A COMPARATIVE STUDY OF THE NUTRITIONAL STATUS OF VOLUNTEER AND PROFESSIONAL MALE BLOOD DONORS

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Abstract:
Purpose: The aim of this study is to compare the nutritional status of male volunteer donors with professional donors who donate blood very frequently.
Design: The sample of the study included 120 volunteer and 120 professional blood donors. The sample was taken from a leading blood bank in Alexandria using a systematic random sampling technique. Data were collected on socioeconomic characteristics, dietary intake and frequency of blood donation. Height and weight were measured and BMI was calculated. Blood samples were taken for hematological and biochemical measurements.
Findings: Professional frequent donors were of limited education, low income and came from large families. They were anemic (65.5%) and underweight (32.5%). Their energy, protein and iron intake was inadequate. The better nourished first-time volunteer donors were less anemic (15.5%) and were overweight (20.8%) or Obese (14.2%).Anemia was hypochromic microcytic characterized by depressed hematological indicators. Frequent blood donation and anemia were associated with lower blood glucose and cholesterol and elevated triglyceride levels.
Value: The study points out the high prevalence of malnutrition and anemia among frequent professional blood donors and the need for their nutritional monitoring and supplementation.

Keywords: *blood donors, volunteers, professionals, anemia, malnutrition, hemoglobin, lipids.*

INTRODUCTION

While Egypt's population has grown to over 80 millions in 2010, the number of blood donors has fallen sharply in recent years. Blood shortage threatens the lives of thousands of patients. Blood could be obtained through governmental blood banks which are conveniently located in some major hospitals or through banks operated by the private sector. Because of the evident shortage of blood, official banks force the patient to bring a relative, friend or a professional donor to donate a quantity of blood equivalent to his needs. Once this is accomplished, the bank will take the necessary measures to provide the patient with his blood needs. This way, the bank will guar-

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antee a semi-adequate supply of blood. In addition, official banks collect blood through campaigns in universities, factories and social clubs. Private blood banks rely mostly on professional blood donors who get paid upon each donation. The bank in turn will charge the patient heavily to cover his blood needs.

Volunteer donors and replacement donors who donate blood for a friend provide the best quality blood. They donate blood rarely and have very low prevalence of blood transmitted diseses.Professional donors are more likely to carry some infections. Their blood is likely to be of lower standard and they tend to donate very frequently.

Attention of health officials in blood banks is concentrated on the prevention of transmitting viral hepatitis through donated blood. The viral infection is highly prevalent in Egypt. Arthur et al (1997) reported that hepatitis C is prevalent in different governments in Egypt. More recently, El-Sherif et al (2007) reported that hepatitis B residual risk is the highest among transfusion transmitted diseases.Despite of the decline in the prevalence of viral hepatitis among asymptomatic Egyptians blood donors (Ismail et al, 2009), the transmission of vial hepatitis through blood donation constitutes a major health problem.

The quality of the donated blood is also evaluated by measuring hemoglobin concentration. It is the simplest technique to identify anemic donors who are not often turned away. More sensitive indicators such as ferritin which reflect body iron stores are rarely measured in blood banks. Anemic donor will donate inferior quality blood to the needy patient. On the other hand; repeated blood donation will have a negative impact on the health of the donor. Simon et al (1998) concluded that the prevalence of iron deficiency anemia increases with the increase in the frequency of blood donation. This was also associated with a significant drop in ferritin level (Alvarez-ossari et al, 2001).It was also reported that high frequency blood donors had evidence of decreased body iron stores and decreased oxidative stress (Zheng, 2005). The situation may be even worse among female donors who are naturally more susceptible to iron deficiency anemia. In a study in Casablanca, it was reported that frequent blood donation by females had a marked negative influence on body iron stores (Belharis and Benchemsi, 2008).

The nutritional status of blood donors receives little attention. While some blood banks measure the blood pressure of the donors, their body is rarely weighed. Underweight donor who does not meet his caloric requirements is very likely to suffer from other nutritional deficiencies. Kalus et al. (2008) reported that vitamin deficiencies occur in apparently healthy first-time as well as repeated blood donors. Malnutrition among blood donors will reduce the quality of the donated blood. On the other hand, repeated blood donation may have a negative impact on the nutritional status of the donors.

The aim of this study is to investigate and compare the nutritional status of professional blood donors who donate blood very frequently for monetary benefit with volunteer donors who donate blood once or twice to meet the need of a relative, a friend or for humanitarian reasons

SUBJECTS AND METHODS

The subjects of this cross sectional study were adult male blood donors in the age group 20 to 50 years. The study included two groups of blood donors. The first group included volunteer donors who donate blood to meet the needs of a close relative or a friend and those donating blood for human-

itarian reasons. The second group included professional donors who donate blood at least once every two months and get monetary benefit in return for the blood they donate. The sample size was determined using power sample calculator and comparing the reported percentage of anemia prevailing in the two groups and using a 5% confidence level and a power of 90%, the estimated required sample size amounted to 120 donors for each group (Danniel, 1995). The sample was taken from the leading blood bank in Alexandria using systematic random sampling technique. Blood donors were informed about the aim of the study and their consent was obtained.

A precoded questionnaire was designed to collect the data of the study and tested through a pilot study which included 15 donors. The finalized version was used to collect the information from each subject through a private interview. Each subject was requested to provide information on his educational level according to which they were classified which into three levels, university level, middle level of education, and low level including illiterates and those with primary school education. Monthly percapita income was used to classify the sample into low income group with monthly income less than 200LE, middle income between 200 and 400 LE and high income bracket with income exceeding 400 LE. Families of the donors were classified according to size into small families with less than 5 members, medium size between 5 and 7 members and large families including 7 or more members. Information was collected on the frequency of blood donation within the six months preceding the study and the reason for donating blood.The body weight of each subject was measured to the nearest 0.5 kg, height was recorded to the nearest 0.5 cm using standard technique (Jelliffe et al., 1989). Height and weight were used to calculate the body mass index (BMI; weight in kilograms divided by height in square meters). Donors were classified according to their BMI into four categories, underweight with BMI less than 18.5, normal 18.5 to less than 25; overweight BMI 25 to less than 30 and obese with BMI more than 30. (WHO, 1995).

A venous blood sample was taken with EDTA added and was used for the measurement of hematological parameters using Beckman 890 counter, these parameters included the red blood cell count (RBC), hemoglobin (Hb), hematocrit (Hct), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin concentration (MCHC) and white blood cell count (WBC). A donor was considered anemic when his hemoglobin level was less than 13 gm/dl. (DeMayer et al, 1989). A separate fasting blood sample was taken and used for the measurement of the biochemical parameters using Hitachi 911 auto analyzer; these parameters included glucose, cholesterol triglycerides and total protein.

Data were analyzed using the SPSS version software package. Chi-square test was used to evaluate association between variables and Monte Carlo exact probability test was applied when the Chi-square test was not valid. Data on hematological and biochemical parameters are presented in the form of means and standard deviations; t test was used to evaluate the significance of the difference between means, p values less than 0.05 were considered significant.

RESULTS

The distribution of volunteer and professional blood donors by socioecomic characteristics is presented in table 1. The results show that 65.8% of the donors received

limited education while only 13.8% were university graduates. The level of education of volunteer donors was significantly higher than that of professional donors,(X^2= 32.0, P<0.001). The results show that 23.3% of the volunteers were university graduates in comparison with 4.2% among professionals, the corresponding rates for those with limited education were 49.2% and 82.5% respectively.

The data show that the majority of the blood donors were from low income bracket (62.1%), such proportion was as high as 81.7% among professional donors which was almost twice as high as that reported among volunteers (42.5%).The results show that 20.0% of the latter group were of high income which was significantly higher than that reported among professional blood donors (2.5%), (X^2=41.72, P<0.001).

The results show that the majority of the professional donors (40%) came from large families as compared with 17.5% of the volunteers. The majority of the latter group came either from medium size or small families, 44.2% and 38.3% respectively, the corresponding rates for professional donors were 29.2% and 30.8% respectively. The difference was statistically significant, (X^2=15.22, P<0.001).

The frequency and reasons for blood donation stated by volunteer and professional donors are presented in table 2. The results show that the great majority of the professional donors (85.5%) donated blood four times or more during the six months preceding the study. Only 14.2% donated three times. On the contrary, 89.2% of the volunteers were donating blood for the first time while 9.1% donated blood twice during the same period.

The reasons for donating blood varied significantly, MCP<0.001. All the professional donors stated that they donated blood for financial payment. The majority of the volunteers (70.8%) donated blood to meet the needs of a close relative and another 17.5% responded to the need of a friend. Donating blood for humanitarian cause was practiced by only 10.8% of the volunteers.

The distribution of the blood donors by body mass index and hemoglobin concentration is illustrated in table3.The results show that the nutritional status of professional donors was significantly impaired when compared with volunteers donors, (X^2=17.51, P<0.01). Underweight was recorded among 32.5% of the professional donors and only 5.8% were obese. On the other hand, the prevalence of underweight was lower to 11.7% among volunteers and obesity was higher to 14.2%. The prevalence of overweight was comparable in both groups.

Anemia was prevalent among 65.0% of the professional donors as compared with a significantly lower rate of 15.8% among volunteers, (X^2=96.18, P<0.001). The results also show that the hemoglobin concentration of 21.7% of professionals was less than 9 gm/dl and another 27.5% were between 9-11 gm/dl. The lower prevalence of anemia among volunteer donors was associated with the high hemoglobin concentration. The results show that the hemoglobin of 52.5% of the volunteer donors was higher than 15.0 gm/dl as compared with a significantly lower rate of 5.8% among professional donors (table3).

The nutrient density and mean satisfaction of RDAs from some nutrients by volunteer and professional donors are presented in table 4.The mean percent caloric intake from carbohydrates was 68.9% by professional donors which was significantly higher than that recorded among volunteers (60.1%), t = 12.74, P<0.001. On the contrary, the mean percent intake from fats (27.5%) and proteins (11.9%) by volunteers was significantly higher by volunteers when

compared with professional donors, the corresponding rates were 21.4% and 9.3% respectively.

The percent satisfaction of RDAs from all nutrients investigated was significantly lower by professional donors when compared with volunteers. The data show that 35.6% of the professional donors consumed less than 67% of their energy needs as compared with 12.9% of the volunteer donors. This was reflected on the limited satisfaction of the RDAs for both protein (38.9%) and iron (40.7%) among professional donors, the corresponding rates for volunteer donors were 14.3% and 15.8% respectively. The satisfaction of the RDAs from calcium, vitamins A and C was slightly but significantly lower by professional donors when compared with the volunteers.

The mean hematological measurements of volunteer and professional donors is presented in table 5.The mean hemoglobin of volunteer donors was 14.68gm dl which was significantly higher than that of professional donors (11.40 gm/dl), ($t=12.02$, $P<0.001$). Hematocrit followed a similar pattern, the corresponding measurements were 44.12% and 36.12% respectively. The red blood cell count of volunteer donors was 4.97 mill/mcl as compared with 4.31 mill/mcl among professional donors. The mean corpuscular volume and mean corpuscular hemoglobin of professional donors was significantly lower than the corresponding measurements of volunteer donors (table 5). No significant difference was reported in the white cell count of both groups.

Table 6 illustrates the mean of some biochemical parameters for volunteer and professional donors. The data show that the glucose concentration of the professional donors (70.3 mg dl) was significantly lower than that of the volunteers (85.6 mg dl), ($t =10.54$, $p = 0.000$). The same trend was recorded for cholesterol which was also significantly lower among professional donors. On the other hand triglycerides was significantly higher among professional donors (198.9 mg/dl) when compared with the volunteers (179.4 mg/dl), ($t = 6.66$, $P<0.01$). Total protein concentration was comparable in both groups.

DISCUSSION

The nutritional status of the blood donor is one of the important factors determining the quality of the donated blood. A well nourished donor free from infectious and non-communicable diseases will donate the best quality blood. The demand for blood products steadily increases and the recruitment of blood donors becomes more difficult. A large sector of the population refuses to donate blood fearing that they will be harmed. Donating experience was perceived as stressful especially for the first-time donors (Hinrich et al, 2008).Blood banks are forced to resort to professional donors to collect the needed blood.

The results of this study show that professional blood donors were mostly illiterate or with limited education, came from large families and had a very limited income (Table 1). Their only motive for blood donation is financial. The better educated volunteer donors with higher income give blood to meet the need of a friend, a relative or for humanitarian reasons (Table 2). Professional donors who are desperate to support their large families and to cover their personal needs will donate blood as frequent as possible. To collect as much income as they can, they will go from one blood bank to the other, using fictitious names and false identification. Many have learned how to disguise needle marks and chemical stigma. As a result they donate blood at a rate that is beyond the ability of their body to compensate.

The results of this study confirm the high prevalence of malnutrition among professional donors when compared with the volunteers.Data presented in table 3 show that 32.5% of the professional donors were under weight and 35.6% were consuming less than two thirds of their daily energy requirements. Their intake from protein and iron was quite limited relative to the recommended dietary allowances. Vitamin A and C intake was less than two thirds the RDAs for more than 11.0% of the professional donors (Table 4). This is in agreement with the results of Kalus et al. (2008) who reported that vitamin deficiencies occurring among blood donors can can be prevented by vitamin supplementation.

When malnutrition was coupled with frequent blood donation, iron deficiency anemia is an expected outcome. The results show that 60.0% of the professional donors were anemic. Data presented in table 5 show that anemia was hypochromic microcytic characterized by a low hemoglobin level, reduced red blood cell volume and mean corpuscular hemoglobin. Javadzadeh et al. (2005) reported that iron deficiency anemia is the most common nutrition disorder in the world and that blood donation is able to cause iron depletion. This was confirmed by Mittal et al. (2006) who postulated that chronic iron deficiency is a well-recognized complication of regular blood donation. Djalali et al. (2006) explained that blood donation leads to substantial iron loss, as about 0.5 mg iron is lost per each millimeter of blood donated. If not compensated for efficiently, the iron loss may eventually lead to anemia.

The prevalence of anemia among volunteer donors was relatively low (15.8%) and was much lower than that reported by curtale et al. (2000) in young workers in Alexandria (44.5%). However it should be pointed out that anemic person will never volunteer to donate blood. Anemia was identified among volunteer donors who came to the blood bank without knowing that they were anemic.

The high prevalence of anemia prevailing among professional donors in this study may lead to a substantial loss of potential blood donors. Anemia was reported as one of the most important reasons for blood donor deferral. Arslan (2007) reported a donor deferral rate of 14.6% in Turkish donors. The most common cause for deferral was low hemoglobin. A comparable deferral rate of 12.8% was reported in a study of American Red Cross blood service (Zou et al. (2008).

The results show that while underweight was highly prevalent among professional donors, overweight and obesity were quite prevalent among volunteer donors, 20.8% and 14.2% respectively. Such rates are comparable to those reported by Abolfotouh et al. (2008) among adult males in Alexandria. A higher estimate was reported by Gallal (2002) at the national level. The prevalence of obesity was very low among the malnourished professional donors who do not meet their daily caloric needs.

The biochemical profile of professional donors is a reflection of their nutritional status and inadequate dietary intake. Mean blood sugar and total cholesterol were lower than that of the volunteer donors (Table 6). The low cholesterol level is associated with the lower hemoglobin recorded in this group. Similar results were reported by Choi, (2001) who reported that serum total cholesterol concentration in severely anemic subjects was significantly lower than normal healthy subjects. This was confirmed more recently by Ozdemir et al, (2007) who reported that the mean level of total cholesterol of anemic women was lower than that of normal subjects. Triglycerides levels were elevated among the anemic professional

donors. Amine and Hegsted (1971) reported that severe iron deficiency anemia was associated with a marked elevation of triglyceride level. Plasma cholesterol was either depressed of unchanged. Iron supplementation was followed by a significant reduction in triglycerides.

The results suggest that volunteers who undergo repeated blood donation and professional donors should receive nutritional care especially in terms of mineral and vitamin supplementation. Tests should be performed to evaluate donors' general health. Low blood hemoglobin should exclude the donor for undetermined period of time. Proper and effective records of blood donors indicating the date of the most recent donation must be kept and exchanged between blood banks.

BIOGRAPHY

Dr. Sally Ezzat is fellow of nutrition at Alexandria university students' hospital. Her duties include operating the nutrition clinic, formulating therapeutic diets and nutrition education of the patients. She teaches nutrition courses and presents public lectures. She is a member of the health care quality assurance unit and the infection control team.

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TABLE 1: DISTRIBUTION OF VOLUNTEER AND PROFESSIONAL BLOOD DONORS BY SOCIOECONOMIC CHARACTERISTICS.

Variable	Volunteer		Professional		Total	
	No.	%	No.	%		
Educational levels						
Low	59	49.2	99	82.5	158	65.8
Middle	33	27.5	16	13.3	49	20.4
University	28	23.3	5	4.2	33	13.8
X^2= 32.05, P< 0.001						
Percapita income (L.E/Month)						
Low	51	42.5	98	81.7	149	62.1
Middle	45	37.5	19	15.8	64	26.7
High	24	20	3	2.5	27	11.2
X^2= 41.72, P< 0.001						
Family size						
Small	46	38.3	37	30.8	83	34.6
Medium	53	44.2	35	29.2	88	36.7
Large	21	17.5	48	40	69	28.7
X^2= 15.22, P< 0.001						
Total	**120**	**100**	**120**	**100**	**240**	**100**

TABLE 2: FREQUENCY AND REASONS OF BLOOD DONATION BY VOLUNTEER AND PROFESSIONAL DONORS DURING THE LAST SIX MONTHS.

Frequency and cause of donation	Volunteer		Professional	
	No.	%	No.	%
Frequency				
First time	107	89.2	0	0
Twice	11	9.1	0	0
Three times	2	1.7	17	14.2
Four or more	0	0	103	85.8
MCP<0.001				
Cause of donation				
Financial	0	0	120	100
Donate to a relative	85	70.8	0	0
Donate to a friend	21	17.5	0	0
Humanitarian cause	13	10.8	0	0
MCP<0.001				
Total	**120**	**100**	**120**	**100**

TABLE 3: DISTRIBUTION OF VOLUNTEER AND PROFESSIONAL DONORS BY BODY MASS INDEX AND HEMOGLOBIN LEVEL.

Variable	Volunteer		Professional	
	No.	%	No.	%
Body mass index				
<18.5	14	11.7	39	32.5
18.5-	64	53.3	51	42.5
25-	25	20.8	23	19.1
30+	17	14.2	7	5.8
X^2= 17.51, P< 0.01				
Hemoglobin (gm/dl)				
<9	0	0	26	21.7
9-	3	2.5	33	27.5
11-	16	13.3	19	15.8
13-	38	31.7	35	29.2
15+	63	52.5	7	5.8
X^2= 96.18, P< 0.001				
Total	**120**	**100**	**120**	**100**

TABLE 4: NUTRIENT DENSITY AND THE MEAN SATISFACTION OF RDAS FOR SOME NUTRIENTS BY BLOOD DONORS.

Variable	Volunteer	Professional	t value	P value
	$\overline{X}$±SD	$\overline{X}$±SD		
Percent energy from				
Carbohydrate	60.1± 5.4	68.9±5.3	12.74	<0.001
Fat	27.5±3.7	21.4±3.2	13.66	<0.001
Protein	11.9±2.6	9.3±2.1	8.52	<0.001
Percent consuming less than 67% of RDAs				
Energy	12.9±2.1	35.6±3.2	49.97	<0.001
Protein	14.3±2.6	38.9±4.5	51.85	<0.001
Iron	15.8±2.4	40.7±5.2	47.63	<0.001
Calcium	13.5±4.8	17.8±3.9	7.61	<0.001
Vit A	9.8±1.5	14.1±2.3	17.15	<0.001
Vit C	7.9±1.7	11.6±2.8	12.37	<0.001

Hematological Measurements	**Volunteer**	**Professional**	**t value**	**P value**
	$\bar{\chi}$ ±SD	**$\bar{\chi}$ ±SD**		
Hemoglobin (gm/dl)	14.68±1.61	11.40±2.52	12.02	<0.001
Hematocrit (%)	44.12±4.6	36.13±5.2	12.61	<0.001
Red Blood cell count (mill/mcl)	4.97±0.68	4.31±0.87	6.55	<0.001
Mean corpuscular volume (fl)	88.23±12.1	83.26±14.01	2.74	<0.001
Mean corpuscular hemoglobin (pg)	29.76±3.92	26.01±4.76	6.66	<0.001
Mean corpuscular hemoglobin concentration (%)	33.74±3.62	30.95±4.51	5.29	<0.001
Blood white cell count (thous/mel)	6.443±1.91	6.597±2.01	0.61	N.S

TABLE 5: MEAN HEMATOLOGICAL MEASUREMENTS OF VOLUNTEER AND PROFESSIONAL DONORS.

Biochemical measurements	Volunteer	Professional	t value	P value
	$\overline{X}$±SD	$\overline{X}$±SD		
Glucose (mg/dl)	85.6±12.2	70.3±10.2	10.54	<0.001
Cholesterol (mg/dl)	211.3±12.9	183.7±16.8	14.27	<0.001
Triglycerides (mg/dl)	179.4±21.6	198.9±23.7	6.66	<0.001
Total protein (g/dl)	7.32±1.01	7.38±0.93	0.479	N.S

TABLE 6: MEAN BIOCHEMICAL MEASUREMENTS OF VOLUNTEER AND PROFESSIONAL DONORS.

Biochemical measurements	Volunteer	Professional	t value	P value
	$\overline{X}$±SD	$\overline{X}$±SD		
Glucose (mg/dl)	85.6±12.2	70.3±10.2	10.54	<0.001
Cholesterol (mg/dl)	211.3±12.9	183.7±16.8	14.27	<0.001
Triglycerides (mg/dl)	179.4±21.6	198.9±23.7	6.66	<0.001
Total protein (g/dl)	7.32±1.01	7.38±0.93	0.479	N.S