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Risk Factors and Nutritional Assessment among Early Adolescent Girls with Iron Deficiency Anemia in Damanhour City

Asmaa Hamed Mohamed [1], Mahassen Ahmed Abd El-Wahed [2], Dalia Ibrahim Tayel [3], Abeer Abd El-Aziz Mohamed Madian [4*] & Neama Yousef Mohammed [5].
* E-mail of the corresponding author: abmadian@hotmail.com

[1.] Demonstrator at Community Health Nursing, Faculty of Nursing, Damanhour University, Egypt.
[2.] Professor of Community Health Nursing, Faculty of Nursing, Alexandria University, Egypt.
[3.] Assistant Professor of Nutrition, Department of Nutrition, High Institute of Public Health, Alexandria University, Egypt.
[4.] Assistant Professor of Community Health Nursing, Faculty of Nursing, Damanhour University, Egypt.
[5.] Lecturer of Community Health Nursing, Faculty of Nursing, Alexandria University, Egypt.

Abstract

Background: The physical and physiological changes that occur in adolescents place a great demand on their nutrition and put them at risk for Iron Deficiency Anemia (IDA). Anemia in the adolescence causes reduced physical and mental capacity and diminished concentration in work and educational performance, and also poses a major threat to future safe motherhood in girls. **Aims:** this study aimed to identify the risk factors for IDA among school girls and to assess nutritional status of girl students with IDA in Damanhour city. **Design:** A case control study design was adopted to carry out this study. **Setting:** the study was conducted at 1 urban and 8 rural preparatory school girls. **Subjects:** The total number of the randomly selected girls was 240 preparatory school girls (120 girl student as cases who have anemia and the same number of girls recruited in control group). **Tools**: data was collected using three tools; **tool (I)** entitled adolescent girl's students profile structured interview questionnaire, **tool (II)** entitled nutritional practices of adolescent girl student's, and **tool (III)** namely anthropometric measurements tool. **Results:** according to multivariate analysis logistic regression girls' students with low parent education, rural residence, and those with intestinal parasite infection were identified as predictors of IDA. Moreover, poor eating habits and menstrual history also played a significant role in the development of anemia. The relationship between academic performance and anemia was very significant in this study. **Recommendations:** Intensify supplementation and or food fortification programs to include iron for school age group. Conduct school's breakfast program, carry out laboratory investigations for anemia, develop school nutrition education programs in curriculum and conduct national nutritional situation analysis survey.

Key words: Early adolescent, Nutritional assessment, Risk factors, Iron Deficiency Anemia & Damanhour city.

1. Introduction

Adolescence is a vulnerable period in the human life cycle for the development of nutritional deficiencies particularly anemia [(1)]. Anemia is a global public health problem affecting both developing and developed countries and has major consequences for human health as well as social and economic development. It affects 24.8% of the world population [(2)]. Egyptian girls aged 5-19 years are somewhat more likely than boys in the same age group to be anemic, where 21 percent of girls compared to 18 percent of boys diagnosed as anemic case [(3)].

Additionally, adolescent girls are facing a series of nutritional challenges which are not only affecting their growth and development but also their livelihood as adults. Adolescents are at risk of iron deficiency anemia due to increased iron requirements, poor dietary intake, and parasitic infections in addition to irregular feeding habits caused by concern about body image compounded by menstrual blood loss among girls particularly those between the age of 12 and 15 years because of the peak in the iron requirement in this age group [(4)]. Anemia is a condition characterized by reduction in the number of red blood cells and/or hemoglobin (Hb) concentration and its causes, types and consequences are varied among different age and countries [(5)]. Interventions to reduce the burden of iron deficiency anemia should address cost-effective prevention and control strategies [(6)].

Knowledge of the degree and causes of anemia in adolescence is important, as this is a window of opportunity for school-based interventions to improve adolescent health as a whole. There is a scarcity of data on anemia in adolescents living in developing countries in the complex ecologic context of poverty, parasitism, and

malnutrition [7]. So community health nurse especially school health nurse has a significant role in the prevention and management of iron deficiency anemia in adolescent girls, the primary prevention of iron deficiency for adolescent girls can be achieved by equip them with enough information about healthy diets, including sources of iron, encourage the students to adopt healthful life style pattern. [8]. Screening for, diagnosing, and treating iron-deficiency anemia are the secondary prevention approaches through detecting the anemic cases during routine Hg screening as one of the school health appraisal plan that conducted yearly on a regular base [5]. It was noticed that, the initiatives to prevent anemia commonly target infants, young children, and pregnant and lactating women, and not necessarily adolescents, the needs of adolescents may remain unmet and the consequences of anemia in adolescents continue [9, 10].

Therefore, this study was **aimed to** identify the risk factors for Iron Deficiency Anemia among school girls and assess nutritional status of girl students with Iron Deficiency Anemia (IDA) in Damanhur city.

Research questions

1- What are the risk factors for Iron Deficiency Anemia among school girls?
2- What is the dietary pattern among girl students with Iron Deficiency Anemia?

2. Material And Methods

2.1 Material

2.1.1Study design:

A Case Control study design was assumed to carry out this study.

2.1.2 Study setting:

The study was conducted in Damanhour city as it is the capital of El- Beheira governorate; it includes the largest number of preparatory school girls. In addition, it also includes both urban and rural educational directorates. One to six from the total fifty six preparatory schools at Damanhur City were chosen randomly to be the settings for the study (One urban out of eight schools namely Shobra girls prep school and eight schools from rural educational directorates out of fifty governmental preparatory schools namely Zokl, Eflakka, Kom-Elnawam, Zawyet-Ghazal girls school, Zarkon, Omar Noaiem, Seif El-din El- katteb, Omar Ebn El-khatab).

2.1.3 Study subjects:

Girl students who are enrolled in the first grade of the selected schools were selected randomly to be included in the study. The total number of girl students at the selected schools was 1340 student. Twenty five percent out of the diagnosed girls students with Iron Deficiency Anemia (Hg level less than 11.5 g/dl) were selected randomly as **cases** for the study (based on school health records results of Hg estimation that were done during routine screening test which was carried out by school health insurance or by family health centers). On the other hand, the selection of **control group** was done from those who have Hg level ≥ 11.5g/dl. The total number of the selected girls was 240 preparatory school girl (120 girl student as cases (who have anemia) and the same number of girls recruited in control group) they were randomly selected.

2.1.4 Inclusion criteria

- Early adolescent girl students (student at the first grade of preparatory school or aged 10-14 years).
- Girl students with hemoglobin concentration < 11.5 g/dl were considered as cases; Controls were selected from those who had a hemoglobin concentration ≥ 11.5 g/dl [11].
- Free from chronic diseases such as diabetes, renal diseases etc.
- No recent surgery carried out for the last 6 months at least.
- Not receiving long acting medical treatment such as insulin, anti-psychotic drugs.

2.1.5 Study tools:

Data was collected using the following study tools

Tool (I): Adolescent girl's students profile structured interview questionnaire:

It was used to collect data about the following information included the following items:

Part I: Socio-demographic data: It included the age, place of residence, student's birth order, parent's marital status, parent's educational level, parent's occupation, and scholastic achievement from students' school records.

Part II: Health status of Girl's students: It included the following:

- Menstrual history of the students such as presence of menstruation, age of menarche, regularity of menstruation, duration of the menstruation per days, associated symptoms with menstruation and the frequency of changing pads used per day.
- History of parasitic diseases, type of parasite present, and type of medication received for parasite and the effect of presence of parasites on desire to eat from the student point of view.

Tool (II): Nutritional practices of adolescent girl student's:

The tool was used to collect the following data:

Part I: Students dietary practices: as number of meals daily, taking breakfast, intake of fast food, snacks intake, tea consumption and number of times consumed per day, fresh vegetables consumption and time of fruit intake.

Part II: Food frequency Questionnaire (FFQ) [12]

Data regarding food intake was collected from every student at the time of interview.

Food frequency questionnaire that were developed by Harvard university [12] was used to estimate the dietary intake and the pattern of consumption of different foods most commonly consumed by adolescent girl's students with special emphasis on special foods rich in iron and vitamin C (e.g. grains, vegetables, fruits, and discretionary calories) based on the availability of the food items commonly consumed in the study area. Iron intake is very important to be assessed for identifying iron deficiency anemia as iron is responsible for red blood cells formation and rising of hemoglobin concentration and vitamin C is considered the most enhancers of iron absorption in the intestine [13].

The quantities of foods and drinks consumed were estimated using common household utensils as cups and plates. The consumption of food was considered high if the food item was consumed ≥ 3 days per week and if it was consumed < 3 days per week, the consumption of this food was considered low. The nutritive value of the daily diet was computed using the Egyptian Food Composition Tables [14]. Nutrient adequacy percent was calculated and compared with dietary reference intake (DRI) [15] of young females that was classified into adequate and inadequate according to the following equation: Percentage adequacy of nutrient = (nutrient intake for adolescent female students / DRI of nutrient) × 100.

Tool (III): Anthropometric measurements:

Anthropometric measurements were taken using standardized techniques and calibrated equipment, height was measured using a non- stretching measuring tape, in centimeters to the nearest 0.1 cm, weight was measured using a standardized weighing scale, in kilograms to the nearest 0.5 kg, and Body Mass Index (Kg/m^2) was calculated using standardized weighting and height chart.

BMI percentiles for age and sex:

The recent WHO (2007) child growth standards [16] were used instead of WHO International classification of underweight, overweight and obesity according to BMI [17] as it more specific for the definition of overweight and obesity. Experts classify BMI-for-age at or above the 95^{th} percentile as obese and between the 85^{th} and less than 95^{th} percentile as overweight, the values between 5^{th} and less than 85^{th} percentiles considered as normal/ average weight and finally, the values less than 5^{th} percentile were used to determine underweight.

2.2 Methods

2.2.1 Administrative process

- Official letters from Faculty of Nursing, University of Alexandria were directed to the directorate of selected governmental preparatory schools in Damanhour city to inform them about the study aims and to seek their permission to conduct the study in these schools.
- Meetings were held with the directors of the selected schools to explain the aim of the study, set the date and time of data collection, assure them that collected data were used only for the study purpose, and to gain their approval and cooperation during data collection.

2.2.2 Development of study tools

Tool (I) was developed by the researcher after reviewing recent literature in order to collect the required data from the studied students.

- Tool (I) was revised by Jury composed of (five) experts in the field of Community Health Nursing for content validity and their recommended modifications were done accordingly.
- Tool (II) was translated in to Arabic language, revised by Jury expertise in order to ascertain that language is clear.
- Content validity of the study tools was tested by Jury consists of a group of 5 experts in the field of community health, their opinions and suggestions were taken into consideration.

2.2.3 Pilot study

The Pilot study was carried out on a sample of 24 students; they were selected from El-Gomhouria preparatory school and Omar Ebn El-Khatab preparatory school, these schools not included in study sample. The data obtained from the pilot study were analyzed. Based on the findings of the pilot study, some questions were clarified and few others added.

2.2.4 Data collection

- The data was collected individually from the students in selected schools at suitable time using tool I, II, III after a brief explanation of the purpose and the nature of the research. The students were asked for an oral and written consent for participation in the study.
- At the beginning of the interview with each student, the researcher was introduced herself, clarify the purpose of interview, and ensure the anonymity and confidentiality of the collected data.
- Weight was measured by a standardized weighing scale, in kilograms to the nearest 0.5 kg and height was measured by a non- stretching measuring tape, in centimeters to the nearest 0.1 cm, to calculate (BMI) based on WHO 2007 growth reference for school-aged children and adolescents [(16)].
- The structured Interview time took approximately from 30 to 45 minutes for each student.
- Data about the Hemoglobin results of students were obtained from their school health records.
- Data about students' scholastic achievements were obtained from their school records.
- Data was collected by the researcher over a period of 3 months (from March to May 2017).

2.2.5 Statistical analysis:

- After data collection, the collected data was coded and transferred into especially designed format to be suitable for computer feeding.
- Data was entered into and analyzed using the statistical package of social science (**SPSS**) version 20.
- After data entry, data was checked and revised through frequency analysis, cross tabulation, and manual revision to discover any error during data entry.
- Variables were analyzed using the descriptive statistics which included: percentages, frequencies, range (minimum and maximum), arithmetic mean, and standard deviation (**SD**).
- The level of significance selected for this study was $\mathbf{p \leq 0.05}$.
- Chi square test ( ) was used for testing the relationship between categorical variables.
- Monte Carlo P-value ($^{\mathbf{MC}}\mathbf{P}$) to test significance was used whenever more than 20% of cells had expected count less than five (invalid Chi square test).
- Fisher Exact test ($^{\mathbf{FE}}\mathbf{p}$) was used in place of chi square test in 2 by 2 tables, especially in cases of small samples, it used to obtain the probability of the combination of the frequencies that are actually obtained.
- Linear Regression Model was used to indicate the predictors of IDA, the model was statistically significant **($p \leq 0.05$)**, and also factor was considered a risk factor for IDA if **OR> 1**, where as if **OR < 1** these factors play as a protective factors for IDA.
- Graphs were done for data visualization by using Microsoft Excel program.

2.2.6 Ethical considerations:

- Permission was obtained to collect the data from the previous schools.
- Written informed consent obtained from the director of each selected school included in the study after explanation of the aim of the study and assure them that collected data will be used only for the study purpose.
- Each director of selected schools informed about the date and the time of data collection.
- Confidentiality and anonymity of individual response was guaranteed through using a code numbers instead of names.

3. Results

Table (1): Distribution of Studied Adolescent Girl's Students (Anemic and Non-Anemic) Consistent with Their Socio Demographic Characteristics

Socio-demographic characteristics	Anemic students (n=120)		Non-anemic students (n=120)		Test of significance (P value)
	No.	%	No.	%	
Age (years)					
11-	2	1.7	3	2.5	$^{MC}p=0.027^{*}$
12-	65	54.2	45	37.5	
13years and more	53	44.2	72	60.0	
Min. – Max. Mean ± SD.	11.50 –14.0 12.48 ± 0.49		11.00–13.50 12.73 ± 0.48		$p<0.001^{*}$
Place of residence Urban Rural	 3 117	 2.5 97.5	 19 101	 15.8 84.2	= 12.811 $p<0.001^{*}$

Socio-demographic characteristics	Anemic students (n=120)		Non-anemic students (n=120)		Test of significance (P value)
	No.	%	No.	%	
Student's birth order					
First	38	31.7	40	33.3	= 0.293 P= 0.864
Second	38	31.7	40	33.3	
Third or more	44	36.6	40	33.3	
Parent's marital status					
Live together	108	90	113	94.2	^{MC}p= 0.182
Divorced	6	5.0	1	0.8	
One of them is widowed	6	5.0	6	5	
Father's education					
Low education	24	20	17	14.2	= 12.175
Middle education	67	55.8	54	45.0	P= 0.032*
High education	23	19.2	43	35.8	
Father's occupation					
Working	68	56.7	111	92.5	^{MC}p= 0.014*
Not working	52	43.3	9	7.5	
Mother's education					
Low education	25	20.8	11	9.2	^{MC}p= 0.033*
Middle education	65	54.2	59	49.2	
High education	25	20.8	45	20.8	
Mother's occupation					
Working	92	76.7	74	61.7	^{MC}p= 0.030*
Not working	28	23.3	46	38.3	

* Statistically significant at $p \leq 0.05$

Table (1): publicized the distribution of studied adolescent girl's students (anemic and non-anemic) consistent with their socio demographic characteristics. Concerning age, it ranged from 11.5-14 years with a mean age of (12.48 ± 0.49) for anemic students. Where, non-anemic students were ranged from 11-13.5 years with a mean of (12.73 ± 0.48). With a statistically significant difference between both groups (^{MC}p= 0.027).

On the subject of place of residence, the majority of anemic and non- anemic students (97.5%, 84.2%) respectively were living in rural areas with a statistically significant difference between both groups (= 12.811, p<0.001). As to students' birth order, table (1) displays that around one third of both groups were ranked as the first or second child (31.7%, 33.3% respectively) while more than one third (36.6%) of anemic group and a similar percent (33.3%) for non- anemic group were ranked as the third or more child in their families. No statistically significant difference between both groups (= 0.293, P=0.864).

The table also represented that, the majority of both groups' anemic and non- anemic students (90.0%, 94.2% respectively) were living with their parents. While, 5.0% of anemic students, their parents were either widowed or divorced/separated compared to (0.8% & 5% respectively) of non- anemic students. No statistically significant difference between both groups (^{MC}p= 0.182). As regard to mothers' education, the highest percent was observed as; mothers obtained middle degree of education (secondary education) among anemic and non-anemic students (54.2% and 49.2%, respectively). A statistically significant difference between both groups (^{MC}p= 0.033).

Pertaining to mothers' occupation, the table depicts that more than three quarters (76.7%) of anemic groups' mothers were working compared to around two thirds (61.7%) of non-anemic groups' mothers. Also, around one fifth (19.2%) of anemic groups' mothers were not working compared to more than one third (34.2%) of non-anemic groups' mothers, with a statistically significant difference between both groups (^{MC}p= 0.030).

In relation to fathers' occupation, the table confirms that more than half (56.7%) of anemic students' fathers were work increased to (92.5%) of non- anemic students' fathers were work. Moreover, more than one third (38.3%) of anemic students' fathers were not working. However, a minority of non- anemic students' fathers were not working/retired (2.5% and 5% respectively). With a statistically significant difference between both groups (^{MC}p= 0.014).

Table (2): Distribution of Studied Adolescent Girl's Students (Anemic and Non- Anemic) Consistent with Their Menstrual History

Menstrual history	Anemic students		Non-anemic students		P
	No.	%	No.	%	
Presence of menstruation	**(n = 120)**		**(n = 120)**		= 4.277 P=0.039*
Absent	55	45.8	71	59.2	
Present	65	54.2	49	40.8	
Age of menarche (years)	**(n = 65)**		**(n = 49)**		t= 0.623 P=0.534
Less than 12 y	15	23.1	12	24.5	
12 or more	50	76.1	37	75.5	
Min. – Max. Mean ± SD.	11.0 – 13.0 12.14±0.42		11.0 – 13.0 12.19 ±0.50		
Regularity of menstruation	**(n = 65)**		**(n = 49)**		^{MC}p=0.280
Irregular	19	29.2	12	24.5	
Regular	46	70.8	37	75.5	
Duration of menstruation (days)	**(n = 65)**		**(n = 49)**		= 3.598 P=0.308
3 days	15	23.1	18	36.7	
4 days	17	26.2	11	22.4	
5 days	22	33.8	16	32.7	
6 days or more	11	16.9	4	8.2	
Min. – Max. Mean ± SD.	3.0 – 7.0 4.45 ± 1.03		3.0 – 8.0 4.12 ± 1.01		t= 1.672 P =0.097
Associated symptoms with menstruation: Dysmenorrheal pain	**(n = 65)**		**(n = 49)**		^{MC}p= 0.086
Absent	3	4.6	4	8.2	
Present	62	95.4	45	91.8	
Frequency of changing pads/ day	**(n = 65)**		**(n = 49)**		^{MC}p= 0.146
1-2 pads/ day	48	73.8	33	67.4	
3 pads/ day	17	26.2	13	26.5	
4 or more pads/ day	0	0.0	3	6.1	
Mean ± SD.	2.12 ± 0.63		2.33 ± 0.69		t= 1.646 P=0.103

* Statistically significant at $p \leq 0.05$

Table (2): Spectacles the studied adolescent girl's students (anemic and non- anemic) consistent with their menstrual history. As regard presence of menstruation, more than half (54.2%) of anemic student had been menstruated compared to nearly two third (59.2%) of non- anemic students hadn't been menstruated yet, with a statistically significant difference between both groups (=4.277, P= 0.039).

Concerning the age of menarche, it ranged from 11-13 years among both groups with a mean age of 12.14±0.42 among anemic students where among non-anemic students were 12.19± 0.50. More than three quarters (76.1%, 75.5% respectively) of both groups were from 12 years or more, with no statistically significant difference between both groups (t=0.623, P= 0.534).

Furthermore, around three quarters of both groups (70.8%, 75.5% respectively) had experience with regular menstruation, with range of (3.0 – 7.0), (3.0 – 8.0 days respectively) between both groups with a mean of (4.45 ± 1.03) among anemic students and (4.12 ± 1.01) among non- anemic students.

In relation to symptoms associated with menstruation, the majority of anemic and non- anemic students (95.4%, 91.8% respectively) were had experience with dysmenorrheal pain. With no statistically significant difference between both groups (^{MC}p= 0.086).

Table (3): Distribution of Studied Adolescent Girl's Students (Anemic and Non- Anemic) Consistent with Their History of Parasitic Infestation

Health History of Parasitic Infestation	Anemic students		Non- anemic students		p
	No.	%	No.	%	
Presence of parasites	**(n = 120)**		**(n = 120)**		=54.456 P<0.001*
Absent	36	30.0	93	77.5	
Present	84	70.0	27	22.5	
Types of parasite ≠	**(n = 84)**		**(n = 27)**		
Ameba	50	59.5	13	48.1	^{MC}p= 0.041*
Pin worm	4	4.8	4	14.8	
Ascaris	9	10.7	0	0.0	
Bilharzias	4	4.8	0	0.0	
Not know	17	20.2	10	37.1	
Medication received for treatment of parasites	**(n = 84)**		**(n = 27)**		=1.312 ^{FE}p= 0.355
No	11	13.1	6	22.2	
Yes	**73**	**86.9**	**21**	**77.8**	
Effect of the presence of parasites on the desire to eat from student point of view	**(n = 84)**		**(n = 27)**		=8.757 P=0.013*
No effect	44	52.4	11	40.7	
Food intake more than normal	17	20.2	13	48.2	
Food intake less than normal	23	27.4	3	11.1	

*Statistically significant at $p \leq 0.05$ ≠ more than one answer

Table (3): discovers the distribution of studied adolescent girl's students (anemic and non- anemic) consistent with their history of parasitic infestation. More than two third (70.0%) of anemic students and only less than one quarter (22.5%) of non- anemic students reported history of parasitic infestation. Statistically significant difference was observed between both groups (= 54.456, p <0.001).

For those students who had parasitic infestation, table shows that, more than half (59.5%) of anemic students and less than half (48.1%) of non- anemic students reported for the presence of Ameba parasite, while the minor percent (4.8%) of anemic students reported for Bilharzias parasite with a statistically significant difference between both groups (^{MC}p= 0.041).

From the student point of view, around half (52.4%) of anemic students and less than half (40.7%) of non- anemic students reported that there is no effect of parasite on the desire to eat. Moreover, nearly one quarter (20.2%) of anemic students compared to less than half (48.2%) of non- anemic students reported that presence of parasite making them consuming food more than normal, with a statistically significant difference between both groups (= 8.757, p=0.013).

Table (4): Distribution of Studied Adolescent Girl's Students (Anemic and Non- Anemic) According to Their Dietary Practices

Food consumption practices	Anemic students		Non- anemic students		P
	No.	%	No.	%	
Number of meals per /day	**(n = 120)**		**(n = 120)**		
One meal	24	20.0	0	0.0	= 59.678
Two meals	82	68.3	57	47.5	P<0.001*
Three meals or more	14	11.7	63	52.5	
Mean ± SD.	1.92 ± 0.56		2.53 ± 0.50		t= 8.875 P<0.001*
Taking breakfast	**(n = 120)**		**(n = 120)**		
Daily	10	8.3	61	50.8	= 95.471
Sometimes	40	33.3	54	45.1	<0.001*
Seldom	35	29.2	4	3.3	
Never	35	29.2	1	0.8	
Intake of fast food	**(n = 120)**		**(n = 120)**		
No	8	6.7	11	9.1	= 5.099
Yes sometimes	53	44.2	65	54.2	P=0.165
Yes always	59	49.1	44	36.7	
Consumed snacks intake	**(n = 120)**		**(n = 120)**		
No	18	15.0	4	3.3	= 9.808
Yes	102	85.0	116	96.7	P=0.002*
Type of snacks ≠	**(n = 102)**		**(n = 116)**		
Juice	13	12.7	54	46.6	<0.001*
Fruits and vegetables	11	10.8	69	59.5	<0.001*
Sweets	27	26.5	44	37.9	0.072
Sandwiches	63	61.8	96	82.8	<0.001*
Consumption of tea	**(n = 120)**		**(n = 120)**		
Daily	57	47.5	23	19.2	= 25.326
Sometimes	30	25.0	32	26.7	P<0.001*
Seldom	13	10.8	30	25.0	
Never	20	16.7	35	29.1	
Frequency of consumption of tea/ day	**(n = 100)**		**(n = 85)**		= 16.031
Once	49	49.0	66	77.6	P<0.001*
More than one time	51	51.0	19	22.4	
Timing of consumption of tea	**(n = 100)**		**(n = 85)**		
Before meal	5	5.0	6	7.1	= 34.356
After meal directly	61	61.0	21	24.6	P<0.001*
After meal >2 hours	21	21.0	52	61.2	
During the meal	13	13.0	6	7.1	
Fresh vegetables consumption	**(n = 120)**		**(n = 120)**		
Always	28	23.3	50	41.7	0.001*
Sometimes	60	50	55	45.8	
No consumption	32	26.7	15	12.5	
Time of fruits intake	**(n = 120)**		**(n = 120)**		
Immediate after intake of meal	70	58.3	20	16.7	0.001*
Late after a period of intake the meal	20	16.7	88	73.3	
No intake	30	25	12	10	

* Statistically significant at $p \leq 0.05$ ≠ more than one answer

Table (4): Regarding the students' dietary pattern, more than half (52.5%) of non- anemic students and only just one tenth (11.7%) of anemic students reported that they had three meals/day, with a statistically significant difference between both groups (=59.678, P<0.001). Furthermore, it was found that just half (50.8%) of non- anemic students had breakfast daily compared to less than one tenth (8.3%) of anemic students. However, around one third (29.2%) of anemic students and only (0.8%) of non- anemic students didn't take breakfast. A statistically significant difference was found between both groups with respect to intake of breakfast (=95.471, P<0.001). Regarding intake of fast food, it was found that around half of anemic and non- anemic students (44.2%, 54.2% respectively) reported sometimes intake of fast food while just half (49.1%) of anemic group and nearly two fifth (36.7%) of non- anemic group were always take fast food, with no statistically significant difference between both groups (P=0.165).

The table also depicts that majority of anemic students (85.0%) and non- anemic students (96.7%) always had snacks, while a minority of both anemic and non- anemic groups (15.0% & 3.3% respectively) had no snacks, with a statistically significant difference between both groups (=9.808, P<0.002). With respect to type of snacks, intake of sandwiches and juice were reported by anemic students (82.8% & 46.6% respectively) and non- anemic students (61.8% & 12.7% respectively). A statistically significant difference was observed between both groups with respect to intake of sandwiches, juice, fruits and vegetables as snacks (P<0.001).

It is also worth mentioning that just half (47.5%) of anemic students consumed tea, while less than fifth (19.2%) of non- anemic students liked tea. Additionally, around half (51.0%) of anemic students and only (22.4%) of non- anemic students consumed tea more than one time per day, with a statistically significant difference between both groups (P<0.001). Concerning the time of tea consumption, more than two third (61.0%) of anemic students had consumed tea after eating food directly compared to only just one quarter (24.6%) of non- anemic students, with a statistically significant difference between both groups (P<0.001).

The table also discloses that more than one quarter (26.7%) of anemic students not consumed fresh vegetables, while more than two fifth (41.7%) of non- anemic students always consumed fresh vegetables. Regarding fruit consuming time, (58.3%) of anemic students consumed it immediately after a meal compared to around three quarters (73.3%) of non- anemic students consumed it later after a meal, with a statistically significant difference between both groups (P=0.001).

Table (5): Distribution of Studied Adolescent Girl's Students (Anemic and Non- Anemic) According to Their Adequacy of Iron and Vitamin C Intake

Adequacy of Iron and Vitamin C intake	Anemic students (n = 120)		Non- anemic students (n = 120)		Chi-square test (p value)
	No.	%	No.	%	
Total iron					<0.001*
Inadequate	23	19.2	4	3.3	
Adequate	97	80.8	116	96.7	
Min. – Max.	8.75 – 786.6		79.88 – 999.6		
Mean ± SD.	207.1 ± 139.6		376.4 ± 187.8		
Vitamin C					
Inadequate	20	16.7	3	2.5	<0.001*
Adequate	100	83.3	117	97.5	
Min. – Max.	14.51 – 1369.0		73.89 – 2215.9		
Mean ± SD.	304.7 ± 265.5		507.2 ± 319.6		

* Statistically significant at p ≤ 0.05

Table (5): demonstrates that the percent adequacy of iron intake was (80.8%) by anemic students and increased to (96.7%) by non- anemic students, with a mean by (207.1 ± 139.6, 376.4 ± 187.8 respectively) to both groups, with an observed significant difference between both groups (P<0.001). Concerning percent adequacy of vitamin C, the vast majority (97.5%) of non- anemic students and just (83.3%) of anemic students had adequately percent of vitamin C. In contrast, only (2.5%) of non- anemic group had inadequate percent of vitamin C intake, with a highly statistically significant difference between both groups respectively (P<0.001).

Table (6) Mean of Daily Consumption and Adequacy of Food Groups among Anemic and Non-Anemic Adolescents

Item	Anemic students (n=120) Mean ± SD	Non-anemic students (n=120) Mean ± SD
Cereals and pulses (g)	10.68 ± 1.32	11.58 ± 1.45
t (P value)	5.075 (<0.001*)	
Red meat, fish, chicken, eggs(g)	12.49 ± 1.60	14.17 ± 2.08
t (P value)	7.004(<0.001*)	
Dairy products (g)	11.65 ± 1.63	13.32 ± 2.08
t (P value)	6.900 (<0.001*)	
Legumes (g)	4.93 ± 1.06	5.61 ± 1.12
t (P value)	4.786 (<0.001**)	
Vegetables (g)	13.66 ± 2.04	15.84 ± 2.42
t (P value)	7.554 (<0.001*)	
Fruits (g)	15.40 ± 2.52	17.49 ± 2.69
t (P value)	6.224 (<0.001*)	
Nuts and sweets (g)	12.25 ± 1.67	13.97 ± 2.25
t (P value)	6.711 (<0.001*)	

* Statistically significant at $p \leq 0.05$

Table (6): displays the mean of daily consumption and adequacy of food groups among anemic and non-anemic adolescents. Concerning **Cereals and pulses**, it clearly appears from the table that the intake different types of cereals and pulses consumed by non- anemic students were greater than that of anemic students with a mean (10.68 ± 1.32) for anemic students and (11.58 ± 1.45) for non- anemic students. Regarding Frequency of weekly consumption of **red meat, fish, chicken and eggs,** the total score was significantly different between both groups with a mean (12.49 ± 1.60, 14.17 ± 2.08) between both groups respectively.

In relation to **dairy products**, the weekly consumption among non- anemic students greater than anemic students, with a statistically significant difference between both groups (t-test= 6.900, P value<0.001). The table (6) also appears that the mean of weekly consumption of **legumes** among anemic students was (4.93 ± 1.06) compared to (5.61 ± 1.12) for non- anemic students, with a statistically significant difference between both groups (t-test= 4.786, P value<0.001). With respect to weekly consumption of **vegetables**, the anemic and non-anemic groups had consumed vegetable with a mean (13.66 ± 2.04, 15.84 ± 2.42 respectively) of both groups. Moreover, weekly consumption of **fruits** by both groups had a mean of (15.40 ± 2.52, 17.49 ± 2.69 respectively).With a statistically significant difference between both groups (t-test= 6.224, P value<0.001). Findings also showed that, the weekly consumption of **nuts and sweets** were more significant in non- anemic students than anemic group with a statistically significant difference between both groups (t-test=6.711, P value <0.001).

Table (7): Multivariate Analysis Logistic Regression for Factor Affecting Iron Deficiency Anemia among Adolescent Girl's Students

Risk factors for iron deficiency anemia	P	OR	95% CI	
			LL	UL
1. Father's occupation	<0.001*	225.647	34.750	1465.232
2. Underachiever students	<0.001*	9.588	2.874	31.981
3. Father's education	<0.001*	0.234	0.131	0.419
4. Absence of snacks	<0.001*	1.530	1.310	1.787
5. Adequacy of vitamin C	<0.001*	0.997	0.996	0.999
6. Mother's education	0.005*	0.761	0.628	0.923
7. Not eating breakfast	0.011*	4.277	1.393	13.138
8. Place of residence	0.017*	7.469	1.437	38.832
9. Eating less than 2 meals/day	0.019*	2.290	1.146	4.576
10. Time of tea drinking	0.020*	0.625	0.421	0.930
11. Drinking tea immediately after a meal	0.021*	0.428	0.208	0.877
12. Presence of parasites	0.022*	35.407	1.690	741.895
13. Student’s age	0.028*	0.424	0.198	0.911
14. Mother 's occupation	0.039*	0.610	1.112	0.976
15. Early menstruation	0.838	1.170	0.262	5.229

OR: Odds ratio OR>1: Risk factors for IDA OR<1: Protective factors for IDA
CI: Confidence interval LL: Lower limit UL: Upper Limit
*: Statistically significant at $p \leq 0.05$

Table (7): reveals multivariate analysis logistic regression for factors affecting iron deficiency anemia in adolescent girl's students: it was done to identify the independent predictors of IDA in early adolescent girls. All the variables were analyzed in bi-variable logistic regression analysis and then those with p – value ≤ 0.05 and those believed to have biological relation with iron deficiency anemia were candidate for multivariable logistic regression analysis. Accordingly, girls’ students with low parent educational status, rural residence, and intestinal parasite infection were identified as predictors of IDA among the early adolescent girls. Likewise, menstrual history also played a significant role in the development of anemia among adolescent girls.

The relationship between academic performance and anemia was very significant in this study as anemic students were 9.59 times to be underachiever as compared to non- anemic students.

With respect to risk factors related to student's dietary practices, the most observable risk factor for IDA was not consumed snacks (OR=1.530, p<0.001). Additionally other factors were found as inadequate percent adequacy of vitamin C intake (OR=0.997, p<0.001), not eating daily breakfast (OR=4.277, p=0.011), eating less than 2 meals/day (OR=2.290, p=0.019), drinking tea immediately after a meal (OR=0.625, p=0.020), and also drinking tea (OR=0.428, p=0.021).

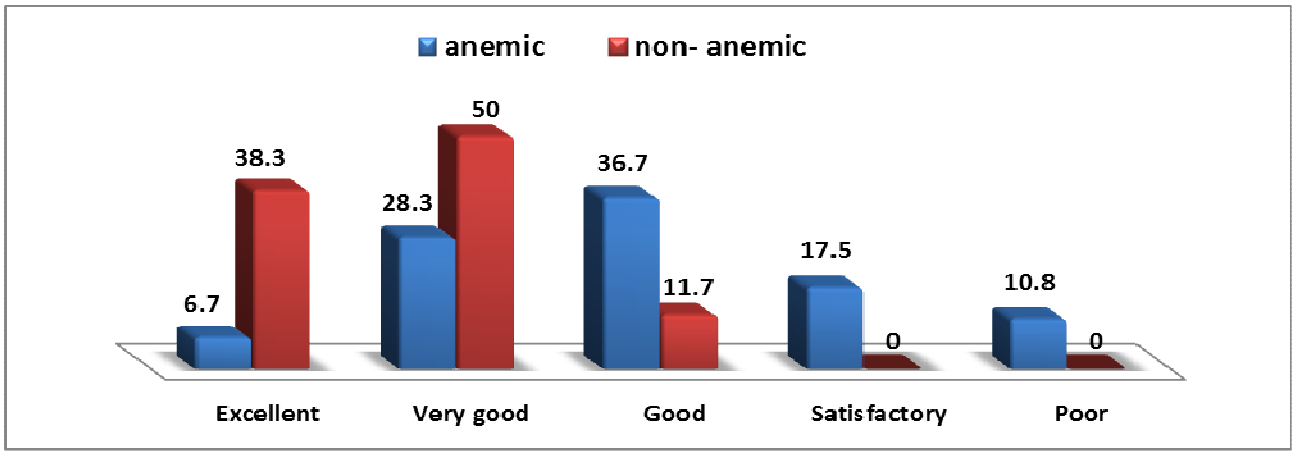

Figure (1): Scholastic Achievement among Anemic and Non- Anemic Students

Figure (1): portrays the scholastic achievement among studied groups, it was observed that, highest percent of students in anemic group (36.7%) obtained good score, however exactly half (50%) of non- anemic group obtained very good score in school report, with a statistically significant difference between both groups (c^2=83.449, P=<0.001).

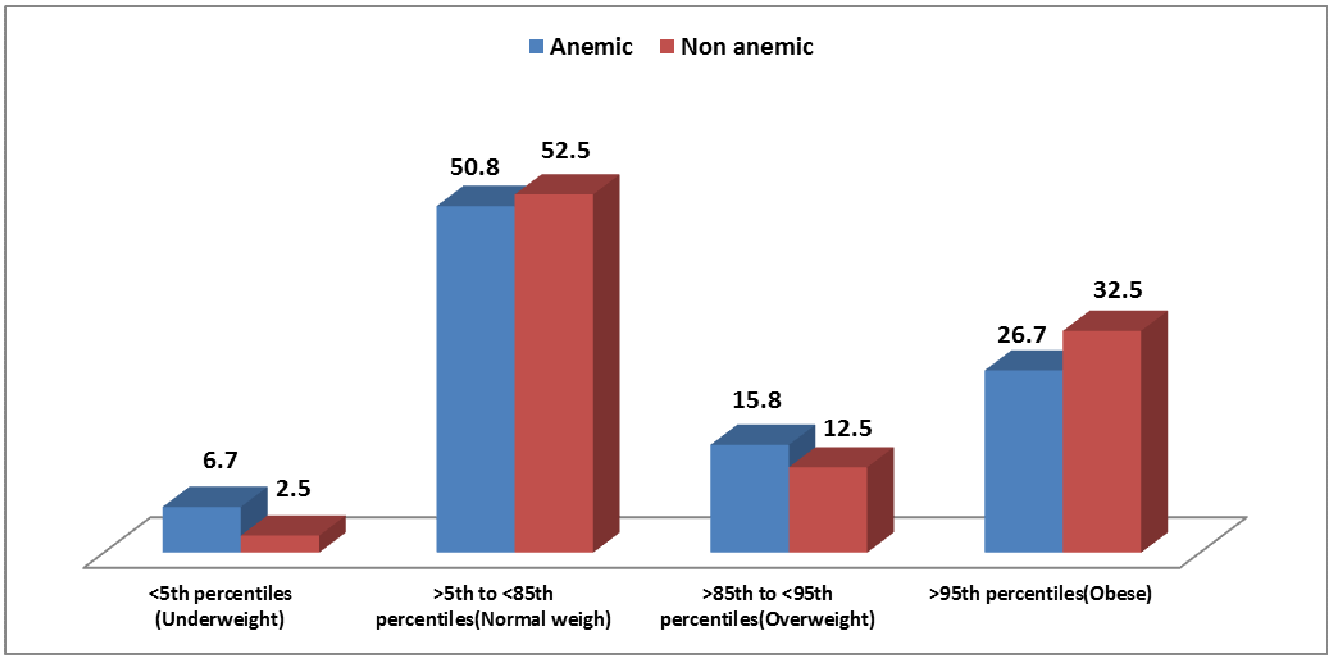

Figure (2) BMI Percentiles among Anemic and Non-Anemic Students

Figure (2) shows that, around half of anemic and non- anemic groups had normal BMI for their age (50.8% & 52.5% respectively). Furthermore, a minority of both groups were underweight (6.7%, 2.5%). Less than fifth of both groups were experiencing overweight (15.8%, 12.5% respectively), while around one third of them were obese students (26.7%, 32.5% respectively).

4. Discussion

Adolescence is a very decisive period in the life span since these are the influential years in the life of adolescents with major physical, psychological and behavioral changes take place. The nutritional requirements during adolescence are relatively high to meet the needs of the growth spurt. Adolescent females are at higher risk of malnutrition since they gain 30% of their adult weight and more than 20% of their adult height between 10 and 19 years. This age group are more susceptible to malnutrition particularly iron deficiency anemia [(18)].

Under nutrition, in every form, presents significant threat to human health. Today the world faces double burden of under nutrition, especially in developing countries where under nutrition contributes to about one third of all child deaths [(19)]. Under nutrition, including Iron Deficiency Anemia is the most important risk factor

of morbidity and mortality among children worldwide, affecting all the body organs, stopping the growth and development, damaging the immunological functions and thus increasing the predisposition to chronic and acute infections [20].

The current study gives a clear picture of 120 anemic adolescent girl's students as the mean age of the anemic students was 12.48 ± 0.49years. Most of them aged 12 up to 13 years and more. This go in line with the study accompanied in schools of Bangladesh (2010) [21] to study the nutritional practices and iron deficiency-related knowledge of preparatory school girls. The study showed that the prevalence of anemia increases with age and becomes maximum (65%) in the age group 12-13 years. 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, and also the similarity of data because the studies done in the same governorate with similar population characteristics.

Moreover, the overall prevalence of IDA in this study was significantly higher among rural school students as compared to urban school students. This result is consistent with the result of Tayel et al (2015) [22], who concluded that the overall prevalence of IDA among adolescent students aged 11-16 years in Alexandria governorate was higher in rural area than urban area. The high prevalence of anemia among students of rural schools as compared to urban schools can be explained by the fact that adolescents living in rural areas are more exposed to parasitic infections and their economic status is relatively poor when compared with urban counterparts. In contrast, those results differed from the results of Assaf (2015) [23], who found that the overall prevalence of anemia among adolescents was significantly less among rural school children as compared to urban school ones.

Among the various determinants of nutritional status, parent's education is probably the next most important factor after the socio-economic status. The father's education, undeniably, is one of the most important factors that decide the nutritional status of children; with the improvement in the father educational standard, the nutritional status of children also improved. This could be because of the greater role of educated fathers in pursuing the appropriate strategy in making greater share of household resources available to children [24]. There is also a strong linkage between maternal education and children's health. Children born to educated women suffer less from malnutrition which manifests as underweight, wasting, stunting and micro- nutrient deficiencies in children and adolescents [25].

In the current study, statistical significant difference was found between mother's education, working status and occurrence of iron deficiency anemia. Data revealed that students with low education or house wife's mothers were 0.761 times more likely to be anemic as compared to students of educated or working mothers who have a better education, paid higher salaries and contribute to increase the family income and upgrade their economic status. Other studies have found a strong link between maternal education, social economic status and child nutritional status including study done in Kenya (2011) [26] and study done by Bbaale (2014) [27]. This is because educated women are more likely to get steadier, higher paying jobs; to get married to men with higher education and higher income; and to live in better neighborhoods, which have influence on child health and survival. In a contrary of the results of current study, the study done in Morocco (2015) [28] among school students revealed that no significant relationship between prevalence of iron deficiency anemia, age, job, and education level of parents.

Academic dropout today is one of the major concerns of families and one of the major issues in each country's educational system as well. Anemia, and especially iron deficiency anemia is one of the common problems among students which can have a negative impact on their academic performance and productivity [29]. The relationship between academic performance and anemia was very significant in this study as anemic students were 9.59 times to be underachiever as compared to non- anemic students, this can be explained by the fact that the first body functions that are affected by iron deficiency are brain enzymes that are related to behavior and cognition[30]. Studies have shown that adolescents with anemia have decreased verbal learning and memory, as well as lower standardized math scores [31]. Even before anemia might develop, iron deficiency can cause shortened attention span, alertness, and learning in adolescents [32]. This result is congruent with the result of study done by Jauregui (2014) [33] who concluded that there is a significant relation between Hb level and academic performance. On the other hand, results of previous studies were inconsistent with the result of Ferrari et al (2011)[34] who concluded that neither educational performance nor intelligence showed significant associations with the iron status among European adolescents, and explained their findings by considering only the results of a single test to assess the educational performance.

Females menstruating at an older age were more susceptible to the development of anemia. The duration of menses hadn't a significant effect on the prevalence of anemia, but a longer duration of menses will lead to more blood loss and as a result the female will be more likely to develop anemia [4]. The results of this

study confirm the fact that menstruation plays an important role in the development of females. The data confirm that menstruation status was significantly affected the prevalence rate of anemia in the investigated adolescent girl's students. On the other hand, the data stipulate that the irregularity of menses wasn't associated with a prevalence of anemia. The results of previous studies suggest that the difference in the prevalence of anemia between males and females was caused the monthly blood losses [35] and its severity was associated with heavy blood losses during a period lasting more than 5 days [36]. This finding was in line with similar studies carried out in Turkey (2012) [9].

Anemia, which can be mild to severe, acute or chronic, is commonly associated with parasitic infestations. It is, however, only one of the multitudes of complications associated with parasitic infestations [37]. This study also showed that the prevalence of anemia among school adolescent's girls who had been infected with intestinal parasites was significantly higher compared to those no infected with intestinal parasites, while students who had parasitic infection were (35.41) times more likely to be anemic than non-infected. This is in line with a previous similar study done by Verma et al (2013) [38]. This might be due to the fact that most identified intestinal parasites have their own contribution on blood loss and/or red cell destruction.

Poor eating habits are the main reason for the high rates of anemia among adolescents in Egypt [22]. 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 [39,40]. The results of the present study indicated that, approximately tenth of anemic adolescents girls students consume three meals per day and nearly three quarters of them skipped one or two meals. 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 [2]. Thus, nutrition education and counseling should be provided to them, and emphasis should be placed on choosing nutrient-dense foods rather than nutrient-empty foods.

It is noteworthy that, more than two thirds of anemic adolescent girls' students in the current study omitted or always skipping breakfast. A study conducted among Italian adolescents reported that 80% of them skipped breakfast that was the cause of developing anemia [34]. Almost the same figure was given by a Malaysian study [35] Additionally the intake of fast food was not considered a risk factor for IDA among adolescent girl's students from this study finding. Another study done by Cynthia et al (2013) [41] disagreed with these results as it confirmed that with increasing dependence on foods outside the home, there was less motivation to make healthy food choices.

The consumption of tea immediately after meals was a common practice among by the anemic adolescent girls. This is a common habit in Egypt as many families would enjoy having a glass of minted tea immediately after meals. Tea drinking is well documented as one of the main factors that inhibit iron absorption, [42] this is confirmed by the finding that anemia was less prevalent among those who never consume tea. Tea consumption in the studied subjects is relatively high, which may contribute to the inhibition of iron absorption in poor families that depends on a plant- based diet. Also, a finding of Frank (2016) [43] was in line with the present study, which revealed that most of iron deficiency anemic cases drink tea immediately after meals.

Current study findings with respect to iron intake revealed that the mean iron intake by anemic girls was below their requirements. This was a function of the limited intake from the animal foods rich in iron and heme contents. Meat and meat products are very expensive and could be only afforded by upper social class families. This was reflected on the percent adequacy of iron which was lower among anemic females. Heme iron and vitamin C are protective factors against anemia; however, the importance of both factors depends on the daily intake from both nutrients. Samaniego-Vaesken (2017) [44] concluded that Total median dietary iron intake was 9.8 mg/day for women that were very low below the RDA. On the other hand, current findings were incongruent with the result of study done in India (2016) [45], which found that iron intake on average was high which may be linked to intake of proteins among Indian adolescent.

The results of the present study showed that around fifth of anemic adolescent girl's students had inadequate intake of vitamin C than the recommended values. Vitamin C is mainly found in fruits and vegetables. Likewise, current study exposed that non- anemic student daily consumption of vitamin C was very high. In contrast, the consumption of anemic students was significantly low. All these results support that iron deficiency anemia is highly associated with low intake of iron- rich foods. This is exacerbated by a low intake of foods that enhance iron absorption such as those rich in vitamin C [46, 47]. Moreover, previous studies among Arab adolescents also revealed low intake of fruits and vegetables. For example, a study in Saudi Arabia (2015) [48] found that around 3/4 of the adolescents sample did not consume fruits and vegetables on a daily basis. Additionally, a study conducted in Jordan (2014) [49] exhibited that around half of the adolescents consumed fruits and vegetables only once per day.

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. 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 [(50)].

Nutrition education by school nurse will involve teaching the student about the risks of IDA, importance of nutrition, providing educational materials as brochures, pamphlets, or distribution of healthy meals that reinforce messages about healthy eating, teaching adolescents skills essential for making dietary change, and providing information on how to sustain eating behavior change. [(32)]

To sum up, all efforts must be done by governmental and nongovernmental organizations, community leaders, social workers, school teachers and the community at large in order to make the adolescent girl's student more conscious about risk factors for IDA, their healthy nutrition, and less favorable to iron deficiency anemia.

5. Conclusion and Recommendations

Success in combating anemia depends on understanding its associated factors. The findings of this study showed that, Iron Deficiency Anemia is associated with poor eating habits, such as low consumption of iron-rich foods or foods that enhance iron absorption (as vitamin C rich foods) and high consumption of foods that inhibit iron absorption (as tea and whole wheat bread). Accordingly, girls' students with low parent educational status, rural residence, and intestinal parasite infection were identified as predictors of IDA among them. Thus, this study **recommended that**: -

- Nutrition education should be part of a comprehensive health education curriculum that focuses on understanding the relationship between personal behavior and health.
- Moreover, it is important to strengthen health education on the consumption of iron rich foods and proper implementation of intervention programs that would increase the hemoglobin levels among the adolescents age group through prophylaxis treatment, dietary modification and helminthes control.
- A nutrition education campaign should be implemented using mass media to inform the public about the health hazards of IDA, the high nutritional requirements during adolescence, and the type of iron rich foods available in Egypt. Special attention should be given to the iron intake of adolescent females at the age of menarche.

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