Anemia among adolescents

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ABSTRACT

Objectives: To determine the prevalence of anemia in a group of apparently healthy school adolescents selected from 2 distinct socio-economic areas (SEAs) in Baghdad; and to assess the importance of diet and some other factors which could be relevant in the epidemiology of anemia in adolescents.

Methods: A random sample of 1051 adolescents were included in the present study, 46% of them (487 adolescents) were from Al-Mansoor area for high socio-economic area (HSEA) and 54% of them (564 adolescents) were from Al-Horya area for low socio-economic area (LSEA) in Baghdad, Iraq. Collection of data was carried out during the period between November 1996 until the end of April 1997. Hemoglobin concentration and packed cell volume levels were determined. Dietary intake of iron, calories, protein and Vitamin C were estimated.

Results: The prevalence of anemia among adolescents in HSEA was 12.9% compared with 17.6% in LSEA. Hemoglobin concentration in males was significantly correlated with age and dietary iron intake while in females it was correlated significantly with years of education of father and mother, number of pads and age at menarche.

Conclusion: Anemia among adolescents was found to be a health problem of moderate severity.

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Anemia is one of the most commonly recognized disorders.[1] Its prevalence in women and preschool children is high,[2] therefore, it needs more attention.[3] Evidence from studies[4,5] showed that adolescents are at an increased risk of developing anemia due to increasing iron demand during puberty, menstrual losses, limited dietary iron intake and faulty dietary habits. No available information on the prevalence of anemia and iron status of adolescents in Iraq. The present study is an attempt to determine whether anemia is a problem among Iraqi adolescents.

Methods. Collection of data was carried out during the period between November 1996 until the end of April 1997. Healthy school male and female (1051) adolescents (aged 11-19 years) were included in the present study. Samples were taken from 2 distinct socio-economic areas (SEAs) in Al-Karkh Region, Baghdad. The selected areas were Al-Mansoor area for high socio-economic area (HSEA) (Area 1) and Al-Horya area (Area 2) for low socio-economic area (LSEA) in Baghdad. Approximately 5% of the school adolescents in the 2 areas were included in the study. The samples were selected using multi-stage stratified random sampling method. Each boy and girl was interviewed directly and separately. A questionnaire form was prepared and filled-up for each student. The questionnaire includes information's on: years of education of father and mother, birth order, number of households and number of rooms (used for calculation of the crowding index), and for females inquiry regarding age at menarche and number of pads used during the whole cycle (used as indicator for blood loss). Height and weight of the students were measured by calculating the body mass index (BMI). A sample of venous blood was drawn from each student and used for determination of packed cell volume (PCV) (Microhematocrit technique) and hemoglobin (Hb) (cyanomethemoglobin method) concentration. Patients with low values of both PCV and Hb concentrations were considered anemic

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(below the cut-off levels suggested by the World Health Organization [WHO]). Dietary intake for each student was assessed using the 24-hours recall method at 1st day of interview and for another 2 non-consecutive days and one for weekend. A known weight or volume household measures and food models were used for estimation of foods eaten each day. Calories and nutrients intake were calculated using food composition tables for Iraqi foods[6] and food composition tables for the Middle East.[7] Mean calorie and nutrient intake for the 3 days was calculated for each student. For analysis of dietary iron, the diet consumed were categorized into low, intermediate, or high bioavailability diet depending on the amount of meat, poultry, or fish and the amount of Vitamin C content of the diet. A low diet contains <30 gms of meat, poultry or fish (lean raw weight) or <25 mg of ascorbic acid daily. An intermediate diet contains 30-90 gms of meat, poultry or fish, or 25-75 mg of ascorbic acid daily. A high availability diet is one that contains more than 90 gms of meat, poultry or fish or >75 mg of ascorbic acid. Alternatively, a high availability diet may contain 30-90gms of meat, poultry or fish plus 25-75 mg of ascorbic acid.[8] The percentage contribution of various food groups or items in the total daily iron intake were calculated and registered for analysis.

Ethical consideration. The Scientific Committee in the Community Medicine Department, College of Medicine, University of Baghdad, Baghdad, Iraq, approved the study. Attempts had been made to assure privacy during a personal interview. An informed verbal consent was obtained from the study subjects before enrolment.

Statistical analysis. The data analysis was carried out using the Statistical Package for Social Science (SPSS). Statistical significance of difference in mean values between groups were assessed using independent samples t-test, significance of association between various epidemiological variables were assessed using chi-square test. Significance of difference between 2 population proportions was tested by Z-test. The relationship between Hb concentration and various variables were examined by calculating the Pearson's correlation coefficient (r) and the significance of correlation (p). Multiple regression analysis was used to overcome the possible interrelation between the potential predictors of Hb concentration.

Results.

A total of 1051 adolescents were included in the present study, 487 adolescents (46%) were from the HSEA (Area 1) and 564 adolescents (54%) were from the LSEA (Area 2). The sample was consisted of 451 males (43%) and 600 females (57%). The demographic and social characteristics of the studied sample were shown in **Table 1** which showed that adolescents from the 2 areas differ significantly in their means for years of education of fathers (p<0.005), mothers (p<0.005), and crowding index (p<0.005). The mean values for Hb and PCV were summarize in **Table 2**. In each area, males had a significantly higher mean values than females. There were statistically significant differences between males from the 2 areas for the mean values of Hb and PCV and between females from the 2 areas for the mean PCV values. **Table 3** shows the prevalence of anemia among adolescents, higher prevalence of anemia was found among adolescents from LSEA compared with HSEA and among females compared with males. The prevalence of anemia by age is shown in **Figures 1 & 2**. Highest prevalence of anemia in males was found at age of 14 years in HSEA and 15 years in LSEA. In females, however, the prevalence of anemia was increased at age of 16 years and 18 years in both areas. On comparing between the prevalence of anemia among males from the 2 areas in each age group, no statistically significant differences were found (Z>0.05) for all age groups studied. The same results were obtained on comparing between the prevalence of anemia among females from the 2 areas in each age group (Z>0.05) with the exception of that at age of 12 years, in which the prevalence of anemia among females from LSEA was significantly higher than that among females from HSEA (Z<0.05). **Table 4** shows distribution of anemic and non-anemic adolescents according to their intake of various iron bioavailability diets stratified by gender. Higher prevalence of anemia was found among both male and female adolescents on low iron bioavailability diet. Significant association was found between iron bioavailability of the diet and the prevalence of anemia in both males and females (x^2, p<0.001). **Table 5** shows the correlations between Hb concentration and the independent variables studied. In males, statistically significant positive correlations were found between Hb concentrations and the following variables; age, BMI, dietary intake of iron, calorie and protein. In females, however, statistically significant positive correlations were found with dietary intake of iron, calorie and protein and with years of education of father and mother while statistically significant negative correlations were found with the age, crowding index, BMI, number of pads and with age at menarche. Multiple regression analysis **(Table 6)** showed that in females, years of education of father and mother had a

Table 1 - Demographic and social characteristics of the studied sample.

Demographic and social characteristcis	HSEA mean ± SD	LSEA mean ± SD	P value
Fathers education (years)	12.8 ± 4.2	9.1 ± 4.5	<0.005
Mothers education (years)	10.7 ± 5	5.9 ± 4.5	<0.005
Crowding index (years)	2.3 ± 1.2	3.6 ± 2.1	<0.005
Age at menarche (years)	12.8 ± 1.8	13 ± 1.3	>0.005

HSEA - high socio-economic area, LSEA - low socio-economic area,

Table 2 - Mean ± SD of hemoglobin concentration and the packed cell volume of male and female adolescents (N = 1051).

Socio-economic area	Hb concentration (g/dl)	PCV %	Hb t-test (P value)	PCV t-test (P value)
Area 1				
M1 (N = 188)	14 ±1.2	40.6 ± 3		
F1 (N = 299)	13.1 ± 1.2	38.1 ± 2.7		
M1 versus F1			112.2 (<0.005)	34.3 (<0.005)
Area 2				
M2 (N = 263)	13.7 ± 1.2	39.4 ± 3.2		
F2 (N = 301)	13.1 ± 1.3	37.5 ± 3	54.1 (<0.005)	27.5 (0.005)
M2 versus F2				
Total adolescents				
M (N = 451)	14.1 ± 1.2	40 ± 3.1		
F (N = 600)	13.1 ±1.3	37.8 ± 2.9		

Statistical analysis: Hb t-test M1 versus M2 = 60.9, p<0.005; F1 versus F2 = 1.92, p>0.05;
PCV t-test M1 versus M2 = 13.8, p<0.005, F1 versus F2 = 11.01, p<0.05.
Hb - hemoglobin, PCV - packed cell volume, M1 - male (area 1), F1 - female (area 1), M2 - male (area 2), F2 - female (area 2), M - male, F - female

Table 3 - Prevalence of anemia in male and female adolescents according to the cut-off level for Hb, PCV,[9] and Hb plus PCV (N = 1051).

Adolescents group	<Hb cut-off levels %	<PCV cut-off levels %	<Hb+PCV cut-off levels %
Area 1			
Male (N = 188)	13.3	12.8	12.8
Female (N = 299)	14.7	14	13
Area 2			
Male (N = 263)	17.5	17.1	16.3
Female (N = 301)	18.9	18.6	18.6
Area I (Total)			
N = 487	14.2	13.6	12.9
Area II (Total)			
N = 1051	18.3	17.9	17.6
Total adolescents			
N = 1051	16.4	15.9	15.4

Cut-off levels for Hb values: all females = <12g/dl,
male (≤14 years) = <12g/dl and males (>14 years) = <13g/dl.
Cut-off levels for PCV values: All females = <36%,
males (≤14 years) = 36% and males (>14 years) = 40%.
Hb - hemoglobin, PCV - packed cell volume

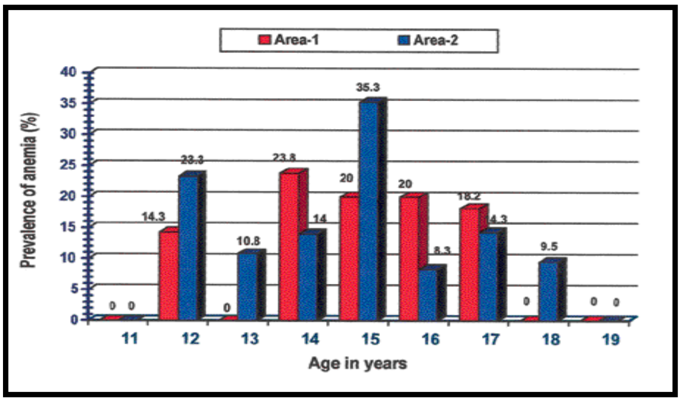

Figure 1 - Prevalence of anemia among males by age.

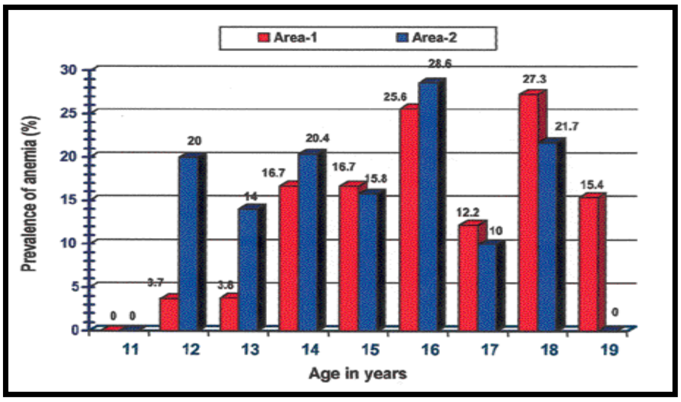

Figure 2 - Prevalence of anemia among females by age.

Table 4 - Distribution of anemic and non-anemic adolescents according to the intake of various iron bioavailability diets (stratified by gender) (N = 1051).

Bioavailability	Anemic n (%)	Non-anemic n (%)	Total
Male*			
High	6 (5.1)	111 (94.9)	**117**
Intermediate	25 (13.5)	160 (86.5)	**185**
Low	36 (24.2)	113 (75.8)	**149**
Total	**67 (14.9)**	**384 (85.1)**	**451**
***Female*†**			
High	19 (6.9)	255 (93.1)	**274**
Intermediate	39 (18.5)	172 (81.5)	**211**
Low	37 (32.2)	78 (67.8)	**115**
Total	**95 (15.8)**	**505 (84.2)**	**600**

*P<0.001, †P<0.001

Table 5 - Pearson correlation coefficients between Hb concentration and studied variable.

Independant variables	Female Area 1	Female Area 2	Male Area 1	Male Area 2
Age	-0.197*	0.064	0.498*	0.413*
Fathers' education (years)	0.244	0.126†	-0.084	-0.06
Mothers' education (years)	0.244*	0.159*	-0.128	-0.084
Birth order	-0.104	-0.041	0.08	0.058
Crowding index	-0.156*	-0.05	0.116	-0.088
Calories intake	0.212*	0.173*	0.127	0.284*
Iron intake	0.276*	0.142†	0.167†	0.370*
Protein intake	0.267*	0.172*	0.144†	0.271*
BMI	-0.185*	-0.039	0.122	0.253*
Number of pads	-0.83*	-0.272*		
Age at menarche	-0.173	0.061		

*P<0.01, †P<0.05
BMI - body mass index, Hb - hemoglobin

Table 6 - Partial correlation coefficient calculated by multiple regression analysis with Hb concentration as the dependent variable.

Independant variables	Female Area 1	Female Area 2	Male Area 1	Male Area 2
Age	0.07	0.117	0.454*	0.299†
Fathers' education (years)	0.142*	0.013	-0.005	-0.034
Mothers' education (year)	0.068	0.196†	0.08	0.01
Birth order	-0.037	0.019	0.005	0.019
Crowding index	-0.073	-0.078	-0.01	-0.033
Calories intake	0.076	0.096	0.008	-0.006
Iron intake	0.057	0.032	-0.007	0.195†
Protein intake	0.079	0.037	0.092	0.004
BMI	-0.053	-0.099	-0.082	-0.089
Number of pads	-0.248†	-0.267†		
Age at menarche	-0.134*	-0.009		
Model R^2	0.225	0.17	0.24	0.21
ANOVA for the model	P<0.001	P<0.001	P<0.001	P<0.001

*P<0.05, †P<0.01
BMI - body mass index, Hb - hemoglobin,
ANOVA - analysis of variance

significant positive relationship with Hb concentration in HSEA and LSEA, while number of pads had a significant negative relationship with Hb concentration in both areas. In male; however, Hb concentration showed significant positive correlation with age in both areas and with dietary iron intake in LSEA only.The study of age at menarche showed that 21%of anemic females from LSEA had not commenced their menstruation. Moreover, the highest proportion of anemic females from LSEA and HSEA were in the first and 3rd year after menarche.

Discussion. Adolescents have been identified by many nutritional surveys to be at increased risk for anemia.[10] Sufficient information on the prevalence and causes of anemia among this group is needed to justify the development of an intervention program. In the present study the prevalence is higher than values reported from developed countries[11] but could be compared favorably with values reported from the developing countries.[12] The WHO proposed a scheme for classification of public health severity of anemia[13] and anemia was considered as mild if prevalence is 1-9%, moderate if it is 10-39% or severe problem if it is more than 40%. Accordingly, the present study showed that anemia of moderate severity among the studied adolescents was considered a health problem. Also anemia was found to be more prevalent in adolescents living in LSEA compared with those living in HSEA. Similar observation was reported in the United States of America[4] and India.[14] The significant differences found in mean years of education of fathers and mother, crowding index and of dietary intake could explain the observed difference between the 2 areas in the prevalence of anemia. In females, the higher prevalence of anemia observed reflect the adverse effect of lower dietary iron intake with menstrual blood loss, which imposes extra demand for iron. Higher prevalence of anemia among the studied males was found at the age of 14-15 years and females at the age of 16-18 years. This is in agreement with many studies reported elsewhere.[15,16] Study of serum ferritin levels in 909 school children and adolescents[17] showed that the highest frequency of low ferritin level and exhausted iron stores in boys was at the age of 12-15 years and in girls at the age of 16-17 years. Concerning the relationship between age and Hb concentration, the present study showed that age was directly and highly correlated with Hb concentration in comparison with other variables studied. Analysis of Hb data from the National Health and Nutritional Examination Survery (NHANES 1) in the USA showed a marked age associated increase in HB concentrations in boys during the 2nd decay with a change of 1.0 gm/dl spread over a 6-8 year period.[18] It had been suggested that, in males the achievement of adult testosterone concentration is associated with an increase in erythropoiesis and Hb concentration.[19] In females, however, after controlling other independent variables, the statistically non-significant correlation that was found in the present study was also reported in other studies.[20] Parent education showed a statistically significant correlation with Hb concentration in females only. In another study on 154 adolescents,[15] emphasis was put on the level of parent education as one of the factors that may be responsible for the high rate of anemia noticed in the studied group. Although many researchers had studied age at menarche as a maturation event, few studies had been conducted to investigate the relationship between age at menarche and hematological data. In the present study, the negative correlation observed between Hb concentration and age at menarche is perhaps due to marginal iron store that was existed during childhood in females with higher age at menarche. This marginal iron store may have been further depleted during the period of accelerated growth and with the commencement of menstruation. The significant inverse relationship was noticed between Hb concentration of females (in both areas) and the number of pad used showed the importance of menstrual blood loss in the epidemiology of anemia among female adolescents. In the present study the bioavailability of dietary iron was considered since it has been found that dietary factors influencing iron availability were better predictors of iron status than iron intake.[21] The importance of iron bioavailability of the diet had been confirmed in this study by the higher prevalence of anemia among male and female adolescents taking low iron bioavailability diet and by the significant associations observed between the prevalence of anemia and iron bioavailability of the diet in both males and females. It should be noted that the prevalence of anemia in each iron bioavailability diet group was higher in females compared with males which means that there are other factors operating to increase the risk of anemia in females, some of these factors were studied in this study by simple and multiple regression analysis.

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Search Word: anemia

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Title: Acquired anemia as a cause of female infertility

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Abstract

The association between anemia and female subfertility has been largely linked to hereditary anemias such as betathalassemia major and sickle cell anemia. Data on acquired anemias as a cause of infertility has been scanty. This report describes 2 female patients with pernicious anemia and a 3rd patient with iron deficiency anemia who suffered from primary infertility. Successful conception followed the correction of their anemia with the appropriate therapy.