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Original Research Article

Anemia and Its Associated Factors among Adolescents in Alexandria, Egypt

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ABSTRACT

Adolescents constitute a vulnerable group of iron deficiency anemia due to increased iron requirements related to rapid growth. The study aimed to estimate the prevalence of anemia and its associated factors among male and female adolescents in Alexandria, Egypt. A cross sectional study was carried out on 405 preparatory school students of both sexes aged between 11-16 years in Alexandria using a stratified sampling technique. Data about socio-demographic characteristics and dietary habits and intake were collected from each student and menstrual history was collected from females. Hemoglobin level, hematocrit value, and red blood cells count were assessed. Anemia was among 27.4% of adolescents (26.4% of males and 28.8% of females). Anemia was significantly associated with low parents' education level, young age at menarche, irregularity and increased duration of menses, low dietary intake of iron-rich foods, inadequacy of dietary iron intake, drinking tea immediately after meal, high consumption of whole wheat bread, and low consumption of vitamin C rich foods and molasses. Low intake of iron rich foods and enhancers of iron absorption and high intake of inhibitors of iron absorption are the main reason for the high rates of anemia among adolescents in Alexandria. Menstrual history played a significant role in the development of anemia among females. A nutrition education is recommended to enhance the nutritional knowledge of adolescents about iron rich foods, enhancer and inhibitors of iron absorption. Special attention should be given to the iron intake of adolescent females at the age of menarche.

Key words: Anemia, adolescents, dietary factors, menstruation, Egypt.

INTRODUCTION

Adolescence is the period of life beginning with the appearance of secondary sex characteristics and ending with the cessation of somatic growth. The World Health Organization (WHO) defines the period of adolescence from 10 to 19 years of age. (1) Adolescents are facing a series of nutritional challenges which are not only affecting their growth and development but also their livelihood as adults. This is a vulnerable period in the human life cycle for the development of nutritional deficiencies particularly anemia which has been neglected by public health programs. The nutritional and health needs of adolescents are high because of the growth spurt and the increased physical activity. (2) To understand the nutritional requirements of the adolescent, health practitioners should be aware of the intensity and timing of the adolescent growth spurt, the differences in the growth spurt between males and females, and the individual variation in timing of the growth spurt from teenager to another. [3] The girl begins her adolescent growth spurt at an average age of 10 years and grows at a peak velocity at 12 years. The boys start adolescence growth spurt around 12 years of age and in a year or two overtake girls. [1]

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. [1] Adolescents iron requirements are particularly high in developing countries due to the high prevalence of infectious diseases and the low bioavailability of iron caused by the nature of their diet which is low in heme iron. [4] As a result, the prevalence of anemia was as high as 72% and 69% among children in developing countries such as India [5] and Jordon [6] respectively. A much lower prevalence around 5% was reported in Norway [7] and the United States. [8]

The problem of anemia in Egypt starts from the early childhood. The results of a survey among infants 6 to 24 months old in Cairo showed that 43% of the infants were anemic. [9] A study conducted in the Governorate of Fayoum in south Egypt showed that 64% of the children had iron deficiency anemia. Children from low social class and those of low maternal education level had a higher risk of anemia. Infant with iron deficiency anemia were found to consume food with low iron content, 50% below recommended daily requirements. [10] However, the data available from different Governorates showed high variability in the prevalence of anemia among adolescents from different governorates. The prevalence of anemia among adolescents in Egypt was generally high. In 1997, the national survey on adolescents in Egypt reported that 47% of adolescent boys and girls were anemic. Anemia was either mild or moderate with severe cases less than 1.0% of the cases; gender difference was almost nonexistent. [11] Egypt Demographic Health Survey (EDHS) in 2000 revealed a reduction in overall prevalence of anemia to reach 30%. [12] A study conducted in the Governorate of Qena in south Egypt in 2004 showed that the overall prevalence of anemia was 46.6% among the age group 10-19 years. [13] A study in 2007 carried out in Al-Gharbia Governorate in the middle of the Delta reported that 55% of the school students were anemic. [14] A much lower prevalence of anemia was reported in a survey conducted in 2009 which showed that the prevalence of anemia in adolescent boys and girls were 35.6% and 26.0% respectively. [15]

Literature review revealed that little information on the prevalence of anemia among adolescents in the Governorate of Alexandria the second most important Governorate on Egypt, this study was conducted to assess the prevalence of anemia among adolescent males and females in Alexandria and to determine the factors associated with the prevalence of anemia.

MATERIALS AND METHODS

Study design and Sampling: A cross sectional study was conducted in Alexandria, Egypt during the period from October to December 2014. The study included a total of 405 adolescents' preparatory school male and female students in the early adolescence age group 11-16 years. The Sample size was statistically calculated based on a 30% prevalence of anemia among adolescents in Egypt [12] and using 5% confidence level and power 95%, the estimated required sample size was 405 adolescents. The studied sample was selected using a stratified sampling technique. Two educational districts were selected at random from a list containing all educational districts. Preparatory schools were stratified into private and governmental schools and according to the number of male and female schools in each district. From each stratum one class was selected at random from a list containing all classes in each school and all students enrolled in the class were included in the study.

Data collection: A predesigned questionnaire was used to collect data from each student through a private interview to collect data about socio-demographic characteristics (sex, age, type of school, parents' educational level, fathers' occupation and working status of mothers). During the interview, data about menstrual history of each female (if she was menstruating or still not, age at menarche, menses regularity, and its duration) was taken. Data about dietary habits (usage of iron supplements, timing of drinking tea in relation to meal, and the consumption of guava and citrus fruits, molasses and whole wheat bread) was also collected. Daily and more than 3 times per week consumption of these foods was considered high and less than that was considered low consumption.

Dietary intake data were collected from each adolescent using the food frequency questionnaire at the time of the interview to determine the dietary intake of adolescents. The consumption pattern of different foods and the most commonly consumed beverages with special emphasis on iron-rich foods and foods that enhance iron absorption (meat and meat products, fish, egg, pulses, molasses, nuts, fruits and vegetables) and foods that inhibit iron absorption (tea and whole wheat bread) were collected. [16] Quantities of foods and drinks consumed were estimated using common house-hold utensils e.g. cups, plates, and tea or table spoons. For items like eggs, slices of bread, pieces of fruits a simple count was used. Then the mean daily intake from each item was analyzed using Egyptian Food Composition Tables of National Nutrition Institute [17] to get the mean daily intake of iron and vitamin C. Percent of iron and vitamin C adequacy was calculated using the formula: nutrient adequacy% = nutrient intake/Dietary Reference Intake (DRI)x 100. [18]

Capillary blood sample was obtained by pricking the fingertip with a sterile lancet. A drop of blood was collected from each adolescent into a disposable microcuvette and the level of hemoglobin (Hb) was determined using the HemoCue photometer (HemoCue AB, Ängelholm, Sweden). The micro hematocrit (Hct) method was carried out to determine Hct value in percent. Red Blood Cells (RBCs) count in millions according to the recommended procedures. [19] Adolescent males and females less than 14 years of age were considered anemic when their Hb concentration was below 12 g/d. older adolescents boys aged 14 years and older were considered anemic when Hb was below 13 g/dl according to WHO. Anemia was classified into three categories according to severity; mild if Hb was between 10 g/dl and the cutoff points, moderate if Hb was between 7g/dl and 9.9 g/dl, and severe if Hb was less than 7g/dl. [20] Red cell indices were calculated using determined Hb, Hct level and RBCs count. Mean corpuscular volume (MCV) is the average volume of individual RBCs in fl which indicates the size of the red cells (MCV = Hct (%) / RBCs count (millions/L) * 10). Mean corpuscular hemoglobin (MCH) is the average weight of Hb in each individual red cell in pg (MCH = Hb (g/dl) /

RBCs count (millions/L)*10). Mean corpuscular hemoglobin concentration (MCHC) is the average concentration of Hb in individual red cell. It is a ratio of the weight of Hb to the volume of the red blood cell in g/dl (MCHC = Hb (g/dl) / Hct (%) *100). [19]

Statistical analysis: Data management was conducted using the Statistical Package for Social Science (SPSS) version "17" software (Chicago, Illinois, US). Data were verified, tabulated and presented in the form of frequency, mean and standard deviation (SD). Data were analyzed using Chi square test for analysis of categorical data; Student's t test was used to evaluate the significance of the difference between means. For all analyses, P value ≤ 0.05 was used to detect statistically significant difference.

Ethical considerations: There is no any conflict of interest. This study was conducted according to the guidelines laid down for medical research involving human subjects and was approved by Ethics Committee of High Institute of Public Health, Alexandria University, Egypt. All measurements were taken following all privacy procedures and all collected data were kept confidential. A formal consent letter was obtained from the parents of every student after they were informed about the study purpose and procedure.

RESULTS

Table (1) Mean blood indices among the studied males and females

Blood indices	Males(n=197) Mean ± SD	Females(n=208) Mean ± SD	t (P value)
Hemoglobin (g/dl)	13.41 ± 1.16	12.35 ± 1.27	4.76 (0.030)*
Hematocrit (%)	39.64 ± 2.42	38.39 ± 2.72	3.51 (0.041)*
Red Blood Cells (10^{12}/L)	4.81 ± 0.34	4.51 ± 0.31	1.87 (0.235)
MCV (fl)	87.31 ± 8.31	85.46 ± 8.47	5.69 (0.023)*
MCH (pg)	27.37 ± 0.66	27.35 ± 0.50	0.50 (0.562)
MCHC (g/dl)	31.64 ± 3.15	32.28 ± 3.03	1.75 (0.361)

*MCV: mean corpuscular volume, MCH: mean corpuscular hemoglobin, MCHC: mean corpuscular hemoglobin concentrate, *P < 0.05*

The mean blood indices of the male and female students are presented in Table1. It demonstrates that the mean hemoglobin concentration and hematocrit value of male students were significantly higher than that of female students (t=4.76, P=0.03 and t=3.51, P=0.041, respectively). The results also show that the red blood cells count of both sexes was not statistically significant. This was reflected on the MCV which was also significantly higher among male students than their female counterparts (t= 5.69, P= 0.023). The results of the MCH and the MCHC did not show any significant variation between both sexes.

The association between the prevalence of anemia and socio-demographic characteristics of the surveyed samples is presented in Table 2. The results show that the prevalence of anemia in this age group was slightly but insignificantly higher among female students (28.8%) when compared with their male counterparts (26.4%). The severity of anemia varied between sexes. Anemia was mild among 88.5% of males and 98.3 % of female adolescents; the corresponding rates for moderate anemia were 11.5% and 1.7%, respectively with statistically significant difference. Severe anemia was not detected in this study.

The data in Table 2 also show that age did not have a significant effect on the prevalence of anemia which was slightly higher in the age group 14-15 years. The results indicate that the prevalence of anemia was very low among students from private schools (16.5%) and significantly higher (38.1%) among students from governmental schools (X^2 = 3.75 P= 0.033). Fathers education level was significantly associated with the prevalence of anemia (X^2=6.92, P=0.025). The highest prevalence of anemia was observed (32.5%) when the fathers' education was low and decreased significantly to 22.8% when the fathers were university graduates. This was also observed with the mothers' education level which was also associated with the prevalence of anemia that was most prevalent when the mothers received lower level of education (31.6%) as compared with 22.2% when the mothers' educational level was high, with statistically significant difference (X^2=13.82, P=0.02). The results also show that the prevalence of anemia was not associated with the fathers' profession or the mothers' working status.

Table (2) Socio-demographic characteristics of anemic and normal adolescents

Socio-demographic characteristics	**Anemic (n=111) No (%)**	**Normal (n=294) No (%)**	**X^2 (*P* value)**
Sex			0.06 (0.333)
Males	52 (26.4)	145 (73.6)	
Females	59 (28.8)	149 (71.2)	
Age in years			
11-	11 (27.5)	29 (72.7)	
12-	24 (25.3)	71 (74.7)	1.17 (0.883)
13-	49 (26.5)	136 (73.5)	
14-	22 (32.4)	46 (67.6)	
15+	5 (29.4)	12 (70.6)	
Type of school			
Private	33 (16.5)	167 (83.5)	13.75 (0.033)
Governmental	78 (38.1)	127 (61.9)	
Father's education level			
Low	49 (32.5)	102 (67.5)	
Middle	22 (27.9)	57 (72.1)	6.92 (0.025)*
High	40 (22.8)	135 (77.2)	
Father's occupation			
Professional	35 (28.5)	88 (71.5)	
Clerk	30 (23.4)	98 (76.6)	1.06 (0.230)
Laborer	19 (25.0)	57 (75.0)	
Retired	8 (27.6)	21 (72.4)	
Skilled manual	9 (23.1)	30 (76.9)	
Mother's education level			13.82 (0.020)*
Low	50 (31.6)	108 (68.4)	
Middle	25 (29.4)	60 (70.6)	
High	36 (22.2)	126 (77.8)	
Mother's working status			
Housewives	39 (24.4)	121 (75.6)	0.04 (0.541)
Working outdoors	72 (29.4)	173 (70.6)	

*$P < 0.05$

The menstrual history of female students and its association with anemia is illustrated in Table 3. The data show that the prevalence of anemia was 31.3% among menstruating females as compared with only 22.9% among still not menstruating females with no statistically significant difference. On the other hand, the prevalence of anemia among females with irregular menstruation was significantly higher (41.1%) than females with regular menstruation (17.9%), (X^2=7.56. P=0.013). The data also show that the age of menarche was significantly associated with the prevalence of anemia, (X^2 = 6.73, P = 0.016). The prevalence of anemia was 40% when the age at menarche was less than 12 years, and decreased to be 33.3% when the age at menarche was between 12 and 13 years, while it was as low as 23.8% when the age at menarche was more than 13 years. The duration of menses also had a significant effect on the prevalence of anemia (X^2=8.96, P=0.001). When the duration of menses was less than 4 days the prevalence of anemia was 16.7% increased to 31.2% when the duration of menses was between 4 and 6 days and reached its highest rate (34.6%) when the duration was more than 6 days.

Table (3) Association between menstrual history and the rate of anemia among adolescent females

Menstrual history	Anemic No (%)	Normal No (%)	X^2 (P value)
Menstruation status	**(n=59)**	**(n=149)**	0.82 (0.721)
Already menstruating	42 (31.3)	92 (68.7)	
Still not menstruating	17 (22.9)	57 (77.1)	
Menses regularity	(n=42)	(n=92)	7.56 (0.013)*
Regular	10 (17.9)	46 (82.1)	
Irregular	32 (41.1)	46 (58.9)	
Age at menarche (years)			
11-	11 (40.0)	27 (60.0)	
12-	19 (33.3)	35 (66.7)	6.73 (0.016)*
13+	12 (23.8)	30 (76.2)	
Duration of menses (days)			
2-	10 (16.7)	30 (83.3)	
4-	20 (31.2)	25 (68.8)	8.96 (<0.001) **
6+	10 (34.6)	37 (65.4)	

*$P < 0.05$, **$P < 0.001$

Table 4 presents the association between some dietary practices and the prevalence of anemia among examined male and female students. The results show that the prevalence of anemia was 13.9% among boys who take iron supplement regularly and increased to 29.9% among those who never take the supplement, the corresponding rates among girls were 20.9% and 31.5% respectively. Drinking tea immediately after meals was associated with a significantly higher prevalence of anemia among both male and female students. The prevalence of anemia was 32.2% among boys drinking tea immediately after meals, decreased to 27.7% among those drinking tea latter and was lower to 20.0% among students who did not drink tea. The same significant association between drinking tea and the higher prevalence of anemia was also noted among female students (X^2=9.02, P<0.001).

The consumption of citrus fruits and guava was significantly associated with a lower prevalence of anemia among adolescent males (X^2=5.43, P= 0.044) but not among adolescent females. The prevalence of anemia was 16.4% among males who consumed citrus fruits and guava regularly and increased to 33.9% among those who consumed both foods at a lower rate. Such trend was insignificant among adolescent females. The results show that the regular consumption of molasses was significantly associated with a lower prevalence of anemia among both sexes of adolescents. The prevalence was as high as 29.6% and 31.1% among males and females who consume molasses rarely, the corresponding rates among males and females who consume molasses regularly were significantly lower to 18.2% and 20.0% respectively. Table 4 also shows that the prevalence of anemia was 28.8% among males consume whole wheat bread regularly and was significantly lower (13.1%) among the group who not consume whole wheat bread (X^2=5.07, P=0.004), the corresponding rates for adolescent females were 30.1% and 9.4%, respectively.

Table 5 presents the mean daily intake from some food groups and percent adequacy from iron and vitamin C. The results show that the mean intake from the meat and meat products was significantly lower among anemic males (80.17 g/day) as compared with an intake of 84.6 g/day by normal males. Such difference was noted among anemic and normal females. The mean daily intake from egg followed the same pattern. On the contrary, the consumption of fish by normal and anemic males was almost similar, while the consumption of fish was significantly higher (X^2=6.22, P=0.001) by normal females when compared with the anemic group, 40.62 g/day and 32.58 g/day, respectively. The results also show that the daily intake from pulses, vegetables, fruits and nuts was significantly higher by normal males and females when compared with their anemic counterparts.

Table (4) Impact of selected dietary habits and anemia among the studied sample

Item	**Males**		**Females**	
	Anemic (n=52) No (%)	**Normal (n=145) No (%)**	**Anemic (n=59) No (%)**	**Normal (n=149) No (%)**
Use of iron supplement				
Usual	6 (13.9)	37 (86.1)	13 (20.9)	49 (79.1)
Never	46 (29.9)	108 (70.1)	46 (31.5)	100 (68.5)
X^2 (*P* value)	10.12 (0.333)		0.33 (0.543)	
Timing of drinking tea in relation to meal				
Immediately after meal	20 (32.3)	42 (67.7)	28 (36.8)	48 (63.2)
Later	18 (27.7)	47 (72.3)	21 (26.2)	59 (73.8)
Never consumed	14 (20.0)	56 (80.0)	10 (19.2)	42 (80.8)
X^2 (*P* value)	9.54 (<0.001)**		9.02 (<0.001)**	
Consumption of citrus and guava				
High	14 (16.4)	71 (83.6)	30 (27.8)	78 (72.2)
Low	38 (33.9)	74 (66.1)	29 (29.0)	71 (71.0)
X^2 (*P* value)	5.43 (0.044)*		1.36 (0.146)	
Consumption of molasses				
High	10 (18.2)	45 (81.8)	10 (20.0)	40 (80.0)
Low	42 (29.6)	100 (70.4)	49 (31.1)	109 (68.9)
X^2 (*P* value)	6.23 (0.024)*		7.32 (0.015)*	
Consumption of whole wheat bread				
High	49 (28.2)	125 (71.8)	56 (30.1)	130 (69.1)
Low	3 (13.1)	20 (86.9)	3 (9.4)	29 (90.6)
X^2 (*P* value)	5.07 (0.044)*		4.99 (0.047)*	

*$P < 0.05$, **$P < 0.001$

Table (5) Mean daily consumption of food groups, selected nutrients intake and adequacy among anemic and normal adolescents

Item	Males		Females	
	Anemic (n=52) Mean ± SD	Normal (n=145) Mean ± SD	Anemic (n=59) Mean ± SD	Normal (n=149) Mean ± SD
Meat and meat products (g)	80.17 ± 6.6	84.61 ± 3.9	95.18 ± 7.9	96.19 ± 3.9
t (P value)	6.50 (<0.001)**		0.21 (0.235)	
Egg (g)	42.58 ± 2.5	46.39 ± 4.1	44.34 ± 2.5	45.33 ± 3.8
t (P value)	3.01 (<0.001)**		1.12 (0.311)	
Fish (g)	33.37 ± 3.6	33.1 ± 2.1	32.58 ± 2.0	40.62 ± 4.6
t (P value)	1.69 (0.114)		6.22 (<0.001)**	
Pulses (g)	89.75 ± 5.3	96.91 ± 9.8	84.49 ± 5.6	94.44 ± 9.5
t (P value)	7.43 (<0.001)**		9.04 (<0.001)**	
Vegetables (g)	139.6 ± 6.7	143.7 ± 11.8	127.66 ± 11.2	139.07 ± 6.8
t (P value)	3.47 (<0.001)**		2.59 (<0.001)**	
Fruits (g)	244.9 ± 25.2	257.4 ± 16.5	262.08 ± 18.9	279.18 ± 25.1
t (P value)	6.23 (0.044)*		3.01 (0.046)*	
Nuts (g)	1.82 ± 0.4	2.83 ± 1.2	1.08 ± 0.4	3.17 ± 0.9
t (P value)	8.47 (0.041)*		13.36 (<0.001)**	
Iron intake (mg)	9.81 ± 0.9	10.96 ± 0.5	9.43 ± 0.3	10.83 ± 0.5
t (P value)	2.47 (0.043)*		2.13 (0.042)*	
Vitamin C intake (mg)	106.33 ± 33.4	139.35 ± 19.9	107.64 ± 13.2	137.64 ± 18.4
t (P value)	11.43 (<0.001)**		8.47 (<0.001)**	
Iron adequacy (%)	83.42 ± 0.7	87.17 ± 0.5	62.87 ± 0.5	69.5 ± 0.5
t (P value)	3.44 (<0.001)**		9.72 (<0.001)**	
Vitamin C adequacy (%)	412.66 ± 17.1	478.70 ± 13.1	429.4 ± 12.4	475.28 ± 17.4
t (P value)	9.86 (<0.001)**		2.53 (<0.001)**	

*$P < 0.05$, **$P < 0.001$

The results of Table 5 also illustrate that the daily iron intake by anemic was less than that by normal males and females with statistically significant difference. The percent adequacy was 83.42% by anemic males and increased to 87.17% by normal counterparts. The corresponding percent adequacy for anemic and normal females was significantly lower to 62.87% and 69.5%, respectively (X^2=9.72, P=0.001). The mean daily intake from vitamin C was high among the examined sample; however, the difference in the intake was significantly higher by normal males and females when compared with the anemic groups. The percent adequacy of vitamin C intake by both males and females was very high; however, the percent adequacy for normal subjects was significantly higher when compared with anemic males and females.

DISCUSSION

Adolescence is a very crucial period in the life span since these are the formative 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. [21]

The primary causes of anemia among adolescents are faulty iron intake or absorption resulting from an iron-poor diet, the presence of inhibitors or the absence of enhancer of iron absorption in the same meal, increased iron requirement to expanded blood volume, and chronic blood loss due to parasitic infestation and monthly losses among females. Iron deficiency anemia is characterized by the production of small microcytic erythrocytes and a decreased level of circulating hemoglobin. This is actually the last stage of iron deficiency, and it represents the endpoint of a long period of iron deprivation. Anemia is the last manifestation of a chronic iron deficiency. [22]

The results of this study show that anemia is prevalent among both adolescent males and female (27.4%). A similar study reported that the prevalence of anemia among adolescent females in India was 41.1% in the age group 10-14 years. The majority of the females had mild anemia, the prevalence was higher among females from low socioeconomic status. [23]

Our data show that even at this early stage of adolescents, the hemoglobin concentration of males was significantly higher than females. This was associated with a similar difference in hematocrit percent and the red cell count. However it was noted the mean value of the blood indices was close to normal reference values. This may be attributed to the fact that anemia recorded in this study was mostly moderate, and indicate that the prevalence of anemia among adolescents in Alexandria is considerably lower than other governorates in Egypt. [12,14]

There are number of anemia risk factors including parasitic infections chronic illness and poor economic status. [3] The variability in the prevalence of anemia between Governorates is a reflection of the socio-economic status of each Governorate which varies to a larger extent between different Governorates. Adolescents living in rural areas are more exposed to parasitic infections and their economic status is relatively poor when compared with urban counterparts. The variation in the prevalence of anemia over the last 20 years is a function of the extensive socioeconomic changes and development in Egypt which was mostly concentrated in urban Governorates.

The data show that the prevalence of anemia was associated with several variables. The difference in the prevalence of anemia between adolescent males and females was not significant in this young age group. This may be attributed to the fact that a good proportion (35.6%) of the adolescent females did not start menstruation and consequently were not exposed to the monthly blood losses (Table 3). Anemia was mild among the majority of adolescents males and females with no sex difference. The degree of anemia and the similarity in the prevalent rates between males and females was reported in another study, [24] although a higher rate of anemia was found among adolescent females particularly those from nuclear families. [25]

The results show that anemia was prevalent among adolescents from governmental schools when compared with students from private schools. This elucidates the impact of economic status of the family on the prevalence of anemia. Students from private schools come mostly from the high socio-economic bracket of the society who can afford to pay the high tuition fees of the private schools while governmental schools are practically free and is mostly attended by students from families who cannot afford the fees of the private schools.

This is confirmed by the finding that the prevalence of anemia was associated with the lower level of education of both parents' education. A higher education of the parents will guarantee a better paying jobs, increase the family income and hence can afford to provide better nutrition for their children. In the meantime, better educated parents would have a better knowledge of the nutritional requirements of their children and would care to cover such needs. A study of anemia among adolescent females in India reported a significant association between socioeconomic status and literacy of their parents. [26]

Anemia was also associated with the mothers' working status, anemia was more prevalent among adolescents whose mothers were housewives when compared with children of working mothers who have a better education, paid higher salaries and contribute to increase the family income and upgrade their economic status (Table 2). This agrees with another study which reported that populations that belong to lower income households have limited access to iron rich foods. [27]

The results of this study confirm the fact that menstruation plays an important role in the development of females. The data show that menstruation status did not affect the prevalence rate of anemia in the investigated young age group (Table 3). On the other hand, the data stipulate that the irregularity of menses was associated with a higher prevalence of anemia. Females menstruating at a younger age were also more susceptible to the development of anemia.

The duration of menses had a significant effect on the prevalence of anemia. When the duration of menses was less than 2 days, 16.7% of the females developed anemia, the prevalence increased to 31.2% when the duration of menses was between 4 and 6 days. A longer duration of menses will lead to more blood loss and as a result the female will be more likely to develop anemia (Table3). The results of previous studies suggest that the difference in the prevalence of anemia between males and females was caused the monthly blood losses [28] and its severity was associated with heavy blood losses during a period lasting more than 5 days. [29]

The consumption of tea immediately after meals was a common practice among by the anemic males and females. 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, [30] this is confirmed by the finding that anemia was less prevalent among those who never consume tea (Table 4).

Whole wheat bread containing relatively large quantities of phytate was consumed at a higher rate by both anemic males and females. Bread is an important component of the Egyptians and provides a large proportion of the daily caloric intake. It could be one of the main factors contributing to the higher prevalence of anemia in view of its poor iron contents with it is also of limited bioavailability. [31]

The data show that the intake of iron supplement did not have a significant effect on the prevalence of anemia. This may be due to the irregular intake of the supplement or the limited bioavailability of the supplemental iron. Citrus fruits and Guava are excellent sources of vitamin C. Both are quite inexpensive fruits and are very common in Egypt. The results data show that high intake of both fruits was associated with a lower prevalence of anemia. Molasses is another good source of iron and is consumed by all social strata. The data show that the high intake of these iron rich sources reduced the prevalence of anemia and because of its low price could be included in the diet of poor families to reduce the prevalence of anemia.

The intake of pulses, vegetables, fruits and nuts by anemic males and females was less than normal individuals. Fruits are good sources of vitamin C that enhances iron absorption. [32] The quantities consumed were very high and was reflected on the intake of vitamin C by all subjects which exceeded the daily requirements. This is due to the nature of the Egyptian diet which is rich in the relatively low priced vegetables and fruits.

The nature of the diet varied significantly between anemic and normal adolescents. Anemic males were consuming significantly lower quantities from meat and meat products while anemic females were consuming less fish than their normal counterparts. The primary sources of heme iron are hemoglobin and myoglobin present in animal foods. Heme iron is highly bioavailable and dietary factors have a little effect on its absorption. [31]

The results show that the mean iron intake by all the examined subjects whether normal or anemic 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 males and 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. [33]

CONNCLUSION AND RECOMMENDATIONS

Anemia is prevalent among young adolescents in Alexandria, Egypt. The findings show that 27.4% of the studied adolescents were anemic. 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). Menstrual history played a significant role in the development of anemia among females. Periodic and high coverage surveys should be carried out to investigate the prevalence among young adolescents in different Governorates in Egypt. A nutrition education campaign should be implemented using mass media to inform the public about the health hazards of anemia, 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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