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Research Article

A Study of Association between Nutritional Status and Anemia in Adult Patients at Wad Medani Teaching Hospital, Gezira State, Sudan (2021-2022)

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Abstract

Anemia remains a significant public health problem globally, particularly in developing countries. Nutritional deficiencies are a major contributor to anemia. This study aimed to investigate the association between nutritional status and anemia among adult patients at Wad Medani Teaching Hospital. A cross-sectional study was conducted among adult patients attending the outpatient clinic at Wad Medani Teaching Hospital during 2021-2022. Data on sociodemographic characteristics, anthropometric measurements, dietary intake, and hematological parameters were collected. Nutritional status was assessed using questionnaire. Overall, the results revealed that older age groups (>46 year) tend to have higher percentages of individuals with weak intake of proteins, fats, and minerals compared to younger age groups (18 - 45 year). However, there is no significant association between age group and carbohydrate or vitamin intake. The results showed that more than three quarters (77.1%) of the study respondents had an onset period of the disease during adulthood. The results also showed statistically significant differences when using Chi-square ($p<0.05$) for statistical analysis of the relationship between the type of anemia and the consumption of proteins, fats, carbohydrates, minerals and vitamins 0.004, 0.000, 0.000, 0.001 and 0.019 respectively. The study found that more than three-quarters (77.1%) of the study participants had anemia, while (22.9%) of the study participants had anemia in childhood. More than two-thirds (72.9%) of the participants had anemia due to iron and vitamin deficiency as a result of poor nutrition. The study recommended eating animal and plant products, especially whole grains rich in iron, vitamin C and B12, or fortified foods to prevent and treat nutritionally related anemia.

Keywords: Anemia, Nutrition, Malnutrition, Adult, Public health, Sudan

Introduction

Sudan, a nation grappling with various socio-economic challenges, is particularly vulnerable to the impact of anemia. Factors such as poverty, food insecurity, inadequate healthcare access, and endemic diseases contribute to the high prevalence of this condition. The burden of anemia in Sudan not only affects individual health but also has broader implications for the country's economic and social development (FMH, 2021).

Anemia, a global health challenge, remains a significant public health issue, particularly in low- and middle-income countries like those in Africa, including Sudan. This condition, characterized by a deficiency in red blood cells or hemoglobin, can lead to a range of health problems, including fatigue, weakness, impaired cognitive function, and increased susceptibility to infections (WHO, 2023). Africa bears a disproportionate burden of anemia, with a high prev-

alence among both children and adults. Several factors contribute to this high prevalence, including iron deficiency, malaria, chronic infections, and inadequate dietary intake (WHO, 2023). Sudan, a country in the heart of Africa, is no exception to this trend. The combination of poverty, food insecurity, poor sanitation, and limited access to healthcare services exacerbates the problem of anemia. This condition can have severe consequences for individual health, economic productivity, and overall societal development. This study aimed to explore the prevalence of anemia among adults in Gezira state, Sudan and delve into the nutritional causes behind it. By understanding the magnitude of the problem, we can identify effective strategies for the prevention and management of anemia to improve public health.

Material and Methods

Site of Study

This study was conducted at Wad Medani Teaching Hospital - Medical wards- in Wad Medani city Gezira State, Sudan during the year (2021- 2022).

Population of Study

All patients admitted in the medical wards at Wad- Medani Teaching Hospital during the study period were included in a cross-sectional study to estimate the associations between diet function and protection against anemia among male and female patients over 18 years of age.

Inclusion and Exclusion Criteria

All cases that met the study requirements and were confirmed to have anemia in medical wards at hospital for the year (2021-2022) were selected, and cases with any other form of anemia-caused by diseases and cases with inherited anemia were excluded.

Questionnaire Designing and Applying

A questionnaire was applied about possible risk factors for anemia, and interviews were conducted with cases in the medical wards after the diagnosis of anemia, and questions related to investigations were applied in the local language. The questionnaire was designed in four parts: personal information, medical history, type of diet before illness, and after illness, with the aim of comparing the two types of diets and their effect on the development of anemia. The questionnaire also included other questions about eating habits, lifestyle, medical and family history, physical activity, and dietary pattern. Questions were asked about daily food intake to determine the amount and type of nutrients consumed from each food. Estimated units of measurement used were a specific volume, slice, cup, or a natural unit such as one egg. The total number of cases was 240 patients; 150 patients were selected to meet the research specifications. Part of the patients were excluded due to the unavailability of their data, and the sample size was reduced to 140 patients. Ethical approval was obtained from the Ministry of Health in Gezira State for the purpose of implementing the study as well as informed verbal consent from participants. Interviews were conducted with a total number of respondents (n=140) and their answers to the questionnaire questions were recorded, and laboratory and biological measurements such as blood hemoglobin level, iron and vitamin deficiency, sickle cell anemia, and body mass index were performed.

Statistical Analysis

The amount of protein, fat, carbohydrate, minerals and vitamins in the participants was statistically measured and compared to each other, and the differences between individuals' means were measured by analysis of variance (ANOVA) and correlation. The relative risks of patients were determined by comparing variables, and measures of central tendency, dispersion, analysis of variance, and chi-square were used in data analysis. All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) version 22.

Results and Discussion

Socio-Demographic Characteristics of Respondents

Table 1 summarizes the demographic characteristics of the respondents. According to the results, 57.1% of studied respondents were males and less than half (42.9%) were females =, (44.3%) their age range between 46 and over. Most of the respondents (40%) were completed their secondary education level, and about (30%), (21.4%) of the respondent were basic and illiterate, respectively and negligible (8.6%) were collegiate. The low educational level of both groups is attributed to weak economic income (25.7). (40%), (32.9%) and (27.1%) of the respondents suffered from iron deficiency anemia, vitamin deficiency and hereditary anemia, respectively and (44.3%) were in the age group 46 years and above. This was unlike the study conducted by Olayemi and Halim in Nigeria (2005), where they found that, age factor was significantly associated with anemia in their study, with the highest proportion of anemic respondents falling within the 18-39 age range. In the study done in Edo State which was carried out among respondents between 21 and 35 years old, they reported a prevalence of anemia as 19.5% in males and 81.8% in females. A study carried out by *Sholeye, et al.,* in Nigeria (2017) also found that the majority of respondents with anemia were 25 years old.

Table 1: Distribution of respondents according to demographic characteristics: gender, age and level of education. (n=140).

Items	Categories	Percent
Gender	Male	57.1
	Female	42.9
Age	18-25	20
	26-35	22.9
	36-45	12.9
	≥ 46	44.3

Educational Level	Illiterate	21.4
	Basic	30
	Secondary	40
	Collegiate	8.6

The results of the study which was conducted by *Ifeoma, et al.,* in Nigeria 2023, was also in contrast with this study where the prevalence of anemia was 9.9% in males and 15.8% in females, with the highest proportion of anemic respondents falling within the 18-39 age range. This mirrors the global point prevalence of anemia which is reported to be higher in females than in males.

The Association between Education Level, Nutrients Intake and Anemia

In Table (2; 3) were find out that overall, there were no significant differences (P<0.05) in protein, fat, mineral, or vitamin intake across the different educational levels. However, the Chi square value in Table 3; at P<0.05) indicates that there is no significant association with protein, mineral, vitamin intake and educational level (P=0.17, 0.301, 0.568), respectively. While carbohydrate values recorded a significant association (p=0.015). A higher percentage of respondents in the basic and secondary education levels reported weak carbohydrate intakes compared to those in the collegiate level. It is important to note that this table only shows associations and does not necessarily imply causation. Other factors, such as income, cultural background, and access to healthy food options, may also influence nutrient intake and educational attainment. The results were close to study conducted in Nigeria by *Halima, et al.,* in (2020) they reported that, severe anemia was significantly associated with a lower educational status of head of household (P=0.003) and a greater number of children per room in the household (P=0.004). Body mass index was not associated with severe anemia. The etiology of severe anemia in children living with sickle cell anemia in Nigeria is likely to be multifactorial with an interplay between an individual's disease severity and other socio-economic factors related to poverty. Another study conducted by *Linn, et al.,* in (2021) their study was in contrast with the present study especially in part of intake of carbohydrate associated with level of education. Their study examined the association between education and intake of total energy and macronutrients by sex. There was a negative association between education and intake of total carbohydrates and added sugar in both women and men. Respondents with long tertiary education had higher odds of being compliant with the recommended intake of total carbohydrates and the maximum recommended level for alcohol, compared to respondents with primary education. Overall, they found that respondents with higher education were more compliant with the Nordic Nutrition Recommendations 2012. *Ifeoma, et al.,* in Nigeria 2023, reported close results to our current study. They noticed that a statistically significant association between the respondents' level of education and anemia status. Most respondents who were not anemic had completed their senior secondary education or had post-secondary education (89.09%) (Tables 1,2).

Table 2: ANOVA table for association of proteins, fats, carbohydrates, minerals, vitamins, with education.

Source of Variation		Sum of Squares	Df	Mean Square	F	Sig.
Protein	Between Groups	1.205	3	0.402	1.686	0.173
	Within Groups	32.395	136	0.238		
	Total	33.6	139			
Fat	Between Groups	1.51	3	0.503	1.945	0.125
	Within Groups	35.176	136	0.259		
	Total	36.686	139			
Carbo-hydrate	Between Groups	1.119	3	0.373	1.365	0.256
	Within Groups	37.167	136	0.273		
	Total	38.286	139			
Mineral	Between Groups	0.41	3	0.137	1.215	0.307
	Within Groups	15.276	136	0.112		
	Total	15.686	139			
Vitamin	Between Groups	0.205	3	0.068	0.665	0.575
	Within Groups	13.967	136	0.103		
	Total	14.171	139			

A cross-sectional study conducted by *Tajeldin, et al.,* (2012) at Kassala, Eastern Sudan, their study revealed that a high prevalence of anemia affected adults regardless of their age, sex and educational level. Therefore, screening for anemia is needed to be done routinely and supplements have to be employed in this setting.

The Association Between the Age Groups of the Respondents and the Intake of Nutrients

Based on the Table (4), results were expressed as Chi-square test and considered significant at 5% level of significance (p< 0.05),

for protein, fat, mineral, or vitamin intake with studied age groups. The association between protein intake and age group is statistically significant (p=0.05). The percentage of individuals with weak protein intake increases with age, with the highest percentage (28.6%) in the >46 age group.

The association between fat intake and age group is also statistically significant (p=0.029). The percentage of individuals with weak fat intake increases with age, with the highest percentage (32.9%) in the >46 age group. The association between carbohydrate intake and age group is not statistically significant (p=0.104). The percentage of individuals with weak carbohydrate intake is relatively consistent across age groups, with the highest percentage (27.1%) in the >46 age group. The association between mineral intake and age group is statistically significant (p=0.001). The percentage of individuals with weak mineral intake increases with age, with the highest percentage (41.4%) in the >46 age group. The association between vitamin intake and age group is not statistically significant (p=0.929). The percentage of individuals with weak vitamin intake is relatively consistent across age groups, with the highest percentage (40%) in the >46 age group.

Overall, the table suggests that older age groups tend to have higher percentages of individuals with weak intake of proteins, fats, and minerals compared to younger age groups. However, there is no significant association between age group and carbohydrate or vitamin intake (Table 3).

Table 3: Association of Proteins, Fats, carbohydrates, Minerals and Vitamins with Educational Level. (n=140).

Items	Scale	Retreat		Basic		Secondary		Collegiate	p- value, sig
		%							Chi-square
Protein	Weak	11.4		18.5		24.2		7.1	0.17
	Adequate	12.8		11.4		15.7		1.2	
	Total	**21.4**		**30**		**40**		**8.6**	
Fat	Weak	12.8		17.1		30		4.3	0.162
	Adequate	8.6		11.4		19		4.3	
	More	1.2		1.2		0		0	
	Total	**21.4**		**4.3**		**40**		**16.3**	
Carb-hydrate	Weak	15.7		18.5		18.5		4.8	0.015
	Adequate	9.9		11.4		21.4		2.4	
	More	1.2		0		0		0	
	Total	**21.4**		**30**		**40**		**8.6**	
Mineral	Weak	17.1		27.1		34.2		8.6	0.301
	Adequate	4.3		2.4		4.8		0	
	Total	**21.4**		**22.8**		**40**		**8.6**	
Vitamin	Weak	18.5		25.7		35.7		8.6	0.568
	Adequate	2.4		4.3		4.3		0	
	Total	**21.4**		**35.7**		**40**		**8.6**	

*P-value considered significant at equal or less than 0.05

According to *Ifeoma, et al.,* in Nigeria 2023, their results disagree and agree with our current study in some parts. They noticed a significant association between age and anemia status (P=0.02), with most respondents who were anemic falling in the 18-39 age range.

According to a study by *Jung Su* (2014) among Taiwanese women, his results support our current study, as he reported in his study that obese/overweight women with iron deficiency anemia (IDA) were slightly older with a lower prevalence of IDA than those with normal weight (p<0.0001). Compared with normal weight IDA women, overweight/obese IDA women were more likely to consume higher amounts of dietary fat (p=0.0591), and lower amounts of carbohydrate (p=0.0457), resulting in increased fat/CHO ratio (p=0.0171). In a univariate analysis, age showed a slight protective effect on IDA for both normal weight and overweight/obese; 0.974 (0.955-0.993) and 0.951 (0.926-0.976); respectively (Table 2). Univariate analysis identified increased IDA risk for overweight/obese women who consumed higher dietary fat and lower CHO (OR: 10.119 (1.267-80.79)). No such relationship was found in IDA women with normal body weight (OR: 0.375 (0.036-4.022)). Another study conducted by *Aprajita, et al.,* 2019, in Garhwal city in India, his results close to our present study, as they reported in their study that finding revealed that age range of 20-39 years was primarily susceptible to anemic condition as compared to the other two age groups. In mild anemic categories, majority of subjects (51.69%) belonged to 20-39 yrs. age group followed by elderly group (40 60 yrs.) having 33.89%, whereas of individual between 0 and 19 yrs. showed least prevalence (14.42%). Individuals of 20-39 yrs. age group also showed higher prevalence (53.33%) in moderately anemic categories by leaving behind other age groups. Same trend also continued in severe anemic group, majority of individuals (46.66%) belong to age range 20-39 years followed by age

range 40-60 years with 40% suggesting that the elderly people are prone to be anemic. Women are clearly more susceptible to anemia due to blood loss during menstruation and childbirth. Elderly men and women lose their appetite for food and therefore lack the elements necessary for the formation of hemoglobin in the blood, which explains the results obtained in this study. Therefore, these age groups need food high in blood-forming elements, some appetite stimulants, and nutritional supplements.

Distribution of Study Respondents According to their types of Anemia

Figure 1 illustrated that more than three quarters (77.1%) of study respondents their period of onset of disease were adult. Table 5 The results showed that (40%), 32.9% and 27.1% of the study respondents suffered from iron deficiency anemia, vitamin deficiency and hereditary diseases respectively. The results of the study showed that patients suffering from nutritional anemia recorded a high degree of malnutrition, especially in consuming products containing protein, minerals and vitamins, which led to their developing nutritional anemia. In Table 6 the results showed that there were statistically significant differences when using chi-square ($p<0.05$) for statistical analysis, for relationship between type of anemia and consumption of proteins, fats, carbohydrates, minerals and vitamins 0.004, 0.000, 0.000, 0.001 and 0.019, respectively. As the results in Table 5 showed, the distribution of the respondents based on the treatments they received for anemia showed that more than two-thirds (72.9%) of the two study samples received Vita-ferol, iron injections, vitamin B12, and folic acid as a treatment for anemia resulting from a deficiency of the nutrients necessary for blood formation. It is clear that the main cause of anemia in the adults under study is the lack of nutrients required for the production of hemoglobin in the blood. Thus requires therapists to develop a schedule of daily meals necessary to increase the quantity and quality of nutrients required to treat nutritionally deficient anemia. *Nowaj, et al.,* in India (2023), their results agree with our current study. They concluded that, problem of iron deficiency remains a major issue in India, where the majority of the states (eastern, north-eastern and central) suffer from high anemia prevalence rate and it increases over time (Table 4).

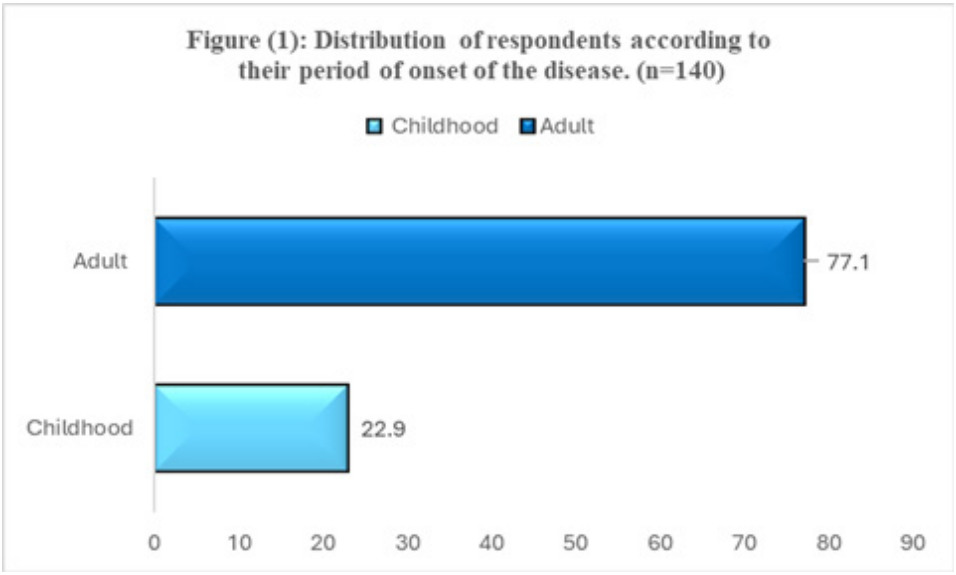

Figure 1:

Table 4: Association of Proteins, Fats, carbohydrates, Minerals and Vitamins with age groups. (n=140).

Items	Scale	18-25 year		26-35 year		36-45 year		>46	p-value, sig
		%							Chi-square
Protein	Weak	8.6		15.1		4.3		28.6	0.05
	Adequate	11.4		7.1		8.6		15.1	
	More	0		0		0		0	
	Total	20		22.9		12.8		44.3	
Fat	Weak	11.4		14.2		5.7		32.9	0.029
	Adequate	7.1		8.6		7.1		11.4	
	More	1.4		0		0		0	
	Total	20		22.9		14.2		44.3	
Carbo-hydrate	Weak	8.6		14.2		8.6		27.1	0.104
	Adequate	10		8.6		4.3		17.1	

	More	1.4		0		0		0	
	Total	20		22.9		12.8		44.3	
Mineral	**Weak**	12.8		21.4		11.4		41.4	**0.001**
	Adequate	7.1		1.4		1.4		2.4	
	More	0		0		0		0	
	Total	20		22.9		12.8		44.3	
Vitamin	**Weak**	17.1		20		11.4		40	**0.929**
	Adequate	2.8		2.8		1.4		4.3	
	More	0		0		0		0	
	Total	20		22.9		12.8		44.3	
*P-value considered significant at equal or less than 0.05									

Table 5: Distribution of study respondents according to their types of anemia and it is treatment. (n=140).

Type	Treatment	Percent
Hemolytic Anemia	Vita Ferol + Blood (t)	2.9
Due to chronic diseases	Epoitin alpha	4.3
Sickle cell diseases	Iron Supplement + Blood (t) + Hydrox	20
Iron deficiency	Vita Ferrol + Ferrus injection + siphol	40
Vitamin deficiency	VB12+ Folic acid	32.9
Total		100
*Blood (t) = Blood transfusion		

Table 6: Association of Proteins, Fats, carbohydrates, Minerals and Vitamins with type of anemia. (n= 140).

Items	Scale	Hemolytic anemia		Due to chronic diseases		Sickle cell anemia		Iron deficiency		Vitamin deficiency		p- value, sig
		%										Chi-square
Protein	Weak		1.4		2.8		5.7		28.8		84	
	Adequate		1.4		1.4		14.2		11.4		11.4	
	Total		2.8		4.3		27.1		40		32.8	0.004
Fat	Weak		0		1.4		7.1		32.8		64.2	
	Adequate		2.8		2.8		11.4		7.1		34.3	
	More		4.3		0		1.4		0		1.4	
	Total		2.8		4.3		20		40		100	0
Carbo-hydrate	Weak		4.3		2.8		5.7		27.1		22.8	
	Adequate		2.8		1.4		14.2		12.8		8.6	
	More		0		0		0		0		1.4	
	Total		2.8		4.3		20		40		32.8	0
Mineral	Weak		1.4		2.8		14.2		38.5		30	
	Adequate		1.4		1.4		5.7		1.4		1.4	
	Total		2.8		4.3		20		40		32.8	0.001
Vitamin	Weak		2.8		17.1		40		32.8		88.5	
	Adequate		0		2.8		7.1		0		11.4	
	Total		2.8		20		40		32.8		**100**	0.019
*P-value considered significant at equal or less than 0.05												

It is observed that multiple socio-demographic factors ranging from poor economic and educational status, rural residence to higher childbearing of women are responsible for predicting anemia levels among the social groups of women in India. To eradicate this problem India should improve women's overall nutrition status and their income. Meanwhile, GOI should be more focused on the existing policies related to anemia and on their actual implementation on grassroots level.

Goyal, et al., in North America (2020), their study concluded that, treatment for anemia brought on by dietary inadequacies frequently involves nutritional therapies, such as iron, vitamin B12, and folate supplements. Blood transfusions could be required in some situations, mainly when the anemia is severe or brought on by genetic diseases. *Kristine, et al.,* in USA (2015) revealed that anemia is highly prevalent in the general population and in the clinical setting. It is associated with diminished quality of life, worsening of clinical outcome, and increased health care costs. Iron deficiency is the predominant culprit, and iron deficiency alone may cause fatigue, RLS, and impaired cognitive function. Iron deficiency anemia should be treated upon diagnosis, and treatment should be considered for iron deficiency without anemia when it is symptomatic (Tables 5,6).

Conclusion

Based on the results, the study concluded that, more than three-quarters of the studied respondents had acquired anemia, while nearly one quarter of them had anemia in childhood. More than two-thirds suffering from anemia caused by iron and vitamin deficiency as a result of malnutrition. Older age groups (>46 years) tended to have higher proportions of individuals who consumed insufficient amounts of proteins, fats, and minerals compared to younger age groups. However, there was no significant association between age group, carbohydrate intake, and anemia. Individuals who consumed insufficient amounts of vitamins had a higher rate of anemia due to chronic diseases compared to those who consumed adequate amounts of vitamins.

Recommendations

The study recommended that, eating animal and plant products rich in iron, such as meat and legumes, are good sources of iron. Eating foods rich in vitamin C, such as citrus fruits and leafy greens, enhances iron absorption. Additionally, vitamin B12 supplements or fortified foods can help maintain healthy red blood cells. Whole grains, such as brown rice and whole wheat bread, also help because of their mineral and vitamin content.

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Disclosure of Conflict of Interest

All authors have no conflict of interest

Ethical Approval

Ethical approval was obtained from the Ministry of Health in Gezira State and the Faculty of Agricultural sciences, University of Gezira ethical committee for the purpose of implementing the study as well as informed verbal consent from participants.

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