National Nutrition Institute

World Food Programme
Egypt

Baseline Survey Data on Iron Deficiency Anemia in Egypt

August 2010

Acknowledgements

The National Nutrition Institute (NNI) wishes to thank the Global Alliance for Improved Nutrition (GAIN) and the World Food Programme in Egypt (WFP) for their support of the research.

NNI also thanks members of the Executive Committee, namely Dr. Nasr El-Sayed and Dr. Khaled Nasr; as well as health authorities in Cairo, Alexandria, Suez, Quena, Beni-Suef, Aswan, Beheira, Sharkia, Kafr El-Sheikh, North Sinai, and New Valley governorates for facilitating operations of field survey throughout the study.

NNI also wishes to recognize the efforts of study teams:

Principle Investigator: Prof. Afaf A. Tawfik, Head, Field Studies & Surveys Department, National Nutrition Institute.

Supervisor: Mahmoud Yousry

Physicians: Azza Hussain; Omnia Ismail; Marian Ragaee; Mona Eid; Jaqueline Ghali.

Dieticians: Samira Salem; Fatma Saeed; Abeer Hosni; Eman Nasaar; Asmaa El Sayed; Asmaa Abd El Wahid; Amina Sami; Mona Abd El Salam; Olaa Ali Ali; Rasha Mostafa; Hoda Mohamed; Samar Darwish; Ghada Ramzy

Social team: Rida Mohamed; Reham Mustafa; Marwa Saede; Mona Yehia; Tamer Mohamed; Mohamed Sherif.

Laboratory team: Dr. Awatef Abdel Maksoud; Dr. Said Abd El Kalq; Asmaa Mohamed; Shimaa Ahmed; Hend Abas; Dina Hamdi; Hanan Heshmat; Hoda Ahmad; Hanan Ez El Din; Amr Gamal; Dalia El Hosaine; Mohamed Bakr; Mona Hanafi

Contents Page

Executive Summary

Micronutrient deficiencies, especially iron deficiency anemia, are a public health problem in Egypt, where the prevalence of anemia reaches about 40% (EHDS, 2005). A national flour fortification project is planned for implementation in early 2008, to fortify wheat flour used for subsidized baladi bread with iron and folic acid aiming to reduce the prevalence of anemia through increase iron and folate status of the Egyptian population. Baseline data is required before commencing fortification project as to be compared to final impact assessment of the project (3-5 years).

Therefore, the objective of this study was to assess of iron deficiency anemia status, and dietary iron and bread consumption among Egyptian population.

Field survey was conducted among 4526 households representing major six geographic regions of the country: Metropolitan (Cairo); Costal (Alexandria); Canal (Suez); Lower Egypt (Sharkia, Behaira, and kafr Elshaik); Upper Egypt (Bani-suif, Aswan, and Kena); Frontier (North Sinai and New Valley). Households were randomly selected from urban and rural residence area. Four target groups were considered: mothers (women of reproductive age 20-49.9 yr); preschool children (<5 yr); schoolchildren (5-<12 yr); and adolescents (12-18 yr). The survey was based on biochemical parameters and dietary practices.

Biochemical analysis was performed at NNI laboratories for collected blood samples from field. Hemoglobin determination was made for 18338 samples; determination of serum ferritin for 12293 samples and C-reactive protein (CRP) was performed for the samples of high ferritin levels to identify infection and/or inflammation. The WHO, 2001 cut-off points of hemoglobin and ferritin for each target group were used.

The collected qualitative and quantitative dietary data were analyzed to determine daily amount and type of bread consumed. Dietary iron intake was calculated using food composition tables and iron adequacy was estimated based on WHO 2002 requirements for iron.

Mean hemoglobin values for mothers, preschool children, schoolchildren, and adolescents were 11.9 g/dl, 11.3 g/dl, 12 g/dl, and 12.5 g/dl, respectively. The prevalence of anemia as indicated by hemoglobin was found among 47.2% of mothers, 39.6% of preschool children, while almost similar percents were recorded for school children and adolescents (35% and 35.7%, respectively). Prevalence of anemia was significantly varied among regions, and the highest percent were recorded for Lower Egypt among schoolchildren (55.7%) and mothers (53%), for Cairo among preschool children (54.1%) and adolescents (52%). No significant difference in the prevalence of anemia was found

between urban and rural, except among preschool children where the percent reach 42.7% in rural area.

Mean ferritin values for mothers, preschool children, schoolchildren, and adolescents were 21.2, 19.0, 22.2, and 20.3ng/ml, respectively. Prevalence of ferritin deficiency (depleted iron stores) was found to be the highest among mothers (49.6%), followed by adolescents (47.4%), then preschool and schoolchildren (38.2%). Prevalence of ferritin deficiency was significantly varied among regions, being very high among mother in Lower Egypt region (60%), and among adolescents in Cairo (61.5%), while Frontier region recorded high percent among schoolchildren (54%) and preschool children (49%). No significant difference was found between residence areas, except it was higher among mother in rural area (52.2%) ,and among urban adolescent (50.2%). Generally no difference was found among gender, except among Cairo adolescent females (47.9%).

The overall status of anemia was identified by hemoglobin/ferritin cross tabulation of 12023 cases, about 35 % of all target population was normal for both hemoglobin and ferritin. Iron deficiency anemia (low hemoglobin and low ferritin) was identified for 18.5%, while 26.2% was classified as iron deficiency (had low iron store with normal hemoglobin). Almost one-fifth (20.6%) of cases had high ferritin values but still anemic (low hemoglobin), and CRP determination confirm the presence of inflammation.

Mean daily dietary iron consumption values for mothers, preschool children, school aged children and adolescents were 17.2mg, 8.3mg, 10.9mg and 12.4 mg respectively. Iron from animal sources accounted for very low percent (16.7%) among mothers, while for other groups the percent was ranged from 24 to 25% of total dietary iron. Inadequate iron (<75% of RDA) was found among 34% of mothers, 49.4% of the preschool children (< 5 years), 46% of the school aged children (5- <12 years), and 39% of adolescents (≥ 12 years old).

The pattern of consumption of iron rich food of the Egyptian households depends mainly on plant source of iron more than the animal source of iron; bread beans were consumed daily by 25% of the households, while more than three quarters (77%) of them consumed eggs weekly. About 50% of the households consumed meat weekly; however 75% of them consumed meat organs monthly and fish were consumed monthly by 57 % of the households. The majority of households (77%) consumed vegetables and fruits weekly. The consumption of iron inhibitors mainly tea represent a major obstacle to dietary iron consumption and one of the bad dietary habit.

The majority of households (70%) purchase bread, the rest baked bread at home, especially in Frontier, Upper & Lower Egypt regions and rural area. Subsidized Baladi bread was the major type of bread consumed accounting for 67%, followed by home-made bread (30%), while white bread was the least. Mean daily bread consumption varied among different groups, adult male consumed 552g, adolescent 451g, mother 433g, schoolchildren 315g, and preschool children 142g. More of bread was consumed in

Frontier, Upper and Lower Egypt regions by almost all target groups than other regions, with Costal being the least bread consumption.

INTRODUCTION

Iron deficiency, and specifically iron deficiency anemia, is one of the most severe and important nutritional deficiencies in the world today, and every age group is vulnerable. Iron deficiency impairs the cognitive development of children from infancy through to adolescence. It damages immune mechanisms, and is associated with increased morbidity rates.

Iron deficiency is defined as a condition in which there are no mobilizable iron stores and in which signs of a compromised supply of iron to tissues, including the erythron, are noted. The more severe stages of iron deficiency are associated with anemia. Because anemia is the most common indicator used to screen for iron deficiency, the terms anemia, iron deficiency, and iron deficiency anemia are sometimes used interchangeably. There are, however, mild-to-moderate forms of iron deficiency in which, although anemia is absent, tissues are still functionally impaired. In addition, although iron deficiency anemia accounts for most of the anemia that occurs in underprivileged environments, several other possible causes should be noted. These include haemolysis occurring with malaria; glucose-6-phosphate dehydrogenase deficiency; congenital hereditary defects in haemoglobin synthesis; and deficits in other nutrients, e.g. vitamins A, B12, and C, and folic acid.

The economic implications of iron deficiency and of the various intervention strategies to combat it, suggest that food-based approaches and targeted supplementation are particularly cost-effective. The highest benefit-to-cost ratio is attained with food fortification.

In Egypt, iron deficiency anemia, remains a public health problem, where the prevalence of anemia reached 40% (EHDS, 2005).

The Ministry of Social Solidarity (MoSS), Food Industries Holding Company (FIHC), National Nutrition Institute (NNI), Ministry of Health (MoH) supported by the World Food Program (WFP) and GAIN are joining efforts to start flour fortification project in Egypt. Subsidized wheat flour (82% extraction rate, used for Baladi bread) is the target for fortification because it consider a staple food item. Flour fortification is set for adding 30ppm iron and 1.5ppm folic acid to wheat flour used for Baladi bread. The project is planned for three years (three phases from 2007 to 2010) to provide fortified flour to majority of population aiming at reducing the prevalence of anemia.

The baseline data is required before commencing fortification project as the data can be compared to final impact assessment of the project (3-5yr).

General Objective

The general objective is to provide baseline data on anemia status in Egypt, using field survey.

Specific Objectives

- To assess iron deficiency anemia status among target population
- To study dietary practice regarding iron food sources
- To identify bread consumption pattern
- To assess folate status among target population
- To study dietary practice regarding folate food sources

Methodology

Field survey was conducted among representative samples of households (HH) aiming four target population groups:

- Women of reproductive age (20 – 49.9 yr.)
- Children under 5 yr of age
- Children 5 - <12 yr of age
- Adolescents 12-19 yr of age

The target population was covered from a stratified community cluster sample technique for household (HH) and the HH sample size calculation considered the following:

- The prevalence of anemia (based on % Hb) at the start of the project (set at 40%)
- The anticipated change in the prevalence of anemia after fortification (set at 50% reduction), thus P2 = 20%)
- The design effect to correct sampling error due clustering technique (set at 2)
- The level of confidence (set at 0.95) and study power (set at 0.95)
- For compensation for non-response 0.1% of the sample is added /stratum

Sample selection:

The country's governorates were divided into different geographic regions: Urban governorates; Costal governorates; Suez Canal; Lower Egypt governorates; Upper Egypt governorates; and Frontiers governorates. Urban and rural areas from Lower & Upper regions were considered.

The governorates were chosen to end up with eleven governorates as follows:

- Urban governorates: Cairo
- Costal governorates: Alexandria
- Canal governorates : Suez
- Lower Egypt governorates: Kafr Elshaik; Sharkia; and Behaira;
- Upper Egypt governorates: Bani-suif; Aswan; and Kena
- Frontier governorates: New Valley and North Sinai

The most recent census data was considered for the selection of villages/cities using PPS technique. Selection of HH in each cluster was randomly selected according to the presence of primary health care facility (PHC), and schools around the mill. The selection of target population was based on mother and children (5yr) at household. Households' children 6-18yr will be selected from the nearest schools (primary, intermediate & secondary schools).

Preparation for field survey:

Survey questionnaire: The survey questionnaire (Annex 1) was designed and computer coded to include records for:

- Identification data: region, area, date, name, etc.
- Bread consumption pattern
- Quantitative & qualitative dietary practice regarding iron food sources
- Biochemical analysis results

Survey team: The survey team consisted from the following:

- Supervisor: survey team supervisor was assigned for each field team to manage the overall survey quality of data collection and compilation
- Data collectors' field worker: the team formulated from 6 nutritionists (4 dieticians, physician and social worker to interview, data collection, and data recording. Chemists and laboratory technicians included in the survey teams for withdrawal of venous blood from target surveyed population.
- Local team coordinator to facilitate survey work at HH, schools and PHC unites

Training: All survey team, except local coordinators, was trained (orientation; class room exercise; and field training on method of interview data collection and recording).

Data collection:

After approval of the research and ethical committees, the surveyed personnel approved to share in the survey and fill a consent form before any procedure of data collection.

Data collection was performed based on personal interview of target members and records the information using survey questionnaire. The data included bio-demographic data, and dietary data. The dietary data include quantitative food consumption (24 hours food intake including bread consumption status of the target populations), and qualitative dietary data (food frequency pattern, dietary intake of iron rich food, enhancers and inhibitors of iron intake) as well as bread consumption pattern for the different target population. Blood samples was collected from the target individuals, coded and sent to NNI laboratories for analysis and the result to be included in the original format.

Dietary Assessment

The surveyed mothers were questioned to collect relevant dietary data; Qualitative dietary assessment: Food frequency for the household and Quantitative dietary assessment: Twenty-Four hour recall and sample weighing for target individuals (Annexes).

1. Qualitative dietary assessment (Food frequency)

Information about the foods and beverages rich in iron and folic acid commonly consumed in Egypt was obtained using Food frequency. The questionnaire included number of intake from each food item daily, weekly, monthly and per year and the mean intake of each item per once was calculated.

2. Quantitative dietary assessment (24 hours recall)

Twenty-Four hour recall and sample weighing for target individuals was used to obtain accurate and detailed information. Recall for the exact foods and beverages intake during the previous 24 hour period prior to the day of data collection, in order to compare the

nutritional value of the food consumed with the recommended nutrient allowances (RNI). Quantities of foods and beverages consumed to be estimated in household measures and grams for final analysis using the NNI Food Composition Tables (2006). Adequacy of the diet consumed was assessed by comparing the macro and micro-nutrient intake with the recommended dietary and nutrient intake (FAO/WHO, 2002). Iron RNI was adjusted according to the criteria stated by WHO, (1989) which considers vitamin C intake and haem iron sources. So, the average Egyptian diet was categorized in the group of intermediate bioavailability of iron**.**

Laboratory analysis:

Biochemical analysis was performed at NNI laboratories. The analysis included determination of hemoglobin and serum ferritin.

Biochemical analysis

A venous blood sample of 5 ml was collected in heparinized tubes from the target individuals. Blood hemoglobin was immediately determined and the rest of the blood sample was centrifuged to obtain the plasma for determination of ferritin and folic acid. The plasma was divided into aliqots in Ependorf vials and stored at -20 c for the analysis. On each vial the ID of the family and the name of the target was recorded.

Determination of hemoglobin

Quantitative calorimetric determination of hemoglobin in the whole blood was determined using Cyanmethemoglobin method and the data are presented in term of gm/dl (**Villanova, 1994**)**.**

Determination of serum ferritin:

The quantitative determination of circulating ferritin in human serum was assayed by a immunoenzymometric assay using Accu Bind Kit according to the method of Tietz (1999)**.** Ferritin values are presented in terms of Ug/l

C-Reactive Protein (CRP):

The quantitative determination of CRP concentration in human serum was done by a immunoenzygmome tric assay using Accu Bind Ellisa Microwells according to Tietz (1995)

Indicators

Criteria of anemia

The prevalence of anemia in a population is best determined by using a reliable method of measuring haemoglobin concentration (**Villanova,** 1994).

Haemoglobin levels (g/dl) below which anaemia is present in a population are:

Age or gender group	Haemoglobin (g/dl)
Non-pregnant women (above 15 years of age)	12.0
Children 6 months to 59 months	11.0
Children 5–11 years	11.5
Children 12–14 years	12.0

The serum ferritin level is the most specific biochemical test that correlates with relative total body iron stores. A low serum ferritin level reflects depleted iron stores and hence is a precondition for iron deficiency in the absence of infection.

Interpretation of serum ferritin as an indicator of the relative extent of depletion of iron stores is presented. The generally accepted cut-off level for serum ferritin, below which iron stores are considered to be depleted, is <15 µg/l.

Relative extent of iron stores on the basis of serum ferritin concentration

Iron stores	Serum ferritin (µg/l)			
	Less than 5 years of age		More than 5 years of age	
	Male	Female	Male	M Female
Depleted iron stores	< 12	< 12	<15	<15

Data management

Double independent data entry was done using SPSS package. A file was prepared, with specific checks set on appropriate fields using the CHECK program to minimize data entry errors. Office quality check was done to ensure completeness of the forms upon receipt by the data management team. Coding was done for certain variables. For the yes / no questions, respectively, the digits "1" and "0" were consistently used throughout the form. After completion of data entry, two independent files were compared. In case any discrepancies between the two files, the original forms were revised and data entry was corrected accordingly.

Data were cleaned after completion of data entry. This involved creating summary tables with minimum and maximum values, frequencies and cross-tabulation. In the event that any outlying values were detected, they were ascertained from the original forms.

Statistical analysis

Descriptive statistics: Data were presented using descriptive statistics in the form of frequencies and percentages for qualitative variables, and means, medians and standard deviations for quantitative variables. Tabular and graphic presentations were used as appropriate.

Quantitative continuous data were compared using the Student t-test for comparing two groups. When normal distribution of the data could not be assumed, the non-parametric Mann-Whitney test was used instead of the Student, t-test. For multiple group comparisons of quantitative data, the one-way analysis of variance test (ANOVA) was used in case of normal distribution, and the kruskal-Wallis test was used in the case of lack of normal distribution. Qualitative variables were compared using chi-square test. Whenever the expected in one or more of the cells in a 2x2 table was less than 5, the Fisher test was used. Statistical significance was set at $p\text{-value}<0.05$

Results

Result of baseline data are presented in three sections: Anemia status; Folate status; and Dietary data

SECTION ONE: ANEMIA STATUS

This section present anemia status based on biochemical analysis among the four target groups: mothers, children (<5 years), schoolchildren (5 -<12 years), and adolescence (>12 years). The results include hemoglobin and ferritin analysis, percent distribution according to the cut-off levels for hemoglobin and ferritin to identify anemia and finally the relation between hemoglobin and ferritin.

Sample:

Basically the total number of households included in the survey was 4526 and the numbers of households' target individuals (mother, children < 5 yr; children 5 to < 12 yr; and adolescents ≥12 yr) were varied according to the type of analysis. Table (1) presents distribution of the total surveyed sample (18338) used for hemoglobin analysis. Mother sample accounted for 24% of the total , children < 5yr represent almost similar percent (23.9%), and schoolchildren < 12 yr represented by 14.3%, while adolescent accounted for 37.1% of the total sample. The sample represents the six geographic regions of the country by almost close percent (13% -17%), except Lower and Upper Egypt regions (each represented by about one-fifth of the total sample). Both urban and rural are presented, however the percent of urban sample was higher (about 65%) due to urban governorates (Cairo and Alexandria).

Table 1: Distribution of Surveyed Samples for Hemoglobin Analysis According to Geographic Region, Residence Area and Gender

Target group	*Mother*	*Children <5yr*	*Children 5 - <12 yr*	*Adolescent ≥12 yr*	*Total*
Total (No.)	**4526**	**4376**	**2620**	**6816**	**18338**
(%)	**(24)**	**(23.9)**	**(14.3)**	**(37.1)**	**(100)**
Geographic Region					
Metropolitan	1101	1097	390	617	**3205**
Costal	660	661	294	710	**2723**
Canal	758	802	633	530	**2723**
Lower Egypt	701	600	388	2080	**3769**
Upper Egypt	660	598	575	2175	**4008**
Frontier	646	618	340	704	**2308**
Residence Area					
Urban	3206	3127	1652	3929	**11914**
Rural	1320	1249	968	2887	**6424**
Gender					
Male	-	2307	1248	456	**4011**
Female	-	2069	1372	6362	**9803**

On the other hand, the total sample used for ferritin analysis was 12293 cases and distributed among the four target groups as shown in Table (2). Mother sample accounted for 25% of the total sample, young children (<5 years) 19%, older children (5-1<12 years) 15%, while adolescent age group accounted for 41% of total sample. The higher percent for adolescent was due to collecting the sample from schools.

Table 2: Distribution of Surveyed Samples for Ferritin Analysis According to Geographic Region, Residence Area and Gender

Target group	*Mother*	*Children <5yr*	*Children 5 - <12 yr*	*Adolescent ≥12 yr*	*Total*
Total (No.)	**3075**	**2345**	**1853**	**5020**	**12293**
(%)	**(25)**	**(19)**	**(15)**	**(41)**	**(100)**
Geographic Region					
Metropolitan	612	387	235	475	**1709**
Costal	341	261	209	613	**1424**
Canal	602	531	443	402	**1978**
Lower Egypt	595	451	310	1487	**2836**
Upper Egypt	490	391	434	1521	**2836**
Frontier	435	324	222	524	**1505**
Residence Area					
Urban	2075	1546	1128	2825	**7574**
Rural	`1000	799	725	2197	**4721**
Gender					
Male	-	1240	881	346	**2467**
Female	-	1105	972	4676	**6753**

Mother and Anemia Status

Hemoglobin analysis:

Normal hemoglobin level for adult female is 12g/dl and above, and this level is consider the cut-off level to identify anemia. Result in Table (3) and Figure (1); present the hemoglobin level among the overall sample of mother (4526). Mean hemoglobin was 11.9g/dl, with minimum and maximum values of 6.4 and 17.4 g/dl, respectively. A normal distribution of the sample (frequency by hemoglobin level) was observed (Fig. 1). Cumulative distribution of mothers according to hemoglobin levels (Fig 2) showed that almost 47% of the sample below 12g/dl (anemic) and most of them (42%) having level between 10- <12 g/dl (mild form of anemia) and the rest 5% had moderate degree of anemia (7- 9.9 gm/dl).

Table 3: Mean, median, minimum and maximum hemoglobin values among mothers

Hemoglobin level (g/dl)	No.	Mean (SD)	Median	Min.	Max.	F	P	Sig.
<12	2135	10.8 (0.79)	11.0	6.7	11.9	16.4	0.000	***
≥12	2391	12.9 (0.84)	12.8	12.0	17.4	21.3	0.000	***
Total	4526	11.9 (1.34)	12.0	6.7	17.4	20.9	0.000	***

Fig. (1): Normal distribution of total sample of Mothers according to Hemoglobin Levels

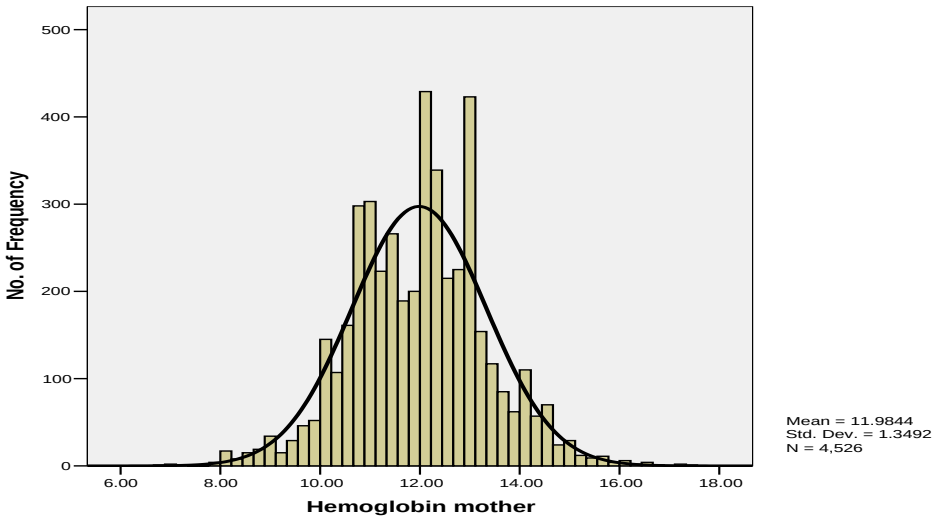
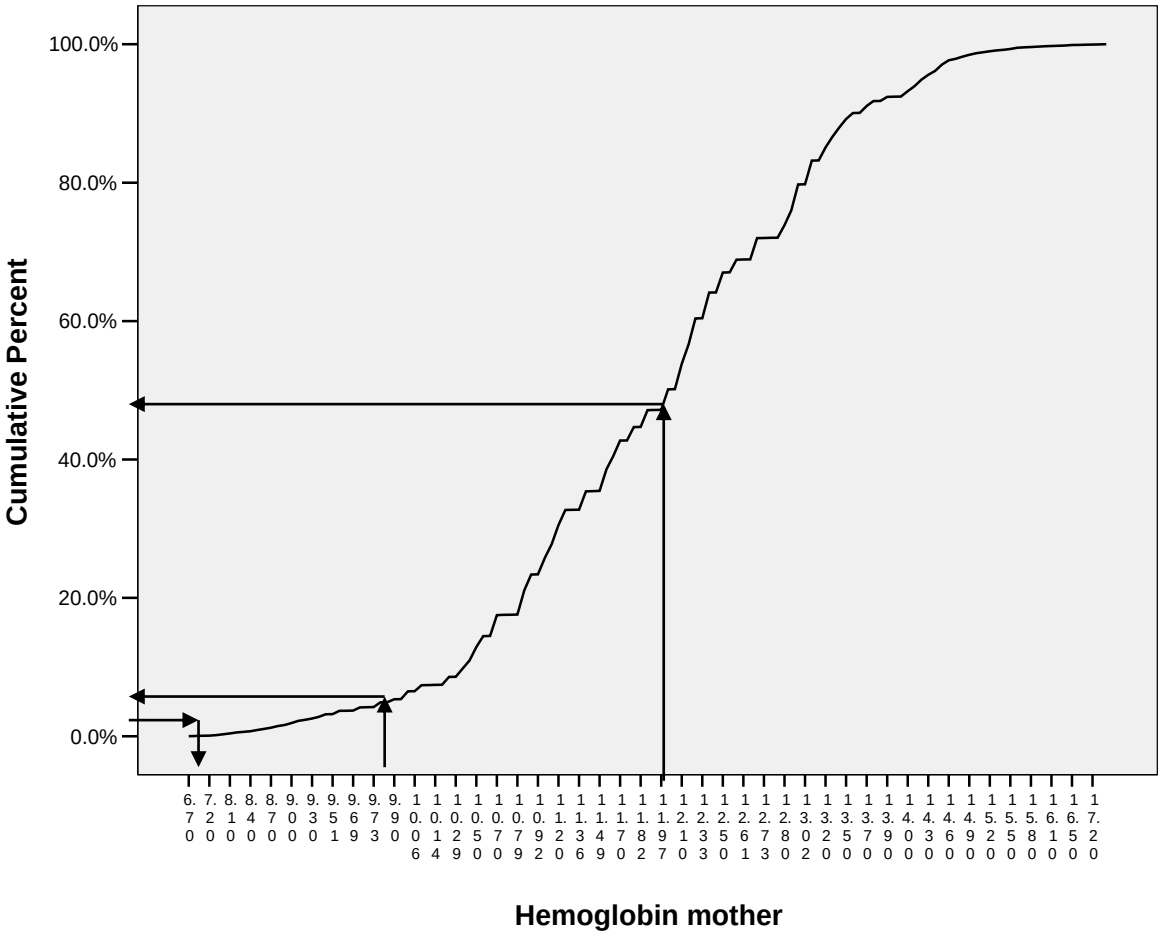


Fig. (2): Cumulative distribution of total sample of Mothers according to Hemoglobin Levels



Hemoglobin level values among mother were used to identify the prevalence of anemia according to geographic and residence area and results are presented in Table (4). A total of 47.2% of mothers were classified as anemic. Prevalence of anemia among regions was different significantly, but the difference was not significant between urban and rural areas. The higher percents were found in Lower Egypt, Upper Egypt, while the lowest percent was found for Frontier region.

Table 4: Percent distribution of mothers according to hemoglobin level by geographic region and residence area

	Hemoglobin level (g/dl)				Statistics
	< 12		≥12		
	No.	%	No.	%	
Total	2135	47.2	2391	52.8	
	Geographic Region				
Metropolitan	534	48.5	567	51.5	Chi-square=56.775 Df =5 P= 0.000 Sig.
Costal	314	47.6	346	52.4	
Canal	347	45.8	411	54.2	
Lower	372	53.1	329	46.9	
Upper	343	52.0	317	48.0	
Frontier	225	34.8	421	65.2	
	Residence Area				
Urban	1488	46.4	1718	53.6	Chi-square=2.541 Df = 1 P= 0.116 Not sign.
Rural	647	49.0	673	51.0	

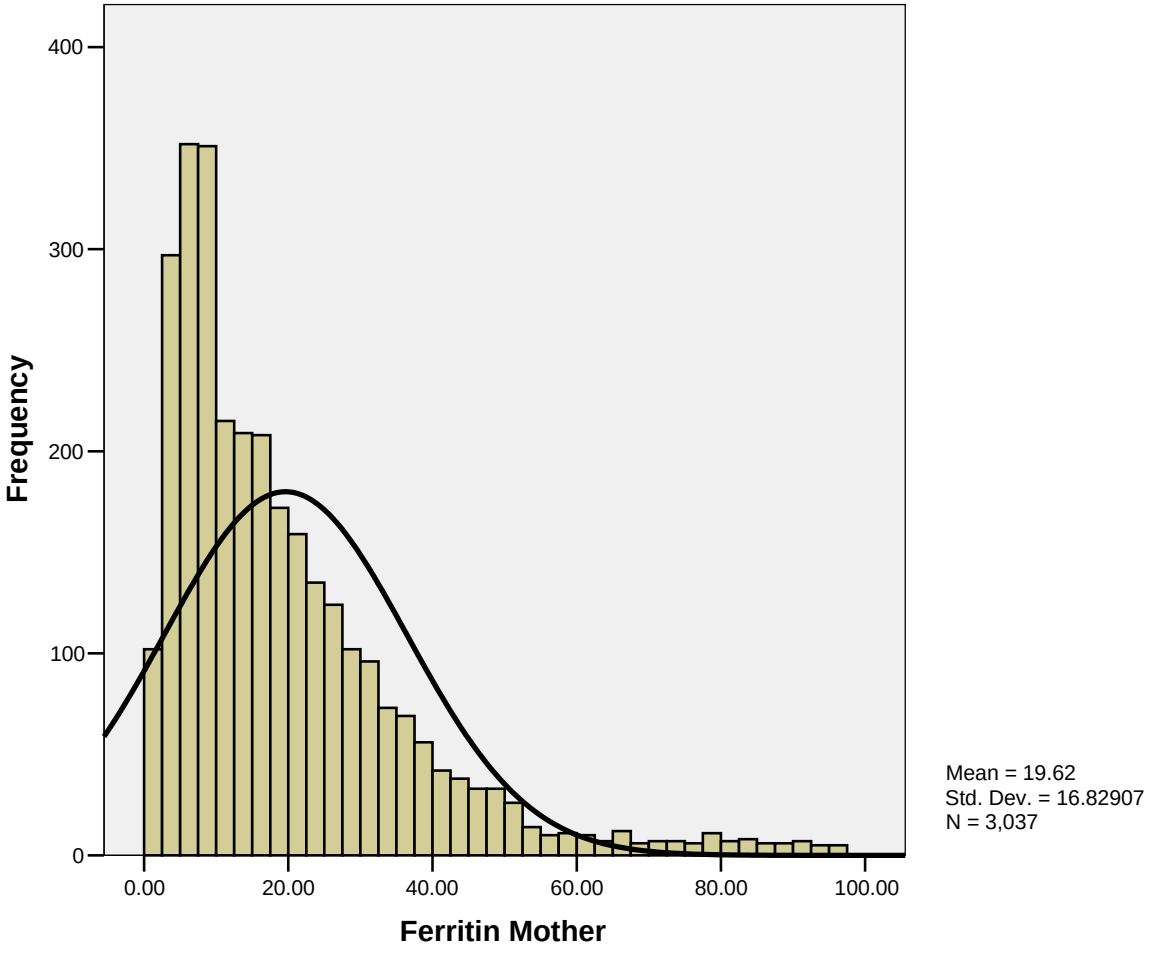
Ferritin analysis:

Serum ferritin of adult female is >15ng/ml, which indicate iron store. Serum ferritin analysis for mother was made for a total of 3075 sample, and Table (5) and Figure (2) present the status of the whole sample. The mean ferritin value was 19.6 µg/l. The recorded minimum and maximum values were 1.02 and 97.4 µg/l respectively.

Table 5: Mean, median, minimum and maximum Ferritin values among mothers

Ferritin level (µg/l)	No.	Mean (SD)	Median	Min.	Max.	F	P	Sig.
<15	1526	7.7 (3.6)	7.59	1.02	14.96	14.33	0.000	***
≥15	1511	31.8 (16.5)	26.7	15.0	97.4	4.954	0.000	***
Total	3037	19.6 (16.8)	14.9	1.02	97.4	20.5	0.000	***

Fig. (2): Normal Distribution of total sample of Mothers according to Ferritin Levels



The serum ferritin levels (cut-off level of <15 µg/l) was used to identify the deficiency of iron store among mother sample, and results is presented in Table (6). Almost half of mothers (49.6%) had depleted iron stores, and the difference between regions was statistically significant. Lower Egypt, Costal and Upper Egypt regions recorded the higher percent (53.3-60.3%) than other regions. With respect to urban and rural residence area no significant difference was detected.

Table 6: Percent distribution of mothers according to ferritin level by geographic region and residence area.

	Ferritin level (µg/l)				Statistics
	< 15		≥15		
	No.	%	No.	%	
Total	1526	49.6	1511	50.4	
Geographic Region					
Metropolitan	234	39.5	359	60.5	Chi-square= 66.955 Df =5 P= 0.000 Sig.
Costal	192	56.6	147	43.4	
Canal	276	46.2	322	53.8	
Lower	359	60.8	231	39.2	
Upper	261	53.5	227	46.5	
Frontier	204	47.6	225	52.4	
Residence Area					
Urban	1004	49.2	1038	50.8	Chi-square=2.905 Df = 1 P= 0.088 Non Sig.
Rural	522	52.2	473	47.5	

Relation between hemoglobin and ferritin among mothers:

Cross tabulation between hemoglobin and ferritin levels for total number of mothers' samples was 3019. Table (7) showed that only 27.2% of mothers had normal hemoglobin and ferritin. Iron deficiency anemia (low hemoglobin and ferritin levels) account for 25.1% of the total sample. Low ferritin level (iron deficient but with normal hemoglobin) reach 25.1% of total sample, while anemic cases with sufficient iron store accounted for 22.6%. CRP analysis showed a quite high percent of mothers (38.1%) had positive CRP value.

Table 7: Percent distribution of mothers according to hemoglobin and ferritin cross tabulation

Ferritin Level (µg/l)		Statistics	Hemoglobin level (g/dl)		Total
			<12	≥12	
	<15	(No.)	757	760	1517
		(%)	**25.1**	**25.1**	**50.2**
	≥15	(No.)	681	821	1502
		(%)	**22.6**	**27.2**	**49.8**
		(No.)	1438	1581	3019
Total		**(%)**	**47.6**	**52.4**	**100.0**

Children under Five-year and Anemia Status

Hemoglobin analysis:

The normal hemoglobin level for young children (<5years) is 11g/ml and above, and this level is consider the cut-off level to identify anemia. Result in Table (8) and Figure (4); present the hemoglobin level among the overall sample of children <5years (4376). Mean hemoglobin was 11.3g/dl, with minimum and maximum values of 7.0 and 17.1 g/dl, respectively. A normal distribution of the sample (frequency by hemoglobin level) was observed (Fig. 4). Cumulative distribution of children < 5 years according to hemoglobin levels (Fig 5) showed that almost 39.6% of the sample was below 11g/dl (anemic) and most of them (29%) having level between 10- <11 g/dl (mild form of anemia) and the rest 11% had moderate degree of anemia (7- 9.9 gm/dl).

Table 8: Mean, Median, Minimum and Maximum Hemoglobin values among total sample of children <5 years.

Hemoglobin level (g/dl)	No.	Mean (SD)	Median	Min.	Max.	F	P	Sig.
<11	1731	10.19 (0.60)	10.40	7.0	10.95	12.41	0.000	***
≥11	12.10	12.10 (0.95)	11.90	11.0	17.10	39.58	0.000	***
Total	4376	11.30 (1.20)	11.20	7.0	17.10	70.87	0.000	***

Fig. (4): Normal Distribution of total sample of Children < 5 years according to Hemoglobin Levels

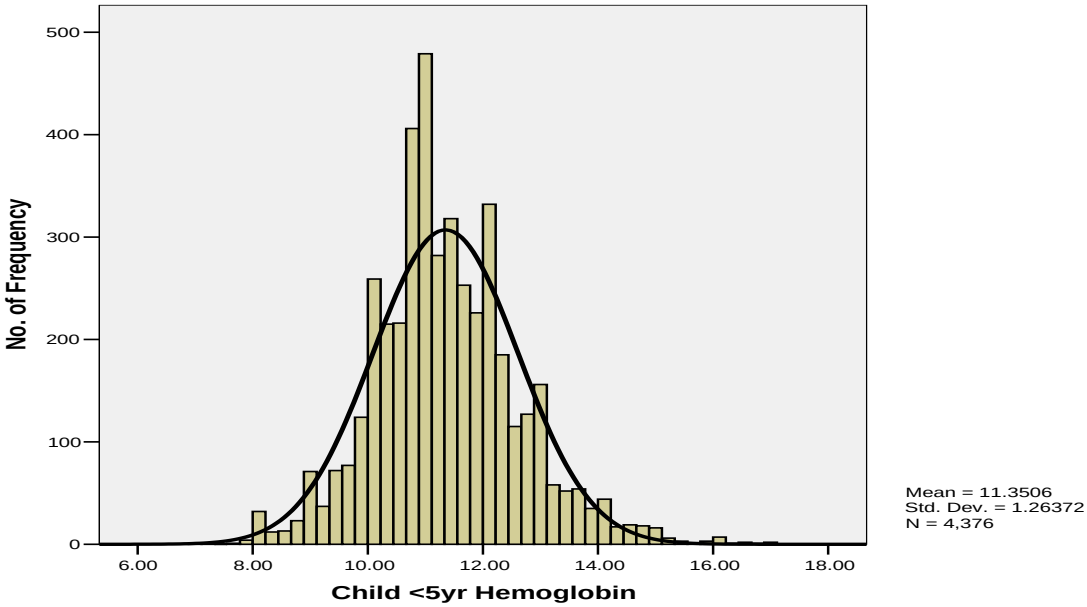
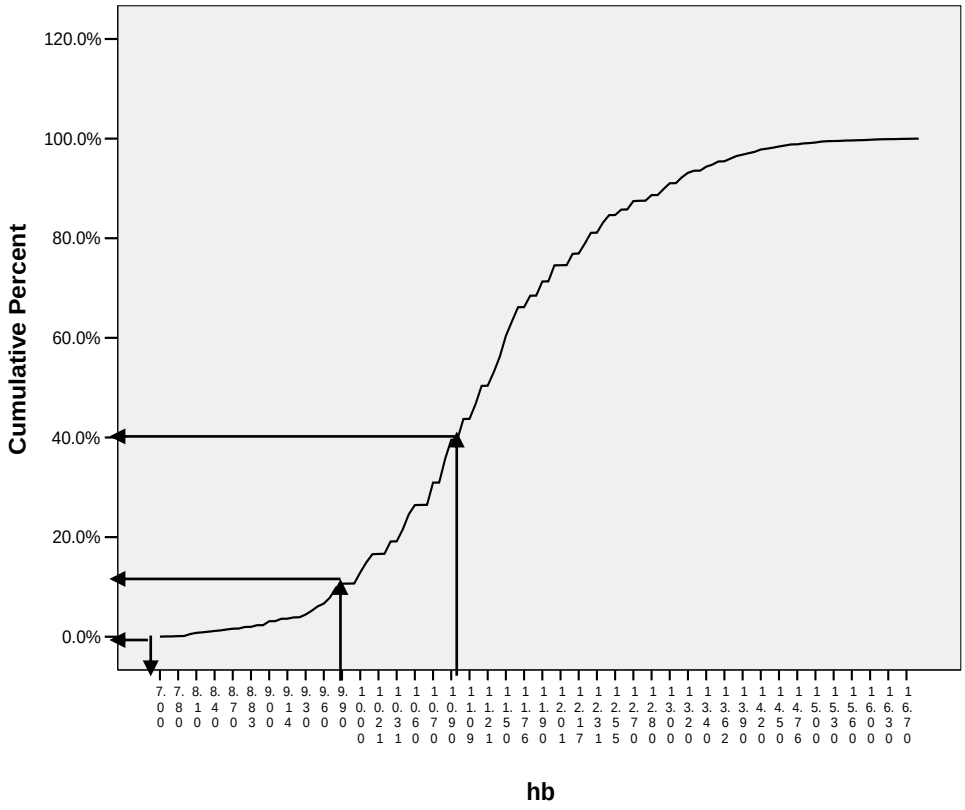


Fig. (5): cumulative Distribution of total sample of Children < 5 years according to Hemoglobin Levels



Hemoglobin level values among children <5 years were used to identify the prevalence of anemia according to geographic and residence area and results are presented in Table (9). A total of 39.6% of children <5 years were classified as anemic. Prevalence of anemia among regions was different significantly, but the difference was not significant between urban and rural areas. The higher percents were found in Metropolitan, Canal, while the lowest percent was found for Coastal region (22.5%).

Table 9: Percent distribution of children <5 years according to hemoglobin level by geographic region, residence area and gender

	Hemoglobin level (g/dl)				Statistics
	< 11		≥11		
Total	No.	%	No.	%	
	1731	39.6	2645	60.4	
	Geographic Region				
Metropolitan	594	54.1	503	45.9	Chi-square=253.3 Df =5 P= 0.000 Sig.
Costal	149	22.5	512	77.5	
Canal	356	44.4	446	55.6	
Lower	264	44.0	336	56.0	
Upper	218	36.5	380	63.5	
Frontier	150	24.3	468	75.7	
	Residence Area				
Urban	1198	38.3	1929	61.7	Chi-square=7.10 Df = 1 P= 0.008 Sign.
Rural	533	42.7	716	57.3	
	Gender				
Male	877	38.0	1430	62.0	Chi-square=4.85 Df=1 P=0.028 Sig.
Female	854	41.3	1215	58.7	

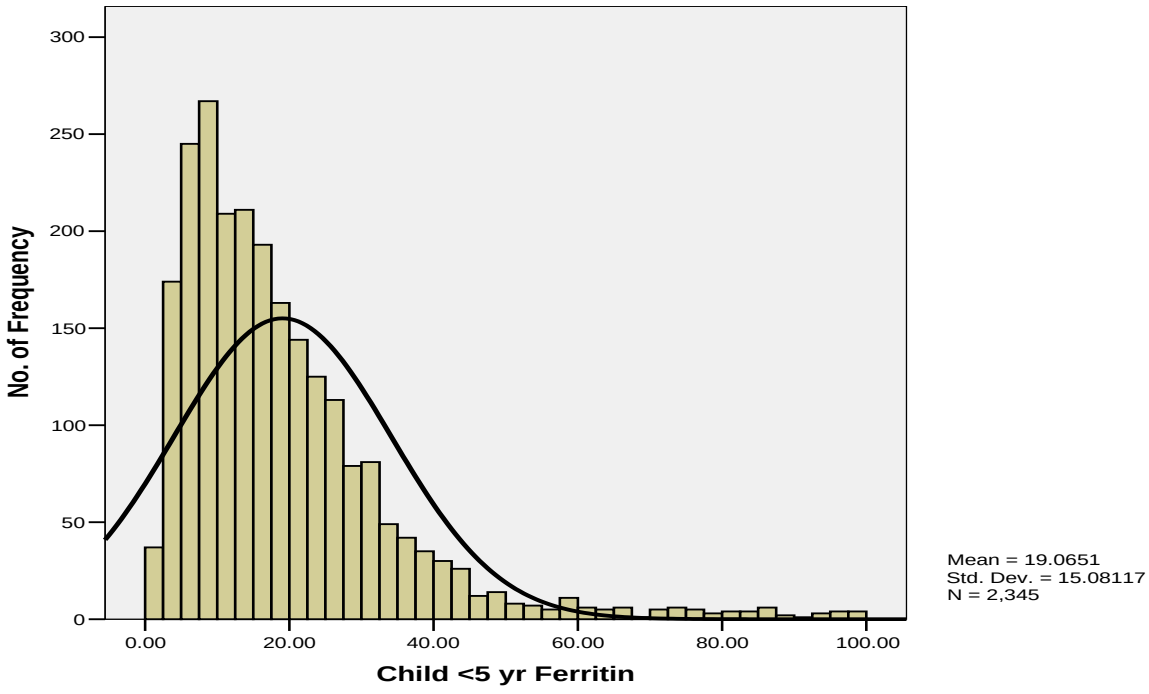
Ferritin Analysis:

Serum ferritin among <5 children is >12 µg/l , which indicate iron store. Serum ferritin analysis for **<5 children** was made for a total of 3075 sample. Table (10) and Figure (6) present the status of the whole<5 children sample. The mean ferritin value was 19.0 µg/l .

Table 10: Mean, median, minimum and maximum Ferritin values among <5y children

Ferritin level (µg/l)	No.	Mean (SD)	Median	Min.	Max.	F	P	Sig.
<12	895	7.26 (2.76)	7.42	1.08	11.99	6.883	0.000	***
≥12	1450	26.30 (14.97)	22.00	12.0	99.83	5.679	0.000	***
Total	3075	19.00 (15.08)	15.40	1.08	99.83	18.024	0.000	***

Fig. (6): Normal Distribution of total sample of Children < 5 years according to Ferritin Levels



The serum ferritin levels (cut-off level of <12 µg/l) was used to identify the deficiency of iron store among **<5 children** sample, and results is presented in Table (11). Almost 40%of **<5 children** (38.2%) had depleted iron stores, and the difference between regions was statistically significant. Lower Egypt, and Frontier regions recorded the higher percent (49.1-46.6%) than other regions. With respect to urban and rural residence area no significant difference was detected.

Table 11: Percent distribution of children <5years according to ferritin level by geographic region, residence area and gender

	Ferritin level (µg/l)				Statistics
	< 12		≥12		
	No.	%	No.	%	
Total	895	38.2	1450	61.8	
Geographic Region					
Metropolitan	136	35.1	251	64.9	Chi-square =68.719 Df =5 P= 0.000 Sig.
Costal	113	43.3	148	56.7	
Canal	138	26.0	393	74.0	
Lower	210	46.6	241	53.4	
Upper	139	35.5	252	64.5	
Frontier	159	49.1	165	50.9	
Residence Area					
Urban	597	38.6	949	61.4	Chi-square =0.3388 Df = 1 P> 0.05 Not sign.
Rural	298	37.3	501	62.7	
Gender					
Male	479	38.6	761	61.4	Chi-square =0.239 Df=1 P=0.625 Not sig.
Female	416	37.6	689	62.4	

Relation between hemoglobin and ferritin among children <5years:

Cross tabulation between hemoglobin and ferritin levels for total number **<5 children**' samples was 2345. Table (12) showed that only 37.6% of them had normal hemoglobin and ferritin. Iron deficiency anemia (low hemoglobin and ferritin levels) account for 15.1% of the total sample. Low ferritin level (iron deficient but with normal hemoglobin) reach 22.7% of total sample, while anemic cases with sufficient iron store accounted for 24.6%. CRP analysis showed a quite high percent **among <5 children** (25.1%) had positive CRP value.

Table 12: Percent distribution of children <5 years according to hemoglobin and ferritin cross tabulation

Ferritin Level (µg/l)		Statistics	Hemoglobin level (g/dl)		Total
			<11	≥11	
	<12	(No.)	355	532	887
		(%)	**15.1**	**22.7**	**37.8**
	≥12	(No.)	576	882	1458
		(%)	**24.6**	**37.6**	**62.2**
Total		(No.)	931	1414	2345
		(%)	**39.7**	**60.3**	**100.0**

Children 5 - <12 years and Anemia Status

Hemoglobin Analysis:

Normal hemoglobin level for **children 5-<12 years** is 11.5g/dl and above, and this level is consider the cut-off level to identify anemia. Results in Table (13) and Figure (7); present the hemoglobin level among the overall sample of 2620 **children 5-<12 years**. Mean hemoglobin was 12.0g/dl, normal distribution of the sample (frequency by hemoglobin level) was observed (Fig 7). Cumulative distribution of children 5- <12 years according to hemoglobin levels (Fig.7) showed that almost 35.3% of the sample below 11.5g/dl (anemic) and most of them (24%) having level between 10.5- <11.4 g/dl (mild form of anemia) and the rest 11.4% had moderate degree of anemia (7.5- 10.4 gm/dl).

Table 13: Mean, median, minimum and maximum Hemoglobin values among total sample children 5-<12 years.

Hemoglobin level (g/dl)	No.	Mean (SD)	Median	Min.	Max.	F	P	Sig.
<11.5	926	10.5 (0.69)	10.80	7.1	11.40	1.870	0.097	NS
≥11.5	1694	12.7 (1.00)	12.60	11.5	17.20	8.532	0.000	***
Total	2620	12.0 (1.38)	11.90	7.1	17.20	24.30	0.000	***

Fig. (7): Normal distribution of total sample of Children 5- < 12 years according to Hemoglobin Levels

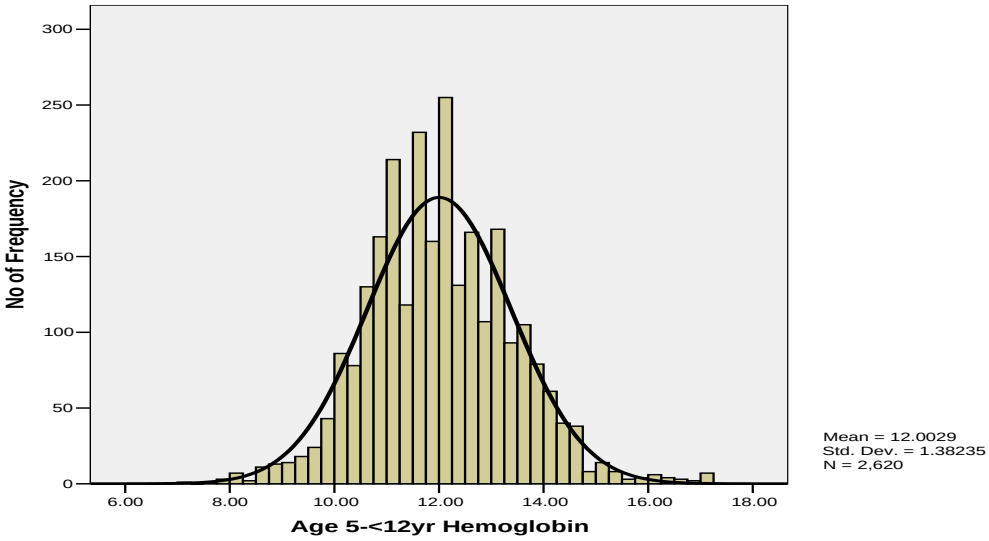
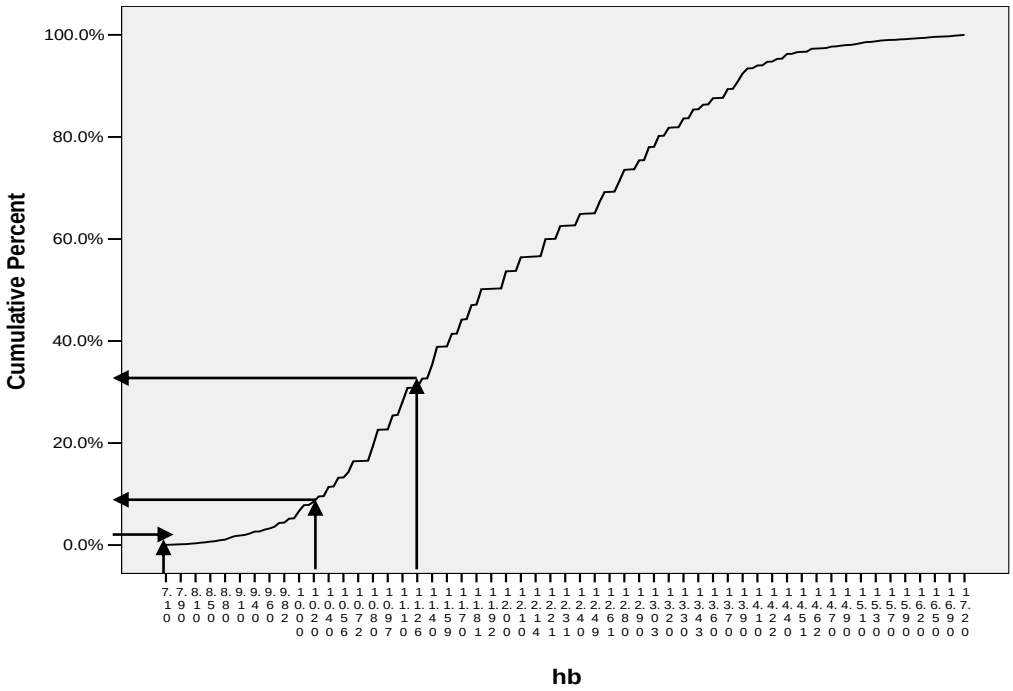


Fig. (8): Cumulative distribution of total sample of Children 5- < 12 years according to Hemoglobin Levels



Hemoglobin level values among **children 5-<12 years** were used to identify the prevalence of anemia according to geographic and residence area and results are presented in Table (14). A total of 35.3% of **children 5-<12 years** were classified as anemic. Prevalence of anemia among regions was different significantly, but the difference was not significant between urban and rural areas and between gender. The higher percents were found in Lower Egypt, Metropolitan, while the lowest percent was found for canal region.

Table 14: Percent distribution of children 5-<12 years according to hemoglobin level by geographic region, residence area and gender

	Hemoglobin level (g/dl)				Statistics
	< 11.5		≥11.5		
	No.	%	No.	%	
Total	926	35.3	1694	64.7	
	Geographic Region				
Metropolitan	177	45.4	213	54.6	Chi-square =133.642 Df =5 P= 0.000 Sig.
Costal	88	29.9	206	70.1	
Canal	149	23.5	484	76.5	
Lower	216	55.7	172	44.3	
Upper	190	33.0	385	67.0	
Frontier	106	31.2	234	68.8	
	Residence Area				
Urban	587	35.5	1065	64.5	Chi-square = 0.07 Df = 1 P= 0.8 Not sign.
Rural	339	35.0	629	65.0	
	Gender				
Male	444	35.6	804	64.4	Chi-square = 0.057 Df=1 P=0.838 Not sig.
Female	482	35.1	890	64.9	

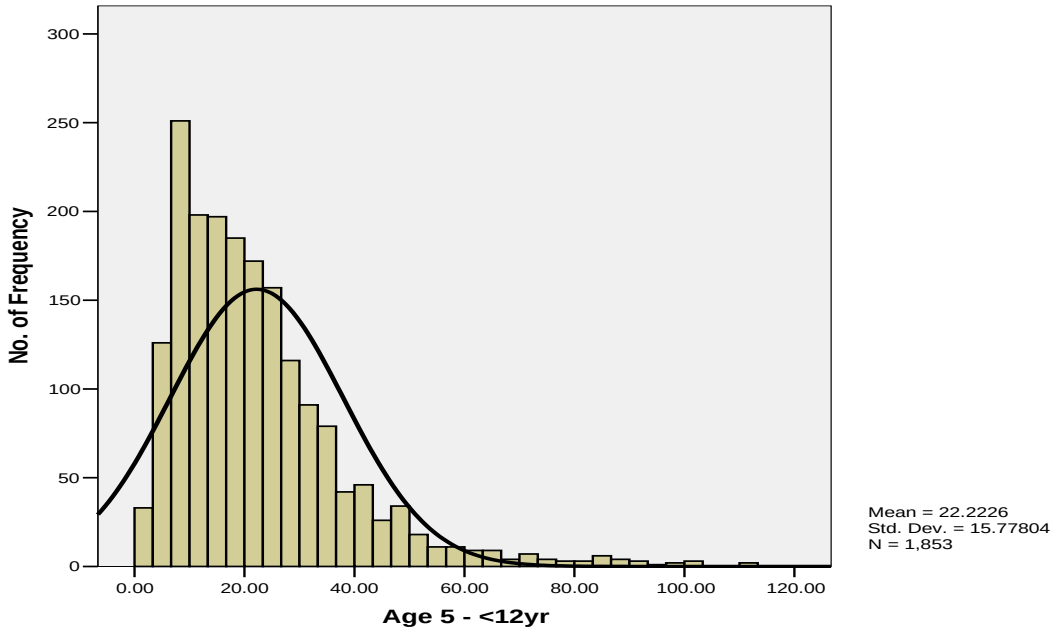
Ferritin Analysis:

Serum ferritin of **children 5-<12 years** is >15 µg/l, which indicate iron store. Serum ferritin analysis for **children 5-<12 years** was made for a total of 1853 sample, and Table (15) and Figure (9) present the status of the whole sample. The mean ferritin value was 22.2 µg/l. The recorded minimum and maximum values were 1.2 and 112.6 µg/l, respectively

Table 15: Mean, median, minimum and maximum Ferritin values among children 5-<12 years

Ferritin level (µg/l)	No.	Mean (SD)	Median	Min.	Max.	F	P	Sig.
<15	707	9.26 (3.3)	9.38	1.30	14.98	1.503	0.187	NS
≥15	1146	30.2 (15.1)	25.6	15.0	112.6	5.041	0.000	***
Total	1853	22.2 (15.7)	18.9	1.30	112.6	9.2	0.000	***

Fig. (9): Normal Distribution of total sample of Children 5- < 12 years according to Ferritin Levels



The serum ferritin levels (cut-off level of <15 µg/l) was used to identify the deficiency of iron store among **children 5-<12 years** sample, and results is presented in Table (16). About 38.2% of **children 5-<12 years** had depleted iron stores, and the difference between regions was statistically significant. Frontier region recorded the highest percent (54.1%). With respect to urban and rural residence area no significant difference was detected, also no significance difference was found among gender.

Table 16: Percent distribution of children 5-<12 years according to ferritin level by geographic region, residence area and gender

	Ferritin level (µg/l)				Statistics
	<15		≥15		
	No.	%	No.	%	
Total	707	38.2	1146	61.8	
Geographic Region					
Metropolitan	97	41.3	138	58.7	Chi-square =39.383 Df =5 P= 0.000 Sig.
Costal	63	30.1	146	69.9	
Canal	162	36.6	281	63.4	
Lower	127	41.0	183	59.0	
Upper	138	31.8	296	68.2	
Frontier	120	54.1	102	45.9	
Residence Area					
Urban	450	39.9	678	60.1	Chi-square =3.696 Df = 1 P= 0.056 Not sign.
Rural	257	35.4	468	64.6	
Gender					
Male	331	37.6	550	62.4	Chi-square =0.242 Df=1 P=0.632 Not sig.
Female	376	38.7	596	61.3	

Relation between hemoglobin and ferritin among children 5-<12 years:

Cross tabulation between hemoglobin and ferritin levels for total number of **children 5-<12 years**' samples was 1836. Table 17, showed that 41.5% of **children 5-<12 years** had normal hemoglobin and ferritin. Iron deficiency anemia (low hemoglobin and ferritin levels) account for 13.6% of the total sample. Low ferritin level (iron deficient but with normal hemoglobin) reach 24.2% of total sample, while anemic cases with sufficient iron store accounted for 20.6%. CRP analysis showed a quite high percent of **children 5-<12 years** (24.1%) had positive CRP value.

Table 17: Percent distribution of children 5-<12 years according to hemoglobin and ferritin cross tabulation

Ferritin Level (µg/l)		Statistics	Hemoglobin level (g/dl)		Total
			<11..5	≥11.5	
	<15	(No.)	250	445	695
		(%)	**13.6**	**24.2**	**37.9**
	≥15	(No.)	379	762	1141
		(%)	**20.6**	**41.5**	**62.1**
Total		(No.)	629	1207	1836
		(%)	**34.3**	**65.7**	**100.0**

Adolescents and Anemia Status

Hemoglobin analysis:

Normal hemoglobin level for a**dolescents** is 12 g/dl and above, and this level is consider the cut-off level to identify anemia. Result in Table (18) and Figure (10); present the hemoglobin level among the overall sample of **Adolescents** (6816). Mean hemoglobin was 12.5g/dl. A normal distribution of the sample (frequency by hemoglobin level) was observed (Fig. 10). Cumulative distribution of adolescents ≥12years according to hemoglobin levels (Fig. 11) showed that almost 35.7% of the sample below 12g/dl (anemic) and most of them (30.5%) having level between 10- <12 g/dl (mild form of anemia) and the rest 5% had moderate degree of anemia (7- 9.9 gm/dl).

Table 18: Mean, Median, minimum and maximum hemoglobin values among adolescents (≥12 years) total sample.

Hemoglobin level (g/dl)	No.	Mean (SD)	Median	Min.	Max.	F	P	Sig.
<12	2436	10.91 (0.97)	11.2	5.7	11.96	72.652	0.000	***
≥12	4380	13.35 (1.03)	13.2	12.0	19.00	19.378	0.000	***
Total	6816	12.48 (1.54)	12.5	5.7	19.00	34.04	0.000	***

Fig. (10): Normal distribution of total sample of adolescents (≥12 years) according to Hemoglobin Levels

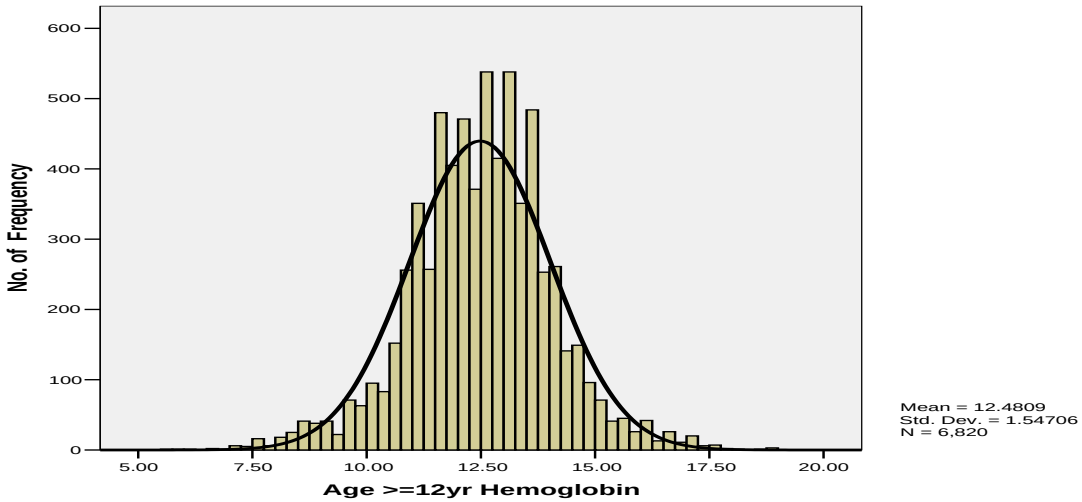
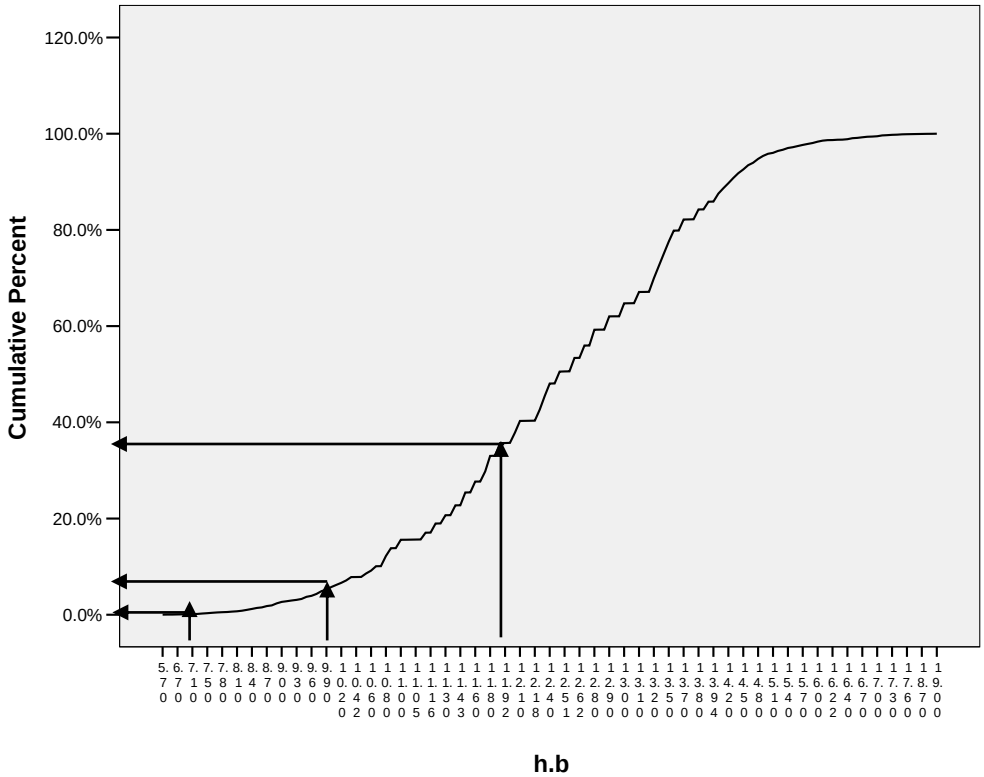


Fig. (11): Cumulative distribution of total sample of adolescents (≥12 years) according to Hemoglobin Levels



Hemoglobin level values among adolescents were used to identify the prevalence of anemia according to geographic and residence area and results are presented in Table (19). A total of 35.7% of adolescents were classified as anemic. Prevalence of anemia among regions was different significantly, but the difference was not significant between urban and rural areas. The highest percent was found in Metropolitan (52.8%) while the lowest percent was found for Canal region (32%). With respect to gender, male recorded significantly higher percent of anemia (52.4%) than female adolescents (34.5%).

Table 19: Percent distribution of adolescents according to hemoglobin level by geographic region, residence area and gender

	Hemoglobin level (g/dl)				Statistics
	< 12		≥12		
	No.	%	No.	%	
Total	2436	35.7	4380	64.3	
	Geographic Region				
Metropolitan	326	52.8	291	47.2	Chi-square =106.948 Df =5 P= 0.000 Sig.
Costal	257	36.2	453	63.8	
Canal	217	40.9	313	59.1	
Lower	665	32.0	1415	68.0	
Upper	711	32.7	1464	67.3	
Frontier	260	36.9	444	63.1	
	Residence Area				
Urban	1402	35.7	2529	64.3	Chi-square =0.027 Df = 1 P= 0.878 Not sign.
Rural	1035	35.9	1852	64.1	
	Gender				
Male	239	52.4	217	47.6	Chi-square =59.117 Df=1 P=0.000 Sig.
Female	2198	34.5	4164	65.5	

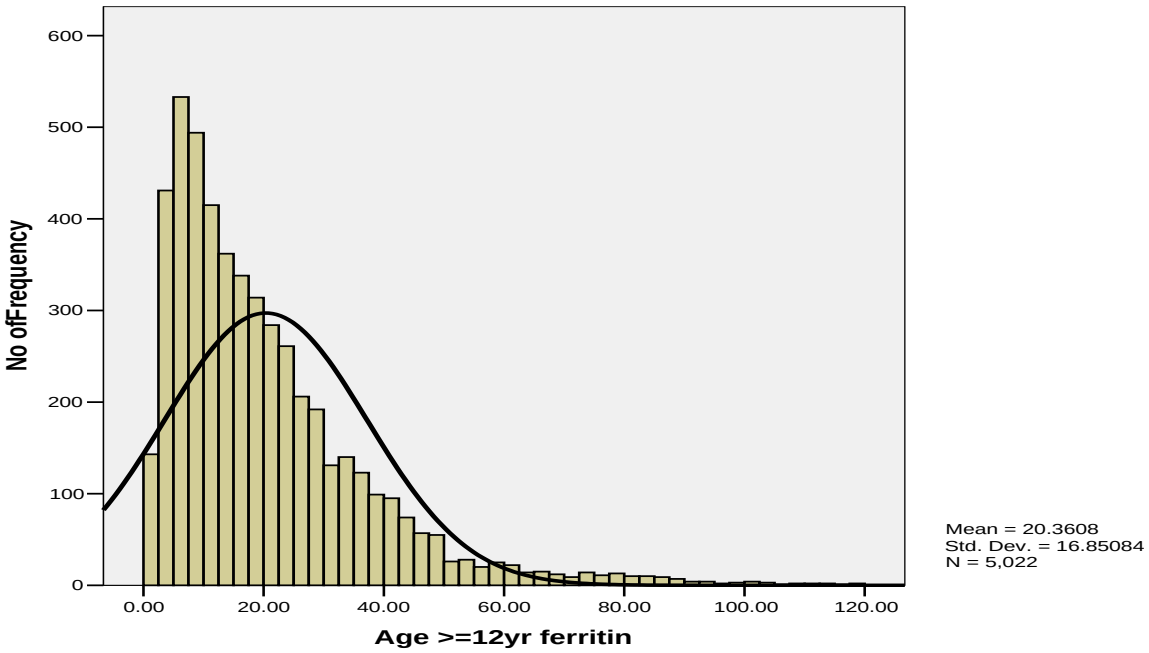
Ferritin Analysis:

Normal serum ferritin of **Adolescents** is >15 µg/l, which indicate normal iron store. Serum ferritin analysis for **Adolescents** was made for a total of 5019 sample, and Table (20) and Figure (12) present the status of the whole sample. The mean ferritin value was 20.4 µg/l, the recorded minimum and maximum values were 1.00 and 118.1 µg/l, respectively

Table 20: Mean, median, minimum and maximum Ferritin values among adolescents

Ferritin level (µg/l)	No.	Mean (SD)	Median	Min.	Max.	F	P	Sig.
<15	2378	8.05 (3.6)	7.9	1. 0	14.97	8.555	0.000	***
≥15	2641	31.42 (26.52)	15.0	15.0	118.1	6.633	0.000	***
Total	5019	20.36 (16.85)	15.9	1.0	118.1	41.48	0.000	***

Fig. (12): Normal distribution of total sample of adolescents according to Ferritin Levels



The serum ferritin levels (cut-off level of <15 µg/l) was used to identify the deficiency of iron store among **Adolescents** sample, and results is presented in Table (21). Almost half of **Adolescents** (47.4%) had depleted iron stores, and the difference between regions was statistically significant. Metropolitan, Lower Egypt, and Frontier regions recorded the higher percent (58.0-61.5%) than other regions. With respect to urban and rural residence area no significant difference was detected. Low ferritin was significantly higher among females than males (47.9% and 39.6% respectively).

Table 21: Percent distribution of adolescents according to ferritin level by geographic region, residence area and gender

	Ferritin level (µg/l)				Statistics
	< 15		≥15		
	No.	%	No.	%	
Total	2378	47.4	2644	52.6	
Geographic Region					
Metropolitan	291	61.5	184	38.5	Chi-square =196.379 Df =5 P= 0.000 Sig.
Costal	230	37.5	383	62.5	
Canal	238	59.2	164	40.8	
Lower	767	51.6	720	48.4	
Upper	548	36.1	973	63.9	
Frontier	304	58.0	220	42.0	
Residence Area					
Urban	1418	50.2	1407	49.8	Chi-square =21.11 Df = 1 P=0.000Sign.
Rural	960	43.7	1237	56.3	
Gender					
Male	137	39.6	209	60.4	Chi-square =8.967 Df=1 P=0.002 Sig.
Female	2241	47.9	2435	52.1	

Relation between hemoglobin and ferritin among adolescents:

Cross tabulation between hemoglobin and ferritin levels for total number of **adolescent**' samples were 4823. Table (22) showed that only 35.3% of **adolescents** had normal hemoglobin and ferritin. Iron deficiency anemia (low hemoglobin and ferritin levels) account for 17.9% of the total sample. Low ferritin level (iron deficient but with normal hemoglobin) reach 29.4% of total sample, while anemic cases with sufficient iron store accounted for 17.4%. CRP analysis showed a quite high percent of mothers (19.1%) had positive CRP value.

Table 22: Percent distribution of adolescents according to hemoglobin and ferritin cross tabulation

Ferritin Level (µg/l)		Statistics	Hemoglobin level (g/dl)		Total
			<12	≥12	
	<15	(No.)	865	1417	2282
		(%)	**17.9**	**29.4**	**47.3**
	≥15	(No.)	840	1701	2541
		(%)	**17.4**	**35.3**	**52.7**
Total		(No.)	1705	3118	4823
		(%)	**35.4**	**64.6**	**100.0**

Overall anemia and iron deficiency anemia among target population

Table (23) summarizes the overall finding of cross tabulation for all target population showed that 34.7% was normal for both hemoglobin and ferritin. Iron deficiency anemia (low hemoglobin and low ferritin) was identified for 18.5%, while 26.2% was classified as iron deficiency (had low iron store with normal hemoglobin). Almost one-fifth (20.6%) of cases had high ferritin values but still anemic (low hemoglobin), and CRP determination confirm the presence of inflammation.

Table 23: Percent distribution of all target population according to hemoglobin and ferritin cross tabulation

Ferritin Status		Statistics	Hemoglobin status		Total
			Anemic	Non-anemic	
	Iron depleted	(No.)	2227	3154	5381
		(%)	**18.5**	**26.2**	**44.7**
	Iron non-depleted	(No.)	2476	4166	6642
		(%)	**20.6**	**34.7**	**55.3**
Total		(No.)	4703	7320	12023
		(%)	**39.1**	**60.9**	**100.0**

Section 2: Dietary data

This section describes the dietary consumption of iron derived from the qualitative and quantitative analysis of the dietary data. The results will be presented to show:

- The frequency and pattern of consumption of food rich in iron, consumption of food that enhance iron absorption as well as food inhibit iron absorption for the households
- Adequacy of consumption of dietary iron compared to the Recommended Nutrient Intake (RNI) according to WHO/FAO/UNU, 2002
- Bread consumption

Sample

Table (24) presents the sample used for dietary data among the four target groups: mothers (adult female); children <5 years; children 5-<12 years; adolescents; as well as adult male. The data on bread consumption were made for the above mentioned groups, while iron dietary intake was focuses on the target groups. Finally household qualitative dietary pattern of iron rich and iron inhibitors was made.

Table (24): Distribution of surveyed sample according to geographic regions

	Adult males	Mothers	Children (<5yr)	Children (5-<12yr)	Adolescents	Total
Metropolitan	864	871	867	476	460	**3538**
Costal	573	578	579	302	392	**2424**
Canal	632	647	644	415	493	**2831**
Lower Egypt	698	703	700	515	764	**3380**
Upper Egypt	664	680	673	629	1057	**3703**
Frontier	629	641	640	415	320	**2645**
Total	**4060**	**4120**	**4103**	**2752**	**3486**	**18521**

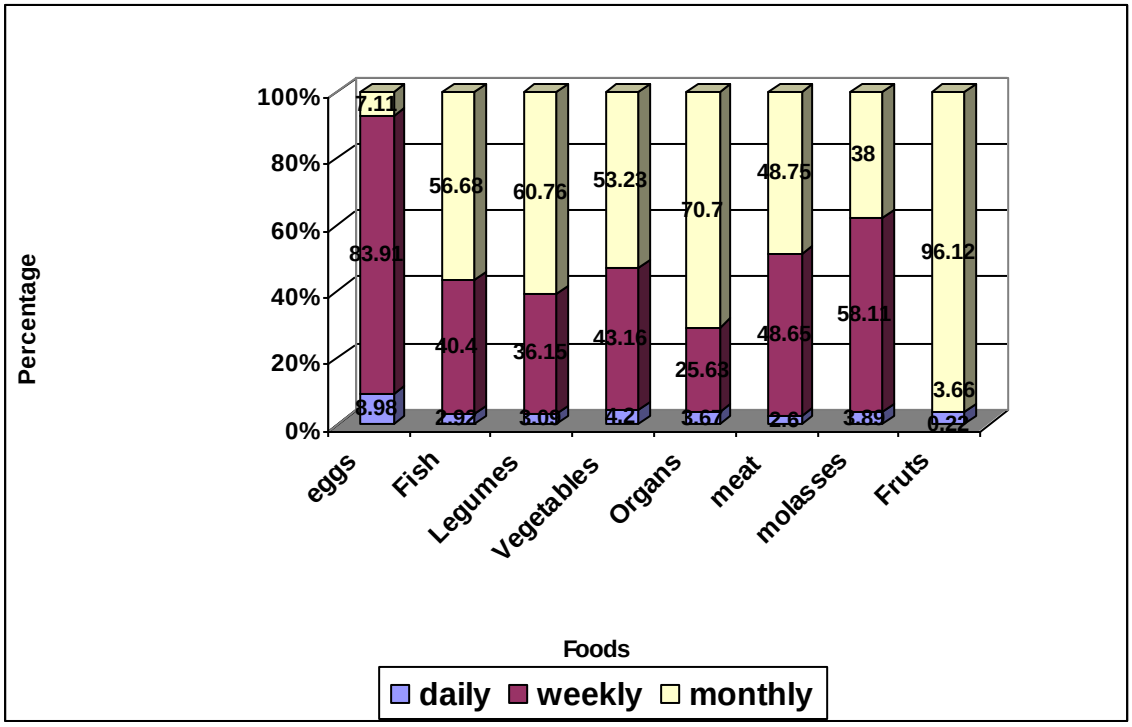
.

Pattern of consumption of dietary iron

1. Consumption of iron rich food

The pattern of consumption of iron rich food of the Egyptian households depends mainly on plant source of iron more than the animal source of iron (more expensive). Broad beans were consumed daily by 25% of the households and weekly by 75% of the households, while more than three quarters (77%) of them consumed eggs weekly as shown in figure (13). About 50% of the households consumed meat weekly; however 75% of them consumed meat organs monthly and fish were consumed monthly by 57 % of the households.

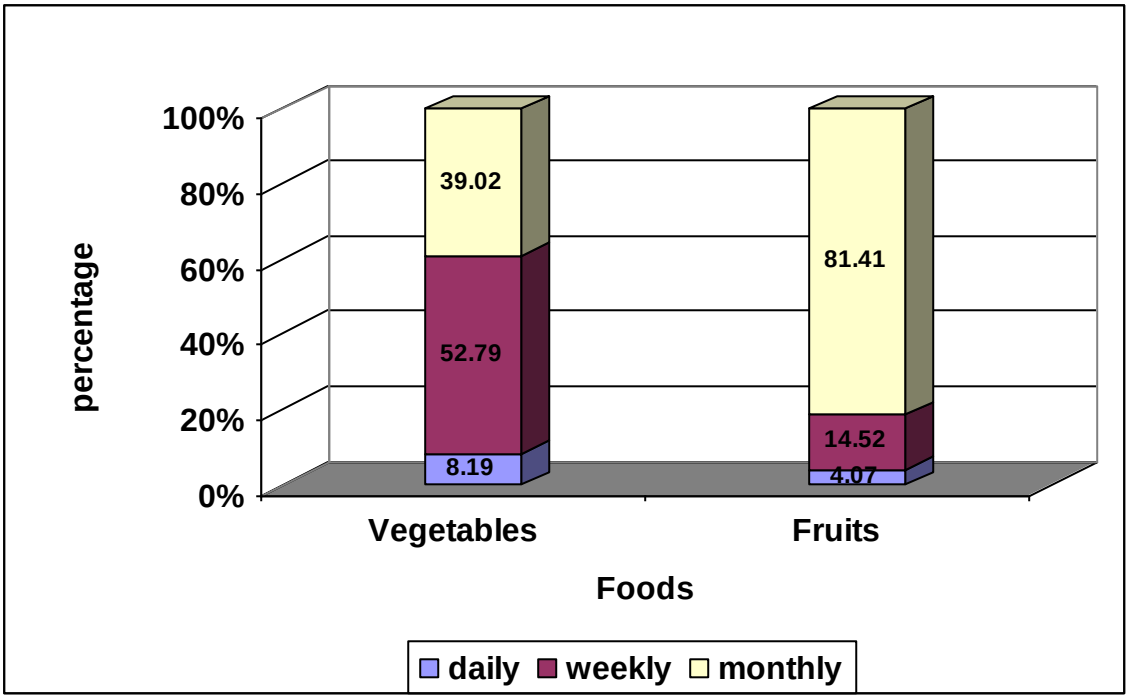
Fig.(13): Frequency of consumption of food rich in iron



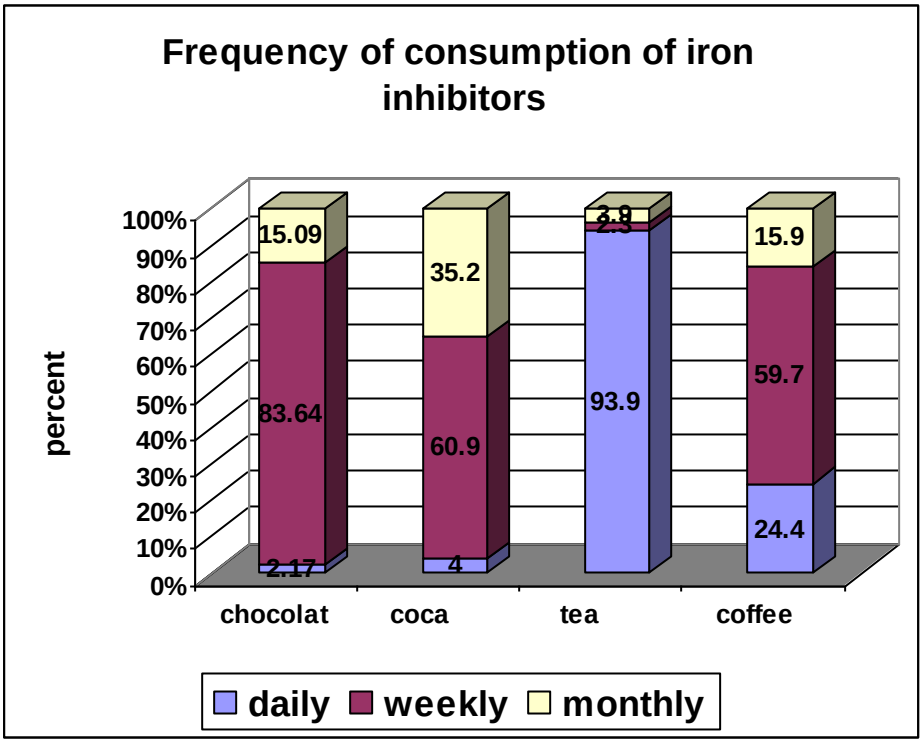
2. Consumption of iron enhancers

The majority of households (77%) consumed vegetables and fruits weekly as shown in figure (14).

Fig. (14): Frequency of consumption of food enhancers



3. **Consumption of iron inhibitors (Fig. 15)**



The

consumption of iron inhibitors mainly tea represent a major obstacle to dietary iron consumption and one of the bad dietary habit. Figure (15) showed that more than 90% of the households (93%) drink tea daily and 60% drink coffee weekly. There were few other bad dietary habits appears in the last few years as drinking fizzy fluids and eating chocolate in between meals; there were 60% of the households had coca drinks and 84% of the sample eat chocolate.

Adequacy of dietary iron intake

1. **Mothers**

The mean daily animal iron dietary intake for mothers was 2.7mg and the total dietary iron intake was 17 mg daily with a very low percent animal to total iron (17) as demonstrated in table (25)

Table (25): Mean and Median Values of dietary iron intake (mg/day) for the total sample of Mothers (N=4094)

	Mean	S. D.	Median	F	P	Sig
Animal iron	2.7	3.3	1.7	3.840	.002	**
Plant iron	14.6	9.9	11.9	50.666	.000	***
Total iron	17.3	10.3	14.5	42.735	.000	***

Table (26) showed that nearly one third of the mothers in the study (34%) consumed <75% of their RNI, while 43% of them consumed satisfactory percent of RNI (≥ 100%). Metropolitan and Coastal regions had higher percent of mothers receiving < 75% RNI of iron. Urban areas had higher percent of unsatisfactory iron intake than rural areas. There were high statistical significance difference regarding the different categories of adequacy of dietary iron by mothers in the geographic regions as well as the location

Table (26): Distribution of mothers according to % Recommended Nutrient Intake (RNI) of dietary iron By Geographic Region and Residence Area

	% RNI						Statistics
	<75%		75-<100%		≥ 100%		
	No.	%	No.	%	No.	%	
Total	1392	34.0	938	22.9	1764	43.1	
	Geographic Region						
Metropolitan	366	42.3	238	27.5	262	30.3	**Chi-square =217.861 Df =10 P= 0.000 Sig.**
Costal	267	44.9	137	23.0	191	32.1	
Canal	243	37.7	152	23.6	249	38.7	
Lower	198	29.0	170	24.9	315	46.1	
Upper	158	23.3	133	19.6	387	57.1	
Frontier	160	25.5	108	17.2	360	57.3	
	Residence Area						
Urban	1007	38.2	621	23.6	1007	38.2	**Chi-square =80.746 Df =2 P= 0.000 Sig.**
Rural	385	26.4	317	21.7	757	51.9	

2. Children < 5 years

The mean daily animal iron dietary intake for children < 5 years was 2.1mg and the total dietary iron intake was 8mg daily with a percent of animal to total iron as 27.5% (table 27).

Table (27): Mean, Median Values of dietary iron intake For the total sample of children < 5 years (N=3633)

	Mean	S. D.	Median	F	P	Sig
Animal iron	**2.1**	**1.77**	**1.5**	**3.2**	**0.007**	**
Plant iron	**6.23**	**4.8**	**4.7**	**38.8**	**0.000**	***
Total iron	**8.32**	**5.21**	**6.8**	**31.9**	**0.000**	***

Table (28): Distribution of children < 5 years according to % Recommended Nutrient Intake (RNI) of dietary iron By Geographic Region and Residence Area

	% RNI						Statistics
	<75%		75-<100%		>100%		
	No.	%	No.	%	No.	%	
Total	1794	49.4	666	18.3	1173	32.3	
Geographic Region							
Metropolitan	442	56.2	161	20.5	183	23.3	
Costal	302	56.3	80	14.9	154	28.7	**Chi-square =144.245 Df =10 P= 0.000 Sig.**
Canal	327	59.1	93	16.8	133	24.1	
Lower	271	47.5	105	18.4	194	34.0	
Upper	220	34.8	119	18.8	293	46.4	
Frontier	232	41.7	108	19.4	216	38.8	
Residence Area							
Urban	1253	53.2	429	18.2	673	28.6	**Chi-square =48.424 Df =2 P= 0.000 Sig.**
Rural	541	42.3	237	18.5	500	39.1	
Gender							
Male	963	48.9	359	18.2	649	32.9	**Chi-square =0.817 Df =2 P= 0.665 Non Sig.**
Female	831	50.0	307	18.5	524	31.5	

Table (28) showed that there were high statistical significance differences regarding the different categories of adequacy of dietary iron by mothers in the geographic regions as well as the location. Half of the children < 5 years in the study (49.4%) consumed <75% of their RNI, while 32% of them consumed satisfactory percent of RNI (≥ 100%). Canal, Metropolitan and Coastal regions had higher percents of mothers receiving < 75% RNI of iron. Urban areas had higher percent of unsatisfactory iron intake than rural areas. There was no statistical difference between gender and the adequacy of consumption of dietary iron.

3. Children 5- <12 years

The mean daily animal iron dietary intake for children 5- <12 years was 2.6 gm and the total dietary iron intake was 11 gm daily with a percent of animal to total iron as 25 (table 29).

Table (29): Mean and Median Values of dietary iron intake (mg/day) For the total sample of children 5-<12 years (N=1408)

	Mean	S. D.	Median	F	P	Sig
Animal iron	2.6	2.5	1.8	4.02	.001	**
Plant iron	8.3	5.8	6.8	7.35	.000	***
Total iron	10.9	6.4	9.4	6.26	.000	***

Table (30) showed that nearly half of the children 5- <12 years in the study (46%) consumed <75% of their RNI, while 34% of them consumed satisfactory percent of RNI (≥ 100%). Metropolitan and Canal then Coastal regions had a higher percentage of mothers receiving < 75% RNI of iron. Urban areas had a higher percentage of unsatisfactory iron in-take than rural areas. There were significant differences regarding different categories of dietary iron by mothers in geographic regions as well as locations.

Table (30): Distribution of children 5- <12 years according to % Recommended Nutrient Intake (RNI) of dietary iron By Geographic Region and Residence Area

	% RNI						Statistics
	<75%		75-<100%		>100%		
	No.	%	No.	%	No.	%	
Total	643	45.7	284	20.2	481	34.2	
Geographic Region							
Metropolitan	126	53.8	37	15.8	71	30.3	**Chi-square=33.191 Df =10 P= 0.000 Sig.**
Costal	68	45.0	27	17.9	56	37.1	
Canal	119	51.5	46	19.9	66	28.6	
Lower	121	44.8	62	23.0	87	32.2	
Upper	129	36.1	72	20.2	156	43.7	
Frontier	80	48.5	40	24.2	45	27.3	
Residence Area							
Urban	428	47.8	171	19.1	297	33.1	**Chi-square=4.562 Df =2 P=0.102 Non Sig.**
Rural	215	42.0	113	22.1	184	35.9	

4. Adolescents

The mean daily animal iron dietary intake for adolescents ≥ 12years was 3mg and the total dietary iron intake was 12.5 mg daily with a percent of animal to total iron as 24 (table 31).

Table (31): Mean and Median Values of dietary iron intake (mg/day) For the total sample of adolescents ≥12 years (N=4841)

	Mean	S. D.	Median	F	P	Sig
Animal iron	3.0	3.5	2.1	9.969	.000	**
Plant iron	9.4	6.2	7.5	12.438	.000	***
Total iron	12.4	7.2	10.9	8.559	.000	***

Table (32) showed that 39% of the adolescents ≥12 years in the study consumed <75% of their RNI, while 40% of them consumed satisfactory percent of RNI (≥ 100%). Frontier region had the highest percent of adolescents receiving < 75% RNI of iron. There were high statistical significance difference regarding the different categories of adequacy of dietary iron by mothers in the geographic regions as well as the location

Table (32): Distribution of children ≥ 12 years according to % Recommended Nutrient Intake (RNI) of dietary iron By Geographic Region and Residence Area

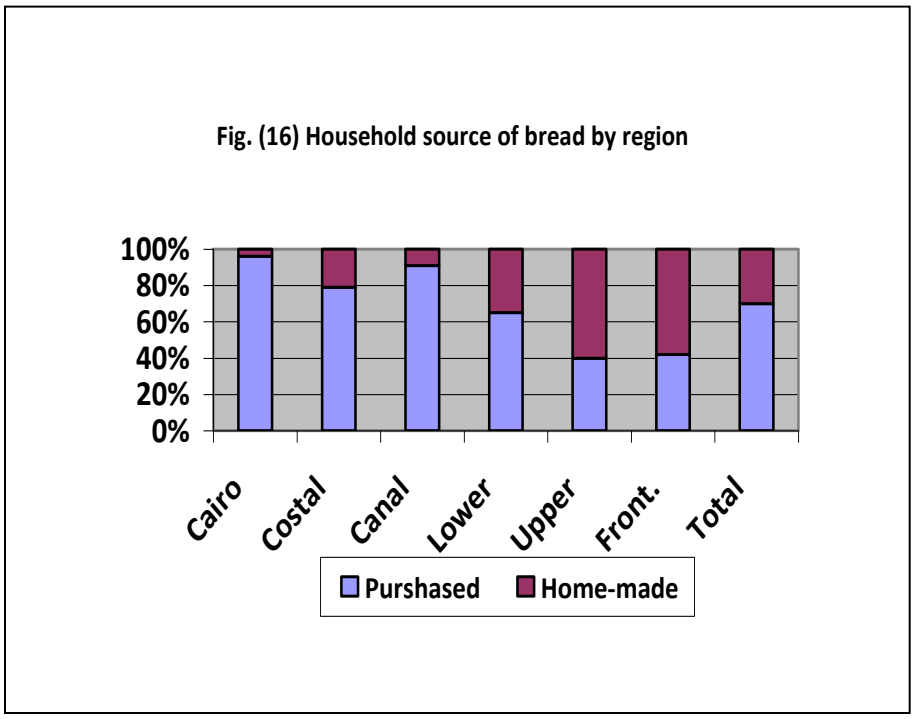
	% RNI						Statistics
	<75%		75-<100%		>100%		
Total	No.	%	No.	%	No.	%	
	1875	38.7	1051	21.7	1915	39.6	
	Geographic Region						
Metropolitan	193	42.0	80	17.4	187	40.7	
Costal	240	46.2	131	25.2	148	2805	**Chi-square =86.839**
Canal	189	37.3	98	19.3	220	43.4	**Df =10**
Lower	489	36.1	304	23.2	553	40.8	**P= 0.000**
Upper	504	33.9	332	22.3	650	43.7	**Sig.**
Frontier	260	50.7	96	18.7	157	30.6	
	Residence Area						
Urban	931	37.4	519	20.8	1043	41.8	**Chi-square =11.187**
Rural	944	40.2	532	22.7	872	37.1	**Df =2 P=0.004 Sig.**

Bread Consumption

Source of bread:

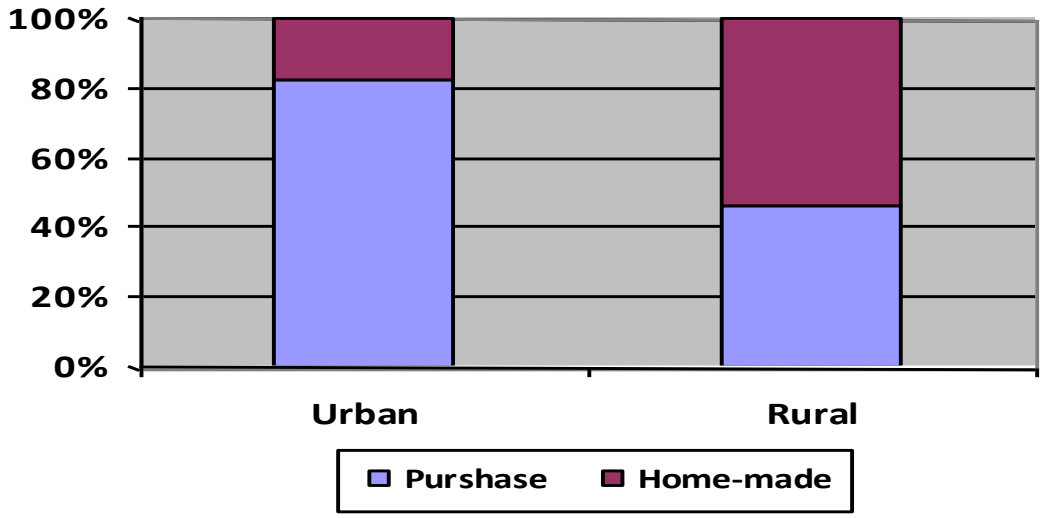
Information about source of bread at household level was investigated among 4120. Figure (16), shows that almost 70% of households purchased bread and 30% relay on baking bread at home. The higher percents of home-made bread were observed for Upper Egypt, frontier, and Lower Egypt regions.

Meanwhile, among households baked bread, most of them used wheat flour, and only 10% of them used a mixture of wheat and maize flour, particularly in Upper and Frontier regions.



With regard to source of bread (Fig. 17) according to residence areas, home-made bread recorded higher percent in rural households than urban (54% Vs. 18%).

Fig. (17) Source of bread at household according to urban and



Bread Consumption:

Result of total daily amount and type of bread consumed by different target groups is presented in table (33). Adults male daily consumed the highest amounts of bread (552 gram) followed by adolescent (451 grams) then mothers (433 gms). Young children (<5 years) consumed less of bread than older children (5-<12 years) being 142 and 315 gram, respectively.

The total amount of daily bread consumed include different types of bread which grouped into Subsidized Baladi bread (made from wheat flour 82% extraction rate), home-made bread (different types made from wheat flour and/or mix of wheat four and maize), French bread and Shami bread (made from white flour of 72% extraction rate)

Table (33): Daily amount (gram) of bread types consumed by target population

Bread Type	Adult males	Mothers	Children (<5yr)	Children (5-<12yr)	Adolescents
Baladi	362	275	77	186	291
Home-made	148	122	38	85	130
French*	37	32	25	41	28
Shami*	5	4	2	3	2
Total	**552**	**433**	**142**	**315**	451

Bread made from white flour (72% extraction rate).

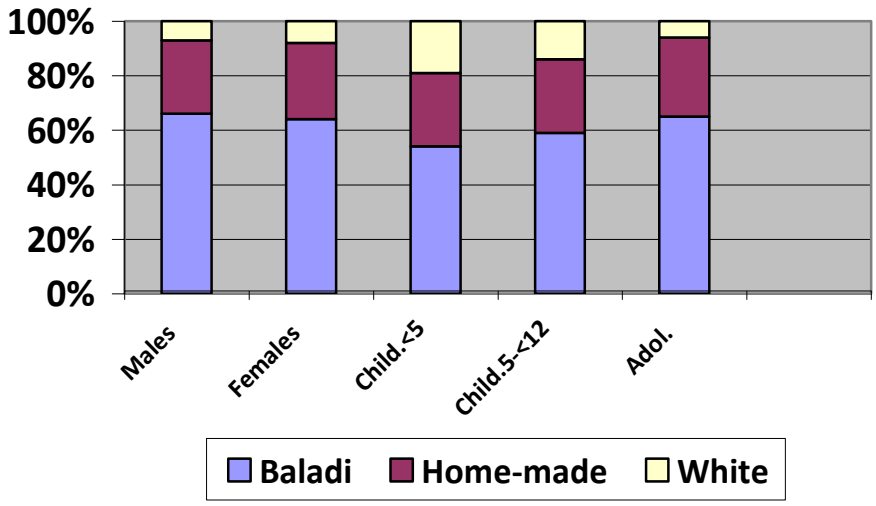
The total daily amount of bread consumed by target population groups are compared among the six geographic regions (table 34). It was observed that the amount of bread consumed in Upper Egypt, Frontier and Lower Egypt by almost all target groups were higher than other regions, while Costal region showed the least daily consumption of bread.

Table (34) : Daily amount (gram) of total bread consumption among different population groups by geographic region

Population group	Metropolitan	Costal	Canal	Lower Egypt	Upper Egypt	Frontier
Adult male	489	414	580	558	645	613
Adult female	360	347	464	452	512	475
Children (< 5year)	117	124	151	129	144	90
Children (5-<12year)	282	279	324	304	361	329
Adolescent	394	362	485	412	471	539

With respect to type of bread, (Fig 18), it was observed that subsidized Baladi bread was the major type consumed accounting from 54 up to 68% of daily bread consumed followed by home-made bread which represent from 26 to 31%. On the other hand, it was observed that the contribution of white bread (French and Shami) accounted for a relatively higher percent among children (14-19%) than other groups (6-8%).

Pattern of bread types to daily consumed bread by target groups



Detailed results on the amount of daily bread consumption according to geographic regions by different target groups are presented in table (35)

Table (35) : Daily amount (gram) of total bread consumption among different population groups by geographic region (Detailed)

Bread type	Cairo	Costal	Canal	Lower Egypt	Upper Egypt	Frontier
Adult male						
Baladi	425	269	472	345	342	267
Home –made	22	93	42	166	267	334
White	61	51	66	47	36	13
Mothers						
Baladi	306	226	369	276	254	202
Home –made	18	80	38	137	223	262
White	36	41	56	39	34	12
Children <5 year						
Baladi	82	65	104	67	81	64
Home –made	4	22	11	39	40	79
White	31	37	37	24	23	11
Children 5-<12						
Baladi	210	168	2450	171	170	149
Home –made	15	55	16	101	153	161
White	57	55	58	41	38	19
Adolescents						
Baladi	341	255	406	232	230	234
Home –made	16	60	35	160	220	290
White	37	47	44	20	21	15

Annex: Folic Acid Deficiency Survey Results

Introduction

WHO Technical Consultation on folate and vitamin B12 deficiencies (WHO, 2008) reported that there is strong evidence that folate deficiency causes megaloblastic anemia. In regions where folate deficiency is more common during pregnancy and lactation, a few studies have associated megaloblastic anemia with prolonged lactation and multiple pregnancies. On the other hand, there is evidence of an inverse association between blood folate concentrations and risk of low birth weight and increased risk of neural tube defects (NTD). Therefore, there is a protective effect of folic acid supplementation or consumption of fortified foods, in the periconceptional period, against NTD. Moreover, serum/plasma folate concentrations affect cognitive function in children than in adults, and some studies have reported lower scores in schoolchildren with low folate status.

Iron/folic acid fortification program for wheat flour (82% extraction) used for Baladi bread consumed by Egyptians has been implemented since 2008, as a long term strategy for prevention and control of iron deficiency anemia. Therefore, baseline data on folate status assessment among Egyptians is an essential component for monitoring and evaluation of the fortification program outcome. Serum folate values were used to assess folate status

Methods

WHO Technical Consultation on folate and vitamin B12 deficiencies (WHO, 2008) has recommended that serum/plasma or erythrocyte concentrations of folate provide practical, least expensive and accurate measurements to picture folate population's status.

Blood sample collection and preparation

- Venous blood samples were centrifuged at 3000 rpm to separate the serum, and then serum was stored in Ependorf contains 40 mg ascorbic acid at -20 C until analysis.
- Serum samples were thawed and 0.1ml of 60% perchloric acid was added, before being centrifuged at 4000 rpm for 20 min. to remove the precipitated protein.
- About 100 ul of the supernatant was taken to inject the HPLC system.

Folate determination:

High Performance Liquid Chromatography (HPLC) with electrochemical detection method was used according to method described by Leeming et al., (1990) to measure 5 methyltetrahydrofolate in serum. The HPLC conditions were:

- The mobile phase contained 8% acetonitrile in 0.033 m orthophosphoric acid, the PH was adjusted to 2.3 with solid sodium hydroxide**.**
- The colum was spherisorb 25 cm X4.6 mm internal diameter
- The loop size was 100ul and the flow rate was 1.5 ml/min
- The detector was fluorimeter(fluorescent spectrophotometer) adjusted at the excitation wavelength 295 nm and the emission wavelength was 365 nm.
- Standard for HPLC analysis was prepared from 5-methyltetrahydrofolate prepared from (5 ng/ml to 20 ng/ml) dissolved at 1% ascorbic acid.

Folate indicators

WHO Consultation has arrived at a consensus for cutoffs levels for folate that should be used for assessing the nutritional status of populations. It was based on the plasma vitamin concentrations below which plasma metabolites become elevated. In addition, these cutoffs are consistent with the recommended intakes of folate, in which blood vitamin concentrations were used to determine Estimated Average Requirements.

The concentrations suggested for defining folate deficiencies based on metabolic indicators are: < 10 nmol/L (4 ng/mL) for serum folate

Results

The results presented in this section include sample characteristics and laboratory data for folic acid analysis and folate status as baseline data.

Sample:

The main target groups for folate status assessment were: mother, children (6 -<12 years), and adolescents (>12 years). Table (1), presents distribution of the total sample (1910 individuals) used for folate analysis. Adolescent group (male and female) was the major group among the surveyed sample (accounted for 51.5%), followed by mother group (30.3%), then children (18.2%). The sample represents four geographic regions of the country: Metropolitan (14%), Costal (18%), Lower Egypt (27%), and Upper Egypt (39%). Canal region, the sample accounted for only 3.2% and represent mother group only, while frontier region sample was missed. Both urban and rural are presented,

however the percent of urban sample was higher (about 58%) due to urban governorates (Cairo and Alexandria). Female accounted for much higher percent (84%) and this was due to consider more of female adolescent in the group as also it include mother sample (being female).

Table 1: Distribution of Surveyed Samples for Folate Analysis According to Geographic Region, Residence Area and Gender

Target	Mother	Children (6 - < 12 yr)	Adolescents (> 12 yr)	Total
Total: No	579	348	983	1910
(%)	30.3	18.2	51.5	100.0
Geographic Region				
Metropolitan	67	68	122	257
Costal	94	118	133	345
Canal	62	-	-	62
Lower Egypt	182	107	217	506
Upper Egypt	174	55	511	740
Residence Area				
Urban	312	210	581	1103
Rural	267	138	402	807
Gender				
Male	-	172	106	278
Female	579	176	877	1632

FOLATE LABORATORY ASSESSMENT

I: Overall surveyed sample:

Results in Table (2) present mean serum folate values for the whole sample (1910) and the three target groups (mother, children and adolescent). Results were very close with an overall mean value for the whole sample of 13.4 nmol/L, and median values (13.7 nmol/L) were very close to the mean.

Table 2 : Mean, median, minimum and maximum of serum folate values among the target groups

Target group	No.	Mean ± (SD)	Median	Min.	Max.
Mother	579	13.1 ± 3.2	12.8	4.8	24.3
Children	348	13.8 ± 3.4	13.7	7.0	30.1
Adolescent	983	13.2 ± 3.2	12.7	6.4	32.4
Total	1910	13.4 ± 3.3	13.7	4.8	32.4

Serum folate values were used to assess folate status among the overall sample and the three target groups. Table (3) shows that overall folate deficiency accounted for 13.7% of the population, and almost similar percentages were recorded for mother, children and adolescent being 14.7%, 14.9% and 12.6%, respectively.

Table 3: Folate status among target groups

Target group	Serum folate level (nmol/L)			
	<10		≥10	
	N0.	%	No	%
Mother	85	14.7	494	85.3
Children	52	14.9	296	85.1
Adolescent	125	12.6	859	87.4
Total	261	13.7	1649	86.3

On the other hand, serum folate values were used to assess folate status according to geographic region, residence area and gender and results are presented in Table (4). A total of 13.7% of whole sample were consider folate deficient as indicated by low serum folate level (<10 nmol/L). Folate deficiency among regions was different significantly, with higher levels in Lower Egypt (23.1%) and Upper Egypt (17.3%) than the three other regions (Costal, Canal and Metropolitan regions). However, no significant difference was found between urban (13.3%) and rural (14.1%) areas. Folate deficiency was slightly higher among male than female being 15.5% and 13.4%, respectively.

Table (4) : Percent distribution of total sample according to serum folate status by geographic region, residence area and gender

	Serum folate level (nmol/L)			
	<10		**≥10**	
	N0.	**%**	**No**	**%**
Total	**261**	**13.7**	**1649**	**86.3**
		Geographic Region		
Metropolitan	19	7.4	238	92.6
Costal	13	3.8	332	96.2
Canal	3	4.8	59	95.2
Lower	117	23.1	389	76.9
Upper	109	17.3	631	82.7
		Residence Area		
Urban	147	13.3	956	86.6
Rural	114	14.1	693	85.9
		Gender		
Male	42	15.5	235	84.5
Female	218	13.4	1414	86.6

II: Mother sample

Results in Table (5) present serum folate level among the overall sample of mother (579). Mean folate level was 13.1 nmol/L, with minimum and maximum values of 4.8 and 24.3 nmol/L, respectively.

Table (5) : Mean, median, minimum and maximum of serum folate values among mother sample

Serum folate level (nmol/L)	No.	Mean ± (SD)	Median	Min.	Max.
<10	85	8.5 ± 1.1	8.7	4.8	9.9
≥10	494	13.9 ± 2.7	13.5	10.0	24.3
Total	579	13.1 ± 3.2	12.8	4.8	24.3
F =398.6	**DF = 2**	**P=0.000*** **			

Serum folate values among mother were used to assess folate status according to geographic and residence area and results are presented in Table (6). A total of 14.7% of mothers were consider folate deficient as indicated by low serum folate level (<10 nmol/L). Folate deficiency among regions was different significantly, with higher levels in Lower Egypt (25.3%) and Upper Egypt (15.6%) than the three other regions (Costal, Canal and Metropolitan regions). However, no significant difference was found between urban and rural areas.

Table (6) :Percent distribution of mothers according to serum folate status by geographic region and residence area.

	Serum folate level (nmol/L)				Statistics
	< 10		≥10		
	No.	%	No.	%	
Total	85	14.7	494	85.3	
Geographic Region					
Metropolitan	6	9.0	61	91.0	Chi-square =89.6
Costal	4	4.3	90	95.7	Df = 4
Canal	3	4.8	59	95.2	P= 0.000
Lower	46	25.3	136	74.7	
Upper	26	14.9	148	85.1	
Residence Area					
Urban	46	14.7	266	85.3	Chi-square = 2.9
Rural	39	14.6	228	85.4	Df = 1 P=0.7

III: Children 6-<12 years

Results of children 6 -<12years revealed that the mean folate values for the total sample was 12.1 nmol/L. A total of 14.9% of children had low folic levels with higher percent in Lower Egypt (Table 7& 8).

Table (7) : Mean, median, minimum and maximum of serum folate values among children (6- <12yr)

Serum folate level (nmol/L)	No.	Mean ± (SD)	Median	Min.	Max.
<10	52	8.7 ± 0.9	8.9	7.0	9.9
≥10	296	14.7 ± 2.9	14.2	10.1	30.1
Total	348	13.8 ± 3.4	13.7	7.0	30.1
F = 560.24	**DF = 2**	**P=**0.000 sig.			

Table (8) : Percent distribution of children (6 - < 12) years according to serum folate status by geographic region, residence area and gender

	Serum folate level (nmol/L)				Statistics
	< 10		**≥10**		
	No.	%	No.	%	
Total	52	14.9	296	85.1	
			Geographic Region		
Metropolitan	7	10.3	61	89.7	Chi-square=81.263
Costal	8	6.8	110	93.2	Df =3
Lower	30	28.8	74	71.2	P= 0.000
Upper	7	12.1	51	87.9	
			Residence Area		
Urban	27	12.9	183	87.1	Chi-square =2.404
Rural	25	18.1	113	81.9	Df = 1 P= 0.076
			Gender		
Male	32	18.6	140	81.4	Chi-square = 2.784
Female	20	11.4	156	88.6	Df = 1 P= 0.06

IV: Adolescents (≥12 years):

Regarding adolescents ≥12 years, results revealed that the mean folate value for the total sample was 13.2 nmol/L. A total of 12.6% of adolescent ≥12 years had low folate levels with higher percent in Lower Egypt followed by Upper Egypt (Tables 9 & 10).

Table (9) : Mean, median, minimum and maximum serum folate values among adolescent (≥12years).

Serum folate (nmol/L)	No.	Mean ± (SD)	Median	Min.	Max.
<10	124	8.84 ± 0.84	9.05	6.40	9.90
≥10	859	13.82 ± 2.91	13.10	10.0	32.40
Total	983	13.20 ± 3.20	12.70	6.40	32.40
F = 297.043	**DF = 2**	**P=**0.000			

Table (10): Percent distribution of adolescent ((school children ≥ 12years) according to serum folate status by geographic region, residence area and gender

	Serum folate (nmol/L)				Statistics
	< 10		**≥10**		
	No.	%	No.	%	
Total	124	12.6	859	87.4	
			Geographic Region		
Metropolitan	6	4.9	116	95.1	Chi-square =92.878
Costal	1	0.8	132	99.2	Df =3
Lower	41	18.9	176	81.1	P= 0.000
Upper	76	14.9	435	85.1	
			Residence Area		
Urban	74	12.7	507	87.3	Chi-square =29.007
					Df =1
Rural	50	12.4	352	87.6	P= 0.8
			Gender		
Male	11	10.4	95	89.6	Chi-square = 2.42
					Df = 1
Female	113	12.9	764	87.1	P= 0.075

References

Tietz ,n, clinical guide to laboratory. Tests 3rd Ed. WB saunders company Philadelphia,PA (1995)

Tietz n, textbook of clinical chemistry cari A Burtis . 3rd ed . WB sannders . Phliadelphia ,(1999)

Chanarin I, Rotman D. Further observations on the relation between iron and folate status in pregnancy. *British Medical Journal*, 1971, 2:81-84

.

Villanova, PA . **(1994)** *Reference and selected procedures for the quantitative determination*
of haemoglobin in blood: approved standards. 2nd ed,National Committee for Clinical Laboratory Standards,.

EHDS, (2005): Egypt Demographic Health Survey

Leeming, R.J.; A. Pollock; L.J. Melville, and C.G.B. Hamon (1990). Measurement of 5-Methyltetrahydrofolic Acid in Man by High-Performance Liquid Chromatography. Metabolism, Vol 39, No. 9, pp 902-904

NNI Food Composition Tables (2006).

FAO/WHO, 2002

WHO (2008): Conclusions of a WHO Technical Consultation on folate and vitamin B12 deficiencies: Food and Nutrition Bulletin, vol. 29, no. 2 (supplement) © 2008, The United Nations University