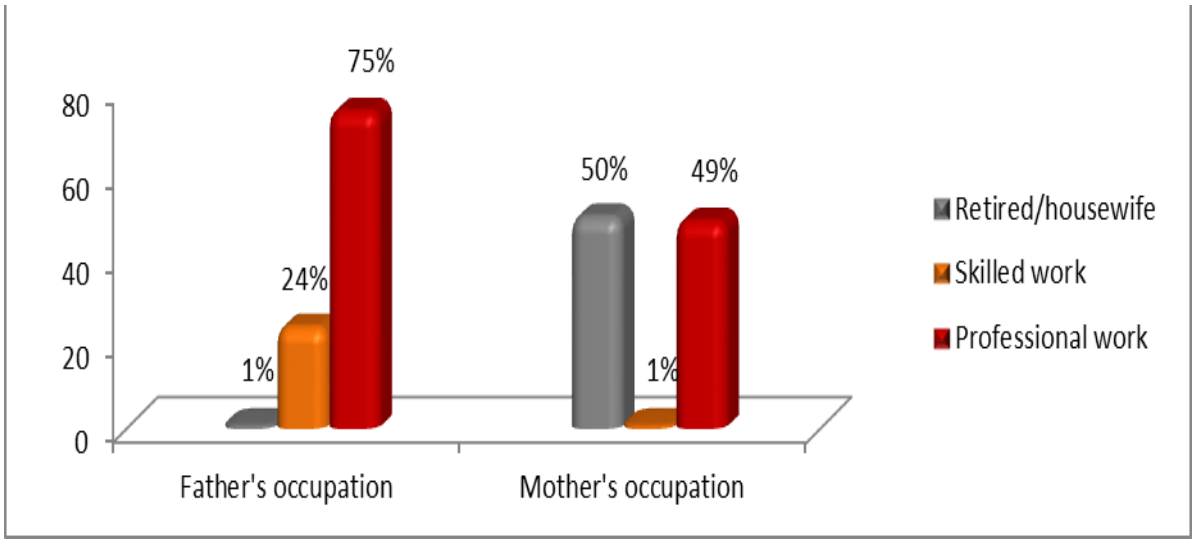


**Figure 2: Distribution of the students according to their parents' occupation**

**Concerning the menstrual history, figure (3)** shows that 27% of the students reported that they did not get their menstruation yet (primary amenorrhea). Less than one third (30.1%) of those menstruating girls had irregular menstruation.

More than half of the sample (54.8%) reported that the duration of menstruation was less than five days, while 45.2% reported that it lasts five days or more. The result shows that more than half of the students (53.4%) were changing their pads three times or more daily. While 46.6% were changing their pads less than three times daily**, figure (4)**.

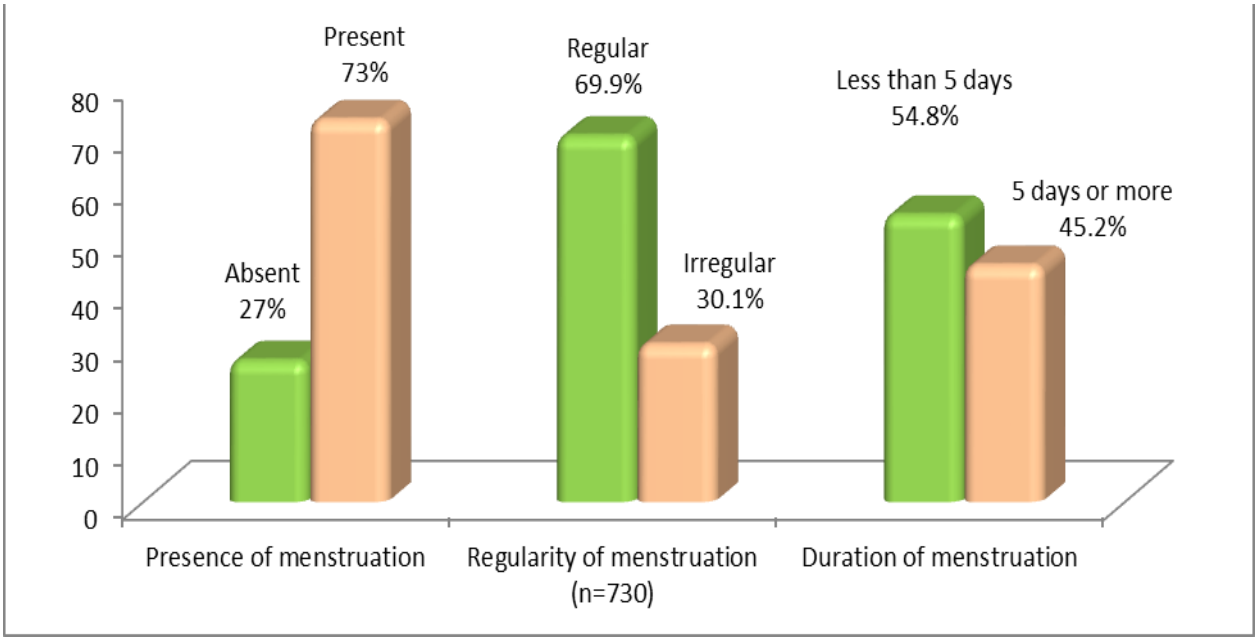


**Figure 3: Distribution of the students according to their menstrual history**

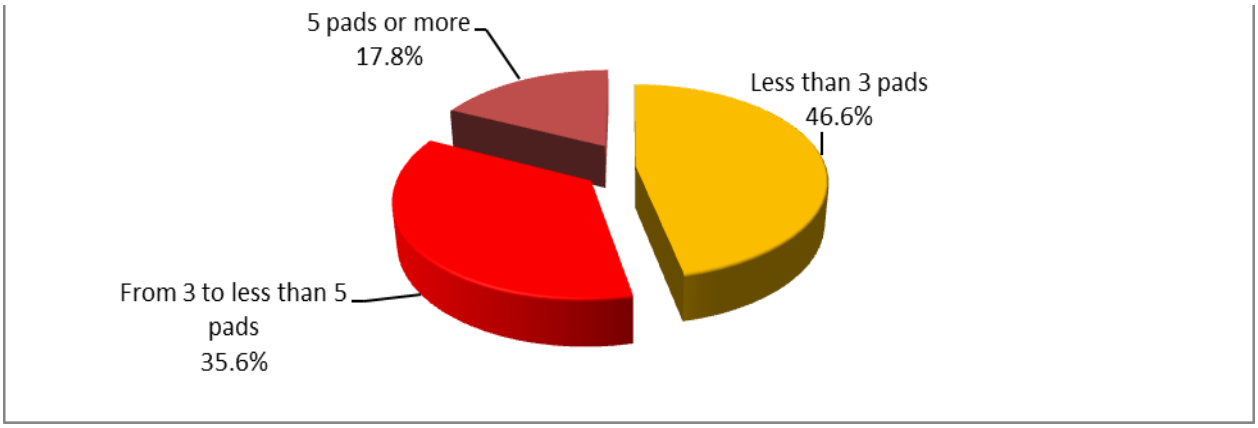


**Figure 4: Distribution of the students according to number of pads used daily**

**Table (2) shows students' medical health status and their present complaints.** The table reveals that, the majority of students (88%) had no medical health problems however; 9% of those had health problems reported respiratory disease, 6% reported parasitic infestation and 3% for diabetes. Also, it was found that 1% of girls had epilepsy.

Concerning present complaints, headache was the first problem mentioned by more than one fourth (26.0%) of the students, followed by low concentration were reported by 25.0%, while lethargy and blurred vision was mentioned by less than one fifth (19.0% and 16.0% respectively) of the students.

**Table (2): Distribution of students according to their medical health status**

| Students' health status (n= 1000) | No | % |
|---|---|---|
| **Medical problems*** | | |
| Respiratory disease | 90 | 9.0 |
| Parasitic infestation | 60 | 6.0 |
| Diabetes | 30 | 3.0 |
| Epilepsy | 10 | 1.0 |
| No problems | 880 | 88.0 |
| **Present complaints*** | | |
| Headache | 260 | 26.0 |
| Low concentration | 250 | 25.0 |
| Lethargy | 190 | 19.0 |
| Blurring of vision | 160 | 16.0 |
| Drowsiness | 110 | 11.0 |
| No complaints | 540 | 54.0 |

*** Not mutually exclusive**

**Table (3) shows students' past history of anemia.** Regarding to previous hemoglobin test, about half of students (49.0%) didn't check it before. However, one tenth of the students (13.7%) reported that they had normal results compared to 37.3% who mentioned previously had anemia. More than two thirds of those previously anemic students (67%) hadn't received any treatment. While, 44% of students reported that they took iron and vitamins but not in a regular base. Forgetness was the first cause for lack of compliance with medication as mentioned by 76.2% of them, followed by gastrointestinal disturbances (32.0%).

**Table (3): Distribution of students according to their history of anemia**

| History of anemia n=1000 | No | % |
|---|---|---|
| **Previous hemoglobin test:** | | |
| Normal hemoglobin level | 137 | 13.7 |
| Presence of anemia | 373 | 37.3 |
| Not done | 490 | 49.0 |
| **Types of medication taken** | | |
| Not taken | 670 | 67.0 |
| Multivitamins | 330 | 33.0 |
| **Compliance with supplementation (n= 330)** | | |
| Regular | 183 | 55.5 |
| Irregular | 147 | 44.5 |
| **Causes of lack of compliance with supplementation (n= 147)*** | | |
| Forgetness | 112 | 76.2 |
| Gastrointestinal tract disturbances | 47 | 32.0 |
| Economic reasons | 5 | 3.4 |

*** Not mutually exclusive**

**Concerning students' dietary practices, table (4)** reveals that more than half of the students (53%) were taking three meals or more per day. More than half of them were always taking their breakfast. It was observed that more than one third of them (34%) sometimes take snacks compared to 22% who were not taking any. Among students who had reported consumption of fast food, 34% reported always taking and 27% reported that they sometimes do. Moreover, it was found that more than half (59%) of students sometimes take fresh vegetables with their meals compared to 22% who reported that they never take it. Regarding time of taking fruits in relation to meals, it was observed from the same table that more than one fifth of students (21%) eat fruits immediately after a period of intake of meal (not less than one hour).

Regarding consumption of tea more than half of the students (53%) reported that they don't drink tea at all compared to 27% who drink tea from one to three times daily. Among students, who were drinking tea 48.9% reported that they drink it immediately after meals. While the majority of them don't drink coffee and not follow dietary regimen.

**Table (4): Distribution of students according to their dietary practices**

| **Dietary practices (n= 1000)** | **No** | **%** |
|---|---|---|
| **Number of meals/ day** | | |
| One | 60 | 6.0 |
| Two | 410 | 41.0 |
| Three meals or more | 530 | 53.0 |
| **Taking breakfast** | | |
| No | 170 | 17.0 |
| Always | 530 | 53.0 |
| Sometimes | 300 | 30.0 |
| **Snacks intake** | | |
| No | 220 | 22.0 |
| Always | 440 | 44.0 |
| Sometimes | 340 | 34.0 |
| **Fast foods intake** | | |
| No | 390 | 39.0 |
| Always | 340 | 34.0 |
| Sometimes | 270 | 27.0 |
| **Time of fruits intake** | | |
| No intake | 150 | 15.0 |
| Immediately after intake of meal | 210 | 21.0 |
| Later after a period of intake of meal | 650 | 65.0 |
| **Fresh vegetables intake** | | |
| No | 220 | 22.0 |
| Always | 190 | 19.0 |
| Sometimes | 590 | 59.0 |

**Table (4) Cont.: Distribution of students according to their dietary practices**

| Dietary practices (n= 1000) | No | % |
|---|---|---|
| **Frequency of drinking tea / day** | | |
| Not drink | 530 | 53.0 |
| One to three times | 270 | 27.0 |
| Four times or more | 200 | 20.0 |
| **Time of drinking tea (n=470)** | | |
| Immediately after meal | 230 | 48.9 |
| After a period of taking meal | 240 | 51.1 |
| **Frequency of drinking coffee/day** | | |
| Not drink | 820 | 82.0 |
| One to three times | 180 | 18.0 |
| **Time of drinking coffee (n=180)** | | |
| Immediately after meal | 80 | 44.4 |
| After a period of taking meal | 100 | 55.6 |
| **Follow diet regimen at the last six months** | | |
| No | 740 | 74.0 |
| For attain more weight | 30 | 3.0 |
| For decrease body weight | 230 | 23.0 |

**Laboratory investigations:**

**Regarding to hemoglobin test performed routinely at first grade of the school table (5)** shows that two thirds of students (66.0%) had normal results compared to 34.0% who had anemia. More than one third of those anemic students (35.3%) don't be included in the study sample because they out of inclusion criteria due to had normal serum iron or severe anemia, chronic disease, parasites and/or had surgical operation at the last six month. While 64.7% of the studied group had iron deficiency anemia based on serum iron screening results and achieve the inclusion criteria.

**Table (5): Distribution of students according to results of their laboratory investigations**

| Students' health status (n= 1000) | No | % |
|---|---|---|
| **Presence of anemia (n= 1000)** | | |
| Normal hemoglobin level | 660 | 66.0 |
| Presence of anemia | 340 | 34.0 |
| **Associated problems with anemia: (n= 340)** | | |
| No problems | 220 | 64.7 |
| Chronic diseases, surgical operation, parasites, other types of anemia | 120 | 35.3 |
| **Degree of anemia (n= 220)** | | |
| Mild anemia (10 - 11.9 g/dl) | 73 | 33.18 |
| Moderate anemia (7 - 9.9 g/dl) | 147 | 66.82 |
| **Types of supplementation received (n= 340)** | | |
| Iron and vitamins | 270 | 79.4 |
| Not taken | 70 | 20.6 |

** 120 students excluded from the sample (not fulfilling the study criteria)

**Figure (5)** reveals types of food rich in iron consumed by the studied sample (no. 220). Regarding their consumption of hem-iron food sources, more than half of the students (56.82%) never take liver or kidney compared to 31.77% who stated that they monthly take it. Nearly three quarters (72.73%) of them were weekly taking red meat. It was observed that more than one third of them (35.45%) weekly take poultry compared to only 20.91% who were not taking it. Among students who had reported consumption of egg, 21.82% reported daily taking and 9.55% reported that they weekly do compared to 17.73% who stated that they never take it**.** Regarding consumption of nonhem-iron food sources, more than two thirds of students (70%) stated that they never take molasses followed by 5.45% who take it daily. More than one third (36.83%) reported that they weekly intake of green vegetables. In addition, nearly one fifth of the students (18.18%) stated that they take beans weekly. Moreover, it was found that less than half (47.73%) of students never take wheat bread compared to 16.36% who reported that they take it daily.

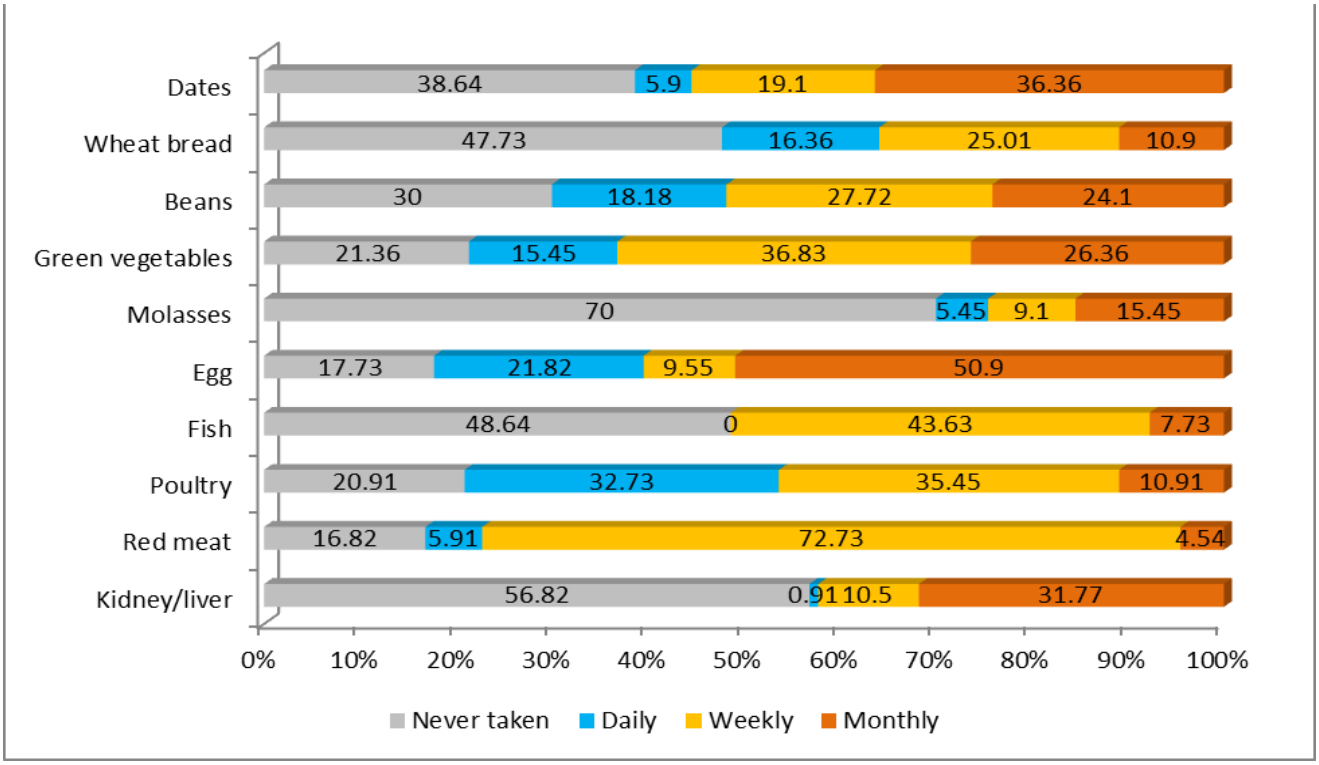


**Figure 5: Distribution of students according to their consumption of food rich in iron**

**Concerning students' dietary practices' scores for intake hem and non-hem iron, figure (6)** presents that the majority of those non-anemic and anemic girls (68.18% and 86.4% respectively) had poor practice scores (<50%). However 27.27% and 13.6% of non-anemic and iron deficiency anemic girls respectively had fair practice level (50 - < 75%)**.**

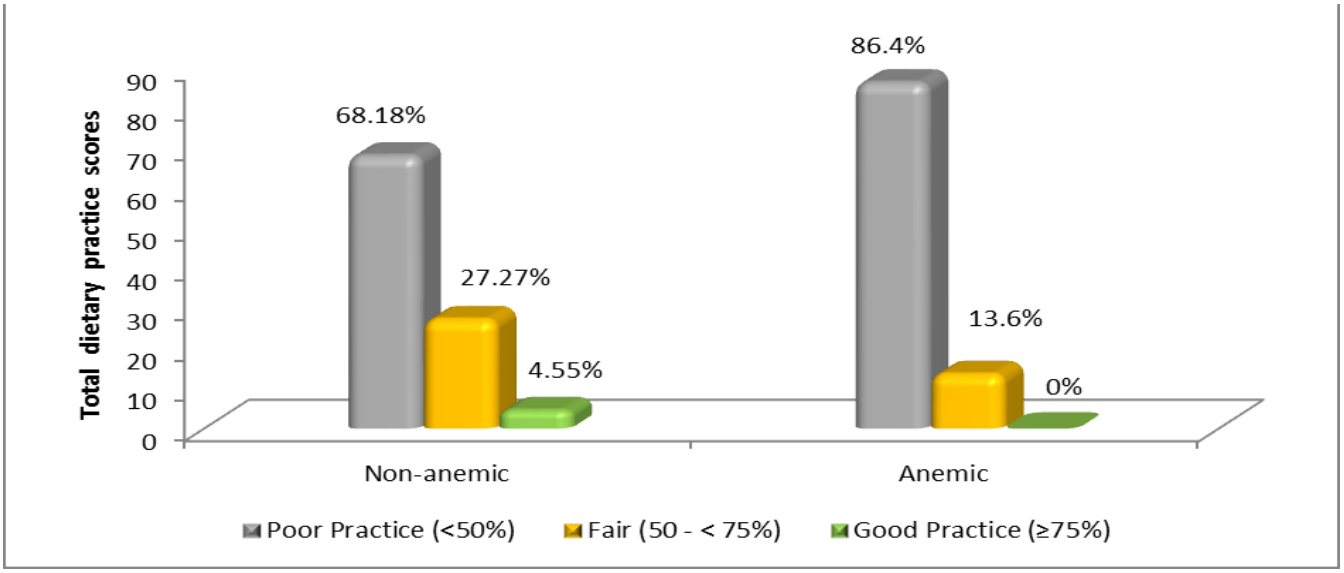


**Figure 6: Distribution of students according to their dietary practices' scores for intake hem and non-hem iron**

**Concerning the impact of the nutritional educational program on the students' laboratory investigation; table 6** shows that none of the students from both control and experimental groups had normal hemoglobin level before program implementation. It was observed that less than one third of the control group (30.0%) and 36.36% of the experimental one had mild anemia at the pre-intervention phase. Then the percent increased to 50.0% for the control group and 31.82% of the experimental group at the post-intervention evaluation. It was also found that more than two thirds of the students of the control group had moderate anemia at pre-intervention phase (70%) compared to (20%) at the post-intervention phase. The mean of the control groups' hemoglobin level was slightly increased from 10.09±0.98 g/dl at the pre-intervention phase to 10.89±1.07g/dl at post -intervention evaluation. The difference between mean of the control groups' hemoglobin level at pre-intervention phase and the post -intervention evaluation phase was statistically significant (Paired-t test=5.783, p <0.001).

Moreover, less than two thirds of the experimental group had moderate anemia at pre intervention phase (63.64%). It was surprising that it decreased to less than one fifth of them (16.36%) at the post-intervention phase. The mean of the experimental groups' hemoglobin concentration was statistically increased from 9.42±1.22 g/dl at the pre-intervention phase to 11.72±0.93 g/dl at post -intervention evaluation. The difference between the experimental group at pre-intervention phase and the post intervention evaluation phase were statistically significant (Paired-t test= 15.725, p <0.001).

Regarding to abnormal decreased in serum iron level; **table 6** also reveals that all students of the control group at pre-intervention phase had abnormal decrease in serum iron level compared to less than half of them at the post-intervention phase (45.45%). The mean of the control groups' serum iron level was significantly increased from 26.38±5.02 µg/dl at pre-intervention phase to be 33.86±8.43µg/dl at the post-intervention phase. The difference between the mean of students' serum iron level at pre-intervention phase and the post-intervention phase was statistically significant (Paired-t test= 7.996, p<0.001). It was observed that less than three quarters of the experimental group had serum iron level denoting absence of iron deficiency anemia at the post-intervention phase

(72.73%) compared to 27.27% had anemia. The mean of the experimental groups' serum iron level was significantly increased from 25.51±5.33µg/dl at the pre-intervention phase to 39.03±8.0µg/dl at the post-intervention phase. The differences between the experimental group at the pre-intervention phase and the post-intervention phase was statistically significant (Paired-t test= 14.751, p< 0.001).

**Table (6): Distribution of the studied groups at pre and post-intervention phases regarding laboratory investigations**

| Items | Control (n=110) | | | | Experimental (n=110) | | | |
|---|---|---|---|---|---|---|---|---|
| | Pre-intervention | | Post-intervention | | Pre-intervention | | Post-intervention | |
| | No | % | No | % | No | % | No | % |
| **Hemoglobin concentration:** | | | | | | | | |
| Normal ( ≥12 g/dl) | 0 | 0.0 | 33 | 30.0 | 0 | 0.0 | 57 | 51.82 |
| Mild anemia (10 - 11.9 g/dl) | 33 | 30.0 | 55 | 50.0 | 40 | 36.36 | 35 | 31.82 |
| Moderate anemia (7 - 9.9 g/dl) | 77 | 70.0 | 22 | 20.0 | 70 | 63.64 | 18 | 16.36 |
| **Mean ±SD** | **10.09 ±0.98** | | **10.89±1.07** | | **9.42±1.22** | | **11.72±0.93** | |
| **Test of sign. b/w control group at pre & post-intervention** | **t (p) 5.783* (<0.001)** | | | | ---------- | | | |
| **Test of sign. b/w exp. group at pre & post-intervention** | ---------- | | | | **t (p) 15.725* (<0.001)** | | | |
| **Serum iron concentration:** | | | | | | | | |
| Normal serum iron 37 – 145 µg/dl | 0 | 0.0 | 60 | 54.55 | 0 | 0.0 | 80 | 72.73 |
| Iron deficiency anemia < 37 µg/dl | 110 | 100.0 | 50 | 45.45 | 110 | 100.0 | 30 | 27.27 |
| **Mean ±SD** | **26.38±5.02** | | **33.86±8.43** | | **25.51±5.33** | | **39.03±8.0** | |
| **Test of sign. b/w control group at pre & post-intervention** | **t (p) 7.996* (<0.001)** | | | | ---------- | | | |
| **Test of sign. b/w exp. group at pre & post-intervention** | ---------- | | | | **t (p) 14.751* (<0.001)** | | | |

*: Statistically significant at $p \leq 0.05$

**Concerning the impact of the nutritional educational program on the total scores of students' knowledge about iron deficiency anemia; table 7** portrays that less than three quarters of the control group (70.91%) and 74.55% of students of the experimental group at pre-intervention phase had poor knowledge scores (< 50%) compared to 63.63% and 19.1% of those students of the control and experimental groups at the immediate evaluation post-intervention phases respectively. However 15.45% and 13.64% of the control group at pre-intervention phase had satisfactory and good level of knowledge (50-< 60%, 60-< 75%) respectively. While 58.18% and 22.72% of the experimental group at the post-intervention phase had satisfactory and good level of knowledge (50-< 60%, 60-< 75%) at the immediate evaluation phase respectively. The total mean scores of knowledge for the experimental group were increased from 41.34±8.05 at the pre intervention phase to be 62.59±11.53 at the post-intervention phase. A highly statistically significant differences were found among the control and experimental groups at the post-intervention evaluation (t test= 18.796, p<0.001).

**Table (7): Distribution of the studied groups at pre and post-intervention phases regarding their total scores of knowledge**

| Items | Control (n=110) | | | | Experimental (n=110) | | | |
|---|---|---|---|---|---|---|---|---|
| | Pre-intervention | | Post-intervention | | Pre-intervention | | Post-intervention | |
| | No | % | No | % | No | % | No | % |
| **Total knowledge scores:** | | | | | | | | |
| Poor knowledge (< 50%) | 78 | 70.91 | 70 | 63.63 | 82 | 74.55 | 21 | 19.1 |
| Satisfactory (50 - < 60%) | 17 | 15.45 | 10 | 9.1 | 23 | 20.9 | 64 | 58.18 |
| Good (≥ 60%) | 15 | 13.64 | 30 | 27.27 | 5 | 4.55 | 25 | 22.72 |
| **Mean ±SD** | **31.54±5.75** | | **37.43±8.01** | | **41.34±8.05** | | **62.59±11.53** | |
| **Test of sign. b/w control & exp. groups at post-intervention** | **t (p) 18.796* (<0.001)** | | | | | | | |

*: Statistically significant at $p \leq 0.05$

## DISCUSSION

Anemia remains one of the most prevalent public health problems in countries of the Eastern Mediterranean Region with major consequences for human health as well as social and economic development. At least half of the anemic cases worldwide are due to nutritional iron deficiency.[18, 19] Globally, it is estimated that two billion people have iron deficiency, most of whom live in developing countries. Egypt is one of the developing countries that are facing the double burden of malnutrition; nutritional anemia is the most common type of it. [20, 21]

Adolescence is a vulnerable period in the human life cycle for the development of nutritional anemia, especially for iron deficiency anemia because of rapid growth rates and inconsistent eating habits.[22, 23] On analyzing the prevalence of anemia, results of the present study revealed that the overall prevalence of anemia among studied adolescent girls was 34.0%, most of them had moderate anemia at the beginning of the study. This result was supported by El-Kaluby (2006) [24]. These results were in contrary to Indian study (2006) [25] which revealed that the prevalence of anemia among adolescent girls was more than 60%. The highest prevalence of anemia exists in India may be due to multi-factorial causes as different nutritional habits. Understanding the causes of anemia and potential mechanisms are crucial to intervene to reduce this burden. [26]

Concerning the socio-demographic characteristics of adolescent students included in this study, it was found that the mean age of the sample was 12.89 ± 0.80 years. Most of them aged 12 up to 14 years and more. This is in line with other study which was conducted in various government schools located in Punjab. [27] The study showed that the prevalence of anemia increases with age and becomes maximum (78.57%) in the age group 15+. It may be attributed to that it is a critical and distinct developmental period of life characterized by significant changes in physical development, emotions, cognition, behavioral and requires increased nutritional demands. This result contradicted with the recent study among adolescent girls by Mahboub (2004) [28], which reported that the most prevalent of anemia among 11 to 12 years. These discrepancies between studies' results may be attributed to differences in the ages of the studied groups and the high prevalence of parasitic infection among young adolescent girls (early adolescence).

In the current study, it was obvious that most of girls were urban residents. This is in line with Mahboub (2004) [28], who reported that anemia was more prevalent among urban than rural

residents. This may be explained by lower consumption of most nutrients by urban communities and increasing in consumption of fat-density foods. On the other hand, people in rural communities still depend on foods from plant source, iron-rich foods and foods that enhance iron absorption because of low cost than the animal sources.

Parent's education seems to be an important factor which affects their adolescents' health. Chaudhary (2008) [29] reported a significant association between the educational status of parents with prevalence of anemia. Findings of the present study confirmed the notion that anemia is most prevalent among girls of highly educated parents. As more than two thirds of mothers in the present study were university educated. This is contradicted to study conducted in Kuwait (2000) [28] among school children, which revealed that iron deficiency anemia was most prevalent when the mother was illiterate and least prevalent in children of university-educated mothers. These differences between the findings may result from the socio-economic differences found between Kuwait and Egypt. In spite of the mother is actually responsible for the nutrition of family and expected to have more knowledge about the nutritional requirements of their children. But the majority of adolescents in this period of life were dependent on outside meals, because they spend long periods of time outside home which makes them depend mainly on fast food. [30] In the present study, less than two thirds of the adolescents prefer eating outside home. These results were confirmed with Fayyad (2004) [31] and Madian (2006) [32].

The present study pointed out that most of anemic students had low family income which may affect their nutritional requirements. This may be due to the association between the availability of high quality food with better socio-economic status.[29] This is inconsistently with Al-Shaikh study (2000) [33] among school students in Kuwait, which postulated that anemia was high among students whose families had enough income; this may be explained as if income increased high consumption of soft drinks, tea and fast foods increased, which may affect the balance between enhancing and inhabiting factors of iron absorption.

With respect to students' medical health status, it was observed that less than half of adolescents reported having one or more health complaints and almost one fourth of them reported headache, followed by low concentration and lethargy. This is expected among adolescents, since it revealed the presence of anemia. These results were in congruent with that of Fichtel [34] who found that the most common complaints of girls in Sweden were headache. Thus, adolescents should develop more awareness regarding their health problems. This will help them to seek medical care and advice for early detection, early treatment and prevention of diseases that affect their functions.

The onset of menstruation is a seminal event of the adolescent female signifying the progress of puberty.[35] It is interesting to note that almost three quarters of adolescent girls in the present study have menstruation. In addition, slightly less than half of them had a period which may last more than 5 days. It is worth mentioning that blood loss with menstruation further contributes to development of anemia. Leenstra et al. (2004) [35] reported that heavy menstruation was the main risk factor for iron deficiency anemia identified in adolescent girls.

Poor eating habits are the main reason for the high rates of anemia among adolescents in Egypt. Their daily iron requirements are not met by the typical diet because of an inadequate intake of iron-rich foods and foods that enhance iron absorption, and/or excess intake of inhibitors of iron absorption, such as tea and whole wheat bread.[36] The results of the present study indicated that, approximately half of adolescents consume three meals per day and nearly half of them skipped one or two meals. They often were skipping breakfast as reported by 17.0% of them. This may be attributed to adolescents' unaccustomed way of taking their breakfast or dinner with their family. In addition, parents' lack of awareness regarding adolescents' nutritional requirements. Thus, nutrition

education and counseling should be provided to them. Emphasis should be placed on choosing nutrient-dense foods rather than nutrient-empty foods. Findings of the present study were similar to Abalkhail (2002) [37].

The present study indicated that, more than half of adolescents sometimes have adequate vegetables consumption. This may be attributed to that vegetable is not expensive compared to meat price. This is in line with Zlotkin Canadian study (2003). [38] As for fruits consumption, the present study revealed that nearly two thirds of girls had fruits after a period of one hour of taking meal and this were in agreement with Mahboub (2004) [26] who reported that 46% of anemic girls never had fruits with meals.

As regard tea which contains tannic acid, a known iron absorption inhibitor, the present study reported that slightly less than half of girls drink tea immediately after meals. A finding of Mahboub (2004) [26] was in line with the present study, which revealed that most of iron deficiency anemic cases drink tea immediately after meals.

Parasitic infection represent a major public health problem that are often contributing factor to iron deficiency anemia.[39] The present study revealed that adolescent's infected with parasites were 6.0%. This is contrary with study conducted among Egyptian adolescents (2000) [40] found much higher percent of parasitic infection among Egyptian adolescents' girls was 57.4%.

Nutrition intervention and education strategies are needed to promote the adoption of healthful eating habits.[41] The present study showed significant improvement of hemoglobin level after three months of intervention. The anemic students' numbers were reduced to become only few numbers after the end of the program. This may be attributed to the change which occurs in student's dietary practices as a result of positive effect of the nutritional educational program on their knowledge, besides the effect of iron supplementation. Most of students willingly took the iron tablets, especially those of the experimental group when they learned more about anemia through the nutritional program. As for changes which occurred in the mean of hemoglobin concentration, the present study revealed that the mean of hemoglobin concentration of the control and experimental groups were different and significantly increased from the beginning of the study to that after the implementation of the program. It is interesting to note that the mean of hemoglobin level of the experimental group were continuously increased during the evaluation phase of the program. Iron therapy in combination with dietary strategies effectively raises the hemoglobin level, replenishes iron stores and prevents reoccurrence of anemia.

Adolescence is a unique intervention point in the life-cycle. It offers a chance to acquire knowledge about optimal nutrition during young adulthood that could prevent or delay adult-onset diet-related illnesses later on.[42] There is no doubt that in the present study nutrition intervention program affect knowledge of adolescent girls participating in the study. Most of students of the experimental group who ended the nutritional program had poor and satisfactory level of knowledge before the beginning of the program. Then, the level of knowledge was significantly increased after the end of the program. It was surprising that control group had achieved improved level of knowledge, it may be attributed to the effect of peer groups who participating in the program. Finally, nutrition intervention program has played an important role for the adolescent's nutrition, gain knowledge, which in turn improves their practices. It must be mentioned that knowing how and why to eat healthfully is important, but knowledge alone does not enable adolescents to adopt healthful eating practices.

School health nurse are in ideal positions to assist the parent in understanding and meeting the present and future health needs of their adolescent's girls. Provide nutritional education and

dietary recommendations that appropriately take into account the adolescent's health status and the food.

**CONCLUSION & RECOMMENDATIONS:** Success in combating anemia depends on understanding its associated factors. This panorama of anemia in Egypt contributes towards planning effective measures for its control, including maintenance of government programs for fortification of wheat and for iron supplementation, as well as actions that aim to improve the population's socioeconomic, housing, sanitation and health conditions. A various consumption patterns by the adolescent girls of certain iron bioavailability modifiers, such as tea, coffee', green vegetables, red meat and fish may provide an indication about the possible underlying causes for their different manifestation of this medical condition. Thus, nutrition education should be part of a comprehensive health education curriculum that focuses on understanding the relationship between personal behavior and health.

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