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IRON STATUS OF FIRST YEAR MEDICAL STUDENTS AT GEZIRA UNIVERSITY

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ABSTRACT

Objectives: To determine the iron status of first-year medical students at Gezira University and identify influence of ethnic group and gender on the iron status.

Materials and Methods: Cross-sectional community based study. The sample consisted of 160 students aged 16-20 years with a mean (± SD) age 18.56 ± 0.94 of both sexes (70 = males, 90 = females). Blood samples were collected from each student and questionnaire was completed. Haemoglobin (Hb), packed cell volume (PCV), serum iron and total iron binding capacity were determined by cyanomethaemoglobin method, microhaematocrit centrifuge and colourmetric methods respectively. Mean corpuscular haemoglobin concentration (MCHC) and transferrin saturation were calculated.

Results: The mean (± SD) concentration of Hb, serum iron and transferrin saturation of all male students was 14.86 ± 1.29 g/dL, 102.46 ± 30.5 ^g/dL and 39.72 ± 11.23% respectively. The mean (± SD) concentrations of Hb, serum-iron and transferrin saturation of all female students was 12.57 ± 0.92 g/dL, 57.51 ± 11.8 ^g/dL and 21.12 ± 5.4% respectively.

Haemoglobin level, serum-iron and transferrin saturation were within normal levels according to WHO criteria. There were significant differences between mean values of biochemical parameters and sex of students and father income $P < 0.05$. There was no significant association between iron status parameters and family size and ethnic groups. There was positive correlation between subject iron status and diet (meat, liver, fruits and hilba).

Conclusion: Iron status of first-year medical students at Gezira University is within normal reference values. This is in line with the health status of the students.

Key words: Iron Status, Haemoglobin, Haematocrit, Transferrin Saturation.

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الملخص :

هدف الدراسة:- هذه دراسة مقطعية أجريت لتحديد وضع الحديد في طلاب السنة الأولي كلية الطب/ جامعة الجزيرة ، ومعرفة تأثير التركيب العرقي وجنس الطلاب على وضع الحديد.

مواد وطرق الدراسة:- شملت الدراسة 160 طالب (أعمارهم بين 16-20 سنة) متوسط العمر 18.56 ± 0.94 للجنسين (الذكور= 70 ، الإناث = 90). تم جمع عينات الدم من كافة الطلاب وملء استبيان ، خضاب الدم (الهيموقلوبين)، الكسر الحجمي ، حديد مصل الدم ، والحديد الكلي المرتبط بالمصل تم تحديدها بواسطة السيان متهيموقلوبين ، جهاز طرد مركزي صغير ومحاليل (طرق قياس اللون) بالتتالي، متوسط تركيز الهيموقلوبين في خلايا الدم الحمر وتشبع الترانسفرين تمّ حسابهما.

النتائج :- كان متوسط تركيز الهيموقلوبين ، الحديد في مصل الدم ، وتشبع الترانسفرين في الذكور 14.86± 1.29 جم/ديسلتر، 102.4±30.5 ميكروجرام/ديسلتر و 39.72 ± 11.23% بالتتالي. وفي الإناث كان التركيز بالتتالي 12.57 ± 0.92 جرام/ديسلتر، 57.51 ± 11.8 ميكروجرام/ديسلتر و 21.12 ± 5.4%. مستويات الهيموقلوبين والحديد في مصل الدم وتشبع الترانسفرين ضمن المستويات الطبيعية تبعاً لمعايير منظمة الصحة العالمية. هنالك فروقات معنوية بين مؤشرات الحديد وجنس الطلاب ودخل الأب ($P<0.05$)، كما انه ليست هنالك فروقات معنوية بين المؤشرات وحجم الأسرة والتركيب العرقي . أيضا هنالك ارتباط موجب بين وضع الحديد والغذاء (استهلاك كل من اللحوم ، الكبد ، الفواكه والحلبة).

الخلاصة :- تشير الدراسة إلى أن وضع الحديد في طلاب السنة الأولي في كلية الطب بجامعة الجزيرة ضمن المستويات الطبيعية وهذا يتفق مع الوضع الصحي لهؤلاء الطلاب.

INTRODUCTION

Iron is required for the synthesis of the haem proteins haemoglobin and myoglobin. It is also needed for formation of the intracellular molecules cytochromes, which are involved in the oxidation of metabolites [1]. The total amount of iron in the body of healthy human adults is 3 - 5 gm distributed on the average as: haemoglobin (3000 mg), storage iron (1 g), cellular iron (150 mg) and plasma iron (3-4 mg) [2] . A deficiency of dietary iron gives rise to iron deficiency anaemia. The incidence of iron deficiency anaemia was reported to be 36% for developing countries, 40% for Africa and South Asia and 5% for developed countries [3]. The consequences of iron deficiency include impaired immunity, increased morbidity from infectious diseases, and decreased physical capacity.

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In infants and children studies have demonstrated impaired motor development, psychological and behaviour effects, and decreased work capacity. More recently iron deficiency at any age has been shown to have adverse effects on cognitive performance with the response to iron supplementation depending on the circumstances [4].

The diet of most people produces from 10-14 mg of iron daily. Meat, meat products, cereals, vegetables and fruits all contain iron, but the amount varies greatly in different samples. Low intake occurs with diet composed mainly of refined cereals, sugar and fats. Milk is a poor source [5] . Iron absorption occurs predominally in the duodenum and upper jejunum. Inorganic iron salt exists in either of two valence status $Fe^{2\pm}$ (ferrous) and $Fe^{3\pm}$ (ferric). Most dietary iron consists of ferric salts, which forms insoluble ferric hydroxide precipitates at physiological pH. Absorption is aided by stomach acidity which maintains ferric iron in a soluble form [6] .

Information concerning iron status in Sudanese teenagers in relation to gender, ethnic group, nutritional status and socio-economic status is lacking. The objectives of this study are to provide this information taking the first year medical students at Gezira University as study group and determinations of haemoglobin, PCV, MCHC, serum iron, total iron binding capacity and transferrin saturation as markers of iron status.

SUBJECTS, MATERIALS AND METHODS

All first year Sudanese medical students, Gezira University (batch 21) were enrolled in the study (n = 160). Informed consent was obtained from each student. Age of students was 16-20 years, with a mean ($\pm$ SD) age of 18.56 $\pm$ 0.94 years. During the first week of the University, clinical examination was performed for each subject and all of them were found healthy. During this week body weights and heights were determined and body mass index (BMI) calculated [7] and the students completed a socio-economic, demographic, nutritional and ethnic origin questionnaire. In the session during which the questionnaire was completed a blood sample was drawn from each student. Approximately 4 ml of blood was collected and this was divided into 1 ml of blood collected in E.D.T.A. container and then analyzed for estimation of haemoglobin by cyanomethaemoglobin method[8] and packed cell volume by micro haemotocrit centrifuge. 3 ml of blood in a centrifuge tube was allowed to clot and serum was separated in a polyethylene tube (iron free) and kept at $20^{o}C$ and analyzed for serum iron and total iron binding capacity using kits obtained from Arab Company for Medical Diagnostics, Amman, Jordan. Mean corpuscular haemoglobin concentration was calculated from haemoglobin and packed cell volume, and transferrin saturation was calculated from serum iron and total iron binding capacity.

All samples and standard solutions were assayed in duplicate. Some samples previously assayed were included as quality control. Values are presented as mean and one standard deviation of the mean of all measured variables. Comparison between different groups was carried out according to Statistical Package for the Social Sciences (SPSS). Analysis of variance and correlation coefficient were the analyses applied. $P < 0.05$ was taken as the level of statistical significance. Statistical calculations were done using Microsoft programme and SPSS under windows computer system (IBM).

RESULTS

A total of 160 students of different gender, socio-economic groups and tribes were the subjects of this iron status study. There were 70 male and 90 female students. The mean values and standard deviation of haemoglobin level (Hb), haemotocrit (PCV), mean corpuscular haemoglobin concentration (MCHC), serum-iron, total iron binding capacity and transferrin saturation (TS) of the two groups are presented in Table 1.

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Table (1) The Parameters used as markers of iron status of subjects (males and females)

Parameters	Subject		Significance
	Males (n = 70)	Females (n = 90)	
Hb (g/dL)	14.86 ± 1.29 [a]	12.57 ± 0.92	*
PCV (%)	44.1 ± 3.83	37.3 ± 2.71	*
MCHC (g/dL)	33.7 ± 0.67	33.7 ± 0.53	N.S.
Serum Fe (ug/dL)	102.46 ± 30.5	57.51 ± 11.8	*
TIBC (ug/dL)	257.64 ± 19.32	276.34 ± 27.3	*
TS (%)	39.72 ± 11.23	21.12 ± 5.4	*

n = number of subjects a = Mean ± standard deviation

* = significant $P < 0.05$

N.S. = Not significant

Comparison between subjects (males and females) was statistically significantly different in Hb, PCV, serum Fe, TIBC and TS ($P < 0.05$). No significant differences were observed in MCHC values.

There were significant differences between levels of father s income in Hb, PCV, serum iron, TIBC and TS ($P < 0.05$). There were no significant differences between the groups in mean corpuscular haemoglobin concentration (Table 2).

Table (2) Subjects iron status and father s income

Parameters	Father s income +				Sig
	Less than 30000 n = 16	30000-50000 n = 25	51000-75000 n = 31	More than 75000 n = 88	
Hb (g/dL)	12.06+0.93a	12.35+1.1	13.05+1.24	14.38+1.37	*
PCV (%)	35.94+3.04	36.8+3.7	38.43+3.66	42.65+4.02	*
MCHC	33.56+0.51	33.58+0.7	33.79+0.43	33.62+0.63	N.

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(g/dL)					S.
Serum Fe (ug/dL)	52.44+7.86	56.92+16.91	69.45+27.4	90.24+31.25	*
TIBC (ug/dL)	290.59+28.15	277.16+33.04	272.6+21.72	259.39+18.24	*
TS (%)	18.37+5	22.26+9.81	26.23+11.17	34.78+ 12.02	*

a = Mean + SD

n = number of subjects * = significant P < 0.05

N.S. = Not significant

\+ = Sudanese dinars per month

There were no significant differences between subjects family size in Hb, PCV, serum iron, and TIBC and transferrin saturation (Table 3).

Table (3) Iron status of subjects and family size

Parameters	Family Size			Significance
	1-3 (n = 2)	4-6 (n = 61)	7-8 (n = 97)	
Hb (g/dL)	13.0 ± 1.84	13.78 ± 1.67	13.45 ± 1.51	N.S.
PCV (%)	38.5 ± 4.95	40.80 ± 4.87	39.98 ± 4.57	N.S.
MCHC (g/dL)	31.9 ± 2.12	33.94 ± 1.39	33.59 ± 0.62	*
Serum Fe (ug/dL)	59.50 ± 14.85	80.64 ± 34.13	75.4 ± 29.5	N.S.
TIBC (ug/dL)	295.5 ± 23.33	263.8 ± 27.08	269.79 ± 30.25	N.S.
TS (%)	30.1 ± 7.07	31.4 ± 13.37	28.53 ± 12.01	N.S.

a = Mean + SD n = number of subjects

* = significant P < 0.05 N.S. = Not significant

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There were no significant differences between subjects tribes in Hb, PCV, MCHC, serum iron, TIBC and TS (Table 4).

Table (4) Subjects iron status and ethnic groups

Parameters	Nubians (n = 30)	Guhaina group (n = 33)	Adnani group (n = 87)	Darfur group (n = 10)	Sig.
Hb (g/dL)	13.74±1.67a	13.75±1.7	13.46±1.54	13.44±1.06	N. S.
PCV (%)	40.73±5.03	39.27±8.6	39.95±4.56	40.0±2.87	N. S.
MCHC (g/dL)	33.74±0.42	33.68±0.43	33.76±1.3	33.23±1.07	N. S.
Serum Fe (ug/dL)	82.77±34.12	82.0±33.17	74.03±29.91	72.6±27.11	N. S.
TIBC (ug/dL)	267.5±28.38	269.12±24.88	267.71±24.24	264±22.87	N. S.
TS (%)	31.65±13.71	31.6±13.18	28.21±13.13	27.65±10.45	N. S.

n = number of subjects N.S. = Not significant

a = Mean ± SD

There was no correlation between milk, vegetables, dates and the iron status of the subjects. However, there was positive correlation between subjects iron status and meat, liver, fruits and hilba (Table 5).

Body mass index values (BMI) are shown in Table 6. Average values were within WHO accepted range.

Table (5) presents the correlation between subjects iron status and nutritional status.

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Foods	Parameters					
	Hb	PCV	MCHC	Serum-fe	TIBC	TS
Vegetables	0.1039 N.C.	0.1038 N.C.	0.032 N.C.	0.066 N.C.	0.045 N.C.	0.0789 N.C.
Hilba	0.001 **	0.001 **	0.156 N.C.	0.001 **	0.01 *	0.001 **
Legumes	0.1428 N.C.	0.1281 N.C.	0.0207 N.C.	0.0668 N.C.	0.0954 N.C.	0.0622 N.C.
Milk	0.0515 N.C.	0.0428 N.C.	0.0546 N.C.	0.0565 N.C.	0.073 N.C.	0.0356 N.C.
Fruits	0.001 **	0.001 **	0.04 N.C.	0.001 **	0.001 **	0.001 **
Meat	0.001 **	0.001 **	0.06 N.C.	0.001 **	0.001 **	0.001 **
Dates	0.156 N.C.	0.143 N.C.	0.0814 N.C.	0.1715 N.C.	0.0716 N.C.	0.1384 N.C.
Liver	0.001 **	0.001 **	0.002 N.C.	0.001 ***	0.001 **	0.01 **

** Correlation at 0.001

* Correlation at 0.01

N.C. No correlation

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Table (6): Classification of BMI for female and male subjects according to WHO (1997).

BMI	Females		Males	
	No.	Percent	No.	Percent
Under - weight	12	13.33	9	12.86
Normal weight	62	68.90	55	78.57
Pre-obese	12	13.33	2	2.86
Obese class I	4	4.44	4	5.71

BMI = Body Mass Index Kg/m^2 (Female (n = 90) 23.7$\pm$ 1.9, Male (n = 70) 21.3 $\pm$ 3.9) No. = Number of subjects

DISCUSSION

The criteria to establish iron status include haemoglobin (Hb), the cut-off point indicator for iron deficiency anaemia is considered HB <13 g/dL for males and 12 g/dL for adult females (WHO, 1968) [9] .The average Hb concentration of the male subjects in the present study (14.86) is higher than those found by Lee (1978) [10] in Kentucky (13.2), Agab Eldour (1997) [11] in Sudan (13.18), and Shaw (1996) [12] in Taiwan (10.3), and Abdalla (1987) [13] in Sudan (14.69). The average Hb concentration of the female subjects (12.57) is lower than that found by Frassineli (1985) [14] in USA (13.4), Brown (1985) [15] in Birmingham (16.0), Soustre, et al (1986) [16] in Paris (13.9), Steyn, et al (2000) [17] in South Africa (13.1) and Shaw, et al (1995) [18] in China (12.). Our result is also higher than those found by Lee (1978) in Kentucky (12.0), Agab Eldour (1997), in Sudan (11.17), Abdalla (1987) in Sudan (12.13), and Shaw (1996) in Taiwan (9.3). [10, 11, 13, 12]. The average PCV percent of the male subjects (44.1) is higher than those observed by Lee (42) [10], Abdalla (42.0) [13] and Agab Eldour (39.5) [11]. While the average PCV percent of the female subjects (37.3) is lower than those found by Frassinelli, et al (1985) [14] (39.4), Lee (39) [10], Abdalla (41.1) [13], Steyn, et al (44.5) [17]. Our result is also higher that observed by Agab Eldour (33.49) [11].

In this study the mean corpuscular haemoglobin conentration of the male subjects was (33.7), and of the females was (33.7). These values are comparable to those found by Frassinelli, et al (33.5) [14], and Steyn, et al (33.5) [17].

Serum iron level of the male subjects (102.46) is higher than that found by Lee (97) , and Shaw, et al (89.6) [10, 12] , whereas serum iron level of the female subjects (57.51) is lower than those observed by Lee (99), Frassineli, et al (104),

Soustre, et al (1986) (111.46), Shaw, et al (95.1), and Steyn (74.49). [14, 16, 12, 17] Total iron binding capacity of the male subjects (257) is lower than that observed by Shaw, et al (358.4) [12] , whereas total iron binding capacity of the female subjects (276) is lower than those found by Frassineli, et al (373.6), Soustre, et al

(404.88), Shaw, et al (386.4). [12, 14, 16]

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The average transferrin saturation percent of the male subjects (39.72) is higher than those observed by Lee (27), Shaw (30) , and Shaw, et al (27) [10, 12, and 18]. Transferrin saturation percent of the female subjects (21.17) is lower than those found by Lee (29), Brown, et al (25.3), Franssineli (28.6), Soustre et al (28.1),

Shaw, et al (27), and Steyn, et al (29). [10, 14-18]

In this study there was significant association between father s income and the subject iron status. This agrees with Suliaman (1995) [19] . The family size in this study was between moderate and big and had no significant association with the iron status of the subjects.

Analysis of nutritional status of the subjects showed a high correlation between subjects iron status and dietary intake of excellent sources of iron (liver, meat, and hilba), also high correlation between subjects vit C consumption and their iron status. There was no correlation between subject iron status and vegetable and milk consumption.

There was no association between the subjects iron status and their ethnic groups because most of our subjects were of mixed African Arab origin and there was no pure African origin. This is in line with the results of Lee in Kentucy where black teenagers had lower haemoglobin and haematocrit than the white teenagers.

In the present study the average BMI for female subjects (23.7) is higher than those observed by Bellisle, et al (1995) [20] in Switzerland (20.2) and in Scotland (21.3), and lower than those observed by Steyn, et al (2000) (22.8) [17]. The average BMI for male subjects was (21.3). In this study only 4.44% of female subjects were found to be obese. This is lower than those observed by Steyn (6.5%) [17] and Melnyk et al (1994) [21] in USA (25%).

CONCLUSION

Haemoglobin level, serum iron and transferrin saturation were within normal levels according to WHO criteria. This is in line with the health status and academic standard of these students. It is concluded from this study that iron status of first-year medical students, Gezira University, is good and must be kept within this normal range.

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