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Association between hemoglobin level and food consumption among female nursing students at King Faisal University, Saudi Arabia

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ABSTRACT

Anemia exerts significant adverse impacts on health and the economy, both in developing and developed nations across the globe. The physiological and physical changes that transpire during adolescence and early adulthood necessitate heightened nutritional requirements. Among teenagers and young adults, anemia manifests as a frequent condition. The objective of our study was to determine the prevalence of anemia and its contributing factors among female nursing students enrolled at King Faisal University in Al Hasa, located in the Eastern Region of Saudi Arabia. Employing a cross-sectional design, we conducted an investigation involving a cohort of 83 nursing students who were in good health. To ensure adherence to COVID-19 safety protocols, we employed a practical sampling method to collect the samples. Hemoglobin (Hb) levels were assessed using a finger-stick capillary blood sample. According to the World Health Organization (WHO) criteria for diagnosing anemia, hemoglobin levels exceeding 12.0 g/dL indicate the absence of anemia. The study findings revealed that 59% of the participants were diagnosed with anemia due to their low hemoglobin levels. Substantial associations were observed between hemoglobin levels, anemia, and clinical factors such as chronic illnesses, heavy menstrual cycles, and dietary supplements. Based on these outcomes, anemia is highly prevalent among female university students. Furthermore, the research population may be susceptible to anemia if they engage in practices such as tea or coffee consumption, irregular meal patterns, or the intake of foods that impede iron absorption.

1. Introduction

Globally, anemia affects developing and developed countries, with major health and economic consequences (WHO, 2020). Anemia due to iron deficiency is a serious worldwide public health issue, affecting work capacity, intellectual performance, and pregnancy irreversibly (Verster and Pols, 1995). Adolescent and young adult bodies undergo significant physiological and physical changes, resulting in greater nutritional needs. It is common for young adults and adolescents to suffer from anemia. During adolescence and young adulthood, anemia plays a substantial role in a number of outcomes, and the severity of anemia has a substantial influence on those outcomes. Some of the consequences of this are a reduction in physical fitness and work capacity, as well as a reduction in school performance (Beard, 2001; Jain and Chandra, 2012). Among the young generation, anemia is a widely prevalent nutritional problem (Prasanth, 2017). The dietary habits of university students will continue into later life and play an influential role in health (Hardcastle et al., 2015). Eating competence is a set of attitudes and behaviors defined by The Satter Eating Competence Model (ecSatter) (Tanja et al., 2015). Educating students on healthy eating practices and dietary patterns is vital, as they are the future of the world (Moradi-Lakeh et al., 2017).

A condition known as iron-deficiency anemia (IDA) is caused either by inadequate iron intake from the diet or by chronic external (non-resorption)

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blood loss. Anemia is diagnosed when iron stores are low, and hemoglobin levels are two standard deviations below what is normal for the patient's age and gender. Around 26% of schoolgirls aged 7 to 14 in Riyadh have IDA (Al Hawsawi et al., 2015). According to Belali (2022), the population of the northern Asir Region in Saudi Arabia has a mild prevalence of IDA.

Anemia is associated with a reduction in red blood cells and/or a reduction in hemoglobin levels (Hb) (WHO, 2011). Anemia is a global public health problem that affects both developed and developing countries. It adversely affects human health and economic development. There are 24.8% of people in the world suffer from it (De Benoist et al., 2008).

The risk of maternal anemia increases among pregnant women and their babies, including stillbirths, premature births, and low birth weights. Iron deficiency anemia causes 20% of perinatal and 10% of maternal deaths in developing countries (Gautam et al., 2019). The maternal mortality rate will decrease by 30% for every 10 g/l increase in maternal hemoglobin (Ali et al., 2019).

There is a lack of information about anemia in Saudi Arabia (Fatin et al., 2011; Elzahrani, 2012). Several studies have been conducted in urban areas of the country, especially on children, young females, and women of childbearing age (Alquaiz et al., 2015; Hanafi et al., 2013).

There is scarce literature on anemia in adolescents and youth, compared to that in women and children. According to another study, iron deficiency anemia is prevalent in 30–56% of Saudi Arabians (Verster and Pols, 1995). In Riyadh City, a cross-sectional study among female adolescents (16–18) revealed a prevalence of 40.5% (Musaiger, 2002).

The issue of anemia is a global concern (Russo et al., 2020). The problem has become a major global health issue, especially in developing countries (WHO, 2020). To improve overall health outcomes, early diagnosis and management of the disease are crucial. Also, knowing the factors associated with anemia in the Gulf region will enhance our understanding of anemia in this region. Accordingly, the purpose of our study was to determine the prevalence of anemia among healthy female nursing students at King Faisal University in Al Hasa, Eastern Region, Saudi Arabia, and its associated factors.

2. Methodology

In this cross-sectional study, blood samples were analyzed to determine the prevalence of anemia among nursing students by measuring hemoglobin concentrations (Hb) and assessing their body mass index (BMI), dietary habits, and awareness of their food intake in order to determine the prevalence of anemia. Additionally, participants were asked to fill out a questionnaire regarding their nutritional knowledge and habits. During January and April 2020, a survey was conducted with first-year students.

A convenient sampling technique was used to collect samples from all first-level students during lab time. A total of 83 students between the ages of 18 and 22 participated in the study. Each participant was informed about the experiment and provided written consent before blood was collected. The study objectives and experimental protocol were explained to the participants. Participants who were not interested in providing their blood voluntarily were excluded.

Based on the prior literature and study of Marías and Glasauer (2014), we developed a structured questionnaire. Additionally, we used the Guidelines for Assessing Nutrition-Related Knowledge, Attitudes, and Practices Manual. Every student was given a questionnaire to assess their dietary habits, socioeconomic status, demographic information, and medical history. There were three major domains in the questionnaire. First, information about the individual's sociodemographic characteristics (age, marital status, history of obstetrics and gynecology). Second, we measured the hemoglobin level, the body mass index, the weight, and the height using portable balances. Third, Nutrition and anemia knowledge, practice, and attitude questions.

Due to social distance and COVID-19 precautions, all precautions were taken.

A capillary blood sample (finger-stick) is taken to test Hemoglobin (Hb); the normal range is (depending on altitude/region) Female adult: 12-16 g/dl. A student with a hemoglobin level of less than 12.00 g/dl was considered anemic. According to WHO criteria for anemia diagnosis, hemoglobin should be greater than 12.0 g/dL.

3. Results

The demographic data of the participants are shown in Table 1. Participants' ages ranged from 19 to 21, with a mean of 19.8 +/- 0.7. In terms of marital status, 68 (81.9%) were single. More than half of the 42 participants (50.6%) had a high family income. 14 (16.4%) of the participants had chronic illnesses. Of the respondents, 21 (25.3%) had heavy menstrual cycles. 60 (72.3%) had a menstrual period lasting between five and seven days. 21(25.3%) of the participants suffered from a heavy menstrual cycle. 60 (72.3%) had a duration of menstruation (days) from 5 to 7 days. 69 (83.1%) cycle length between 21 to 35 days. 52 (62.7%) believe they have hair loss. Concerning the use of food supplementation, 39 (47%) reported that they use it. Almost a quarter of the population (22.8%) used vitamin D.

Table 2 shows the mean and SD of the participants' clinical data. Among the study participants, the hemoglobin level was 11.06±1.43. The study participants ranged in weight from 42 to 89 kilograms. The weighted mean is 56.4±10.4. Height ranges from 145 to 169, and the mean is 158.3±4.7. BMI mean is 22.3±4.07. Of the participants, 66.3% were in the normal category. The overweight category accounted for 18.1% of the population.

Table 1: Study participants' demographic characteristics

Data			
Age	Range	19-21	
	Mean ±SD	19.8±0.7	
Marital status	Single	68	81.9%
	Married with children	9	10.8%
	Married and pregnant	6	7.2%
Family monthly income	less than 5000	7	8.4%
	From 5000 to 1000	34	41%
	More than 1000 SR	42	50.6%
Chronic disease	Yes	14	16.4%
	No	69	83.1%
Menstrual history	Heavy cycle		
	Yes	21	25.3%
	No	47	56.6%
	Not sure	15	18.1%
	Duration of menstruation (days)		
	Less than 5	8	9.6%
	from 5 to 7	60	72.3%
	more than 7	15	18.1%
	Length of cycle		
	Less than 21	12	14.5%
	from 21 to 35	69	83.1%
	more than 35	2	2.4%
Hair loss	Yes	52	62.7%
	No	15	18.1%
	Not sure	16	19.3%
Food supplementation	Yes	39	47%
	No	44	53%
	Vitamin D	19	22.8%
	Iron	11	13.2%
	Folic acid	6	7.2%
	Calcium	4	4.8%

Table 2: Clinical data of the participants

Data	Number	Percent
Hemoglobin level means and St. D 11.06 ± 1.43		
Weight		
Range	42-89	
Mean ±SD	56.4±10.4	
Height		
Range	145-169	
Mean ±SD	158.3±4.7	
BMI		
Range	17.2-33.9	
Mean ±SD	22.3±4.07	
BMI category		
Underweight	9	10.8%
Normal	55	66.3%
Overweight	15	18.1%
Obese	4	4.8%

Table 3 illustrates participants' knowledge of iron-rich foods and anemia. There is no doubt that most of the participants, 81 (97.6%) have some knowledge of anemia. Nearly one-third of the participants, 32 (38.6%) have a fair knowledge of the symptoms of anemia. In particular, 45 (54.2%) have a fair knowledge of the effect of iron deficiency on children, while 42 (50.6%) have some knowledge of the effects of iron deficiency on women. A majority of participants, 76 (91.6%), have a fair understanding of anemia's causes. Regarding the prevention of anemia, the majority of the participants 81 (97.6%) had fair knowledge about it. Nearly two-thirds of the participants 66 (79.5%) know that meat and organs are foods rich in iron. Regarding knowing that foods help the absorption of iron, 26 (31.3%) are aware that fresh citrus fruits are vitamin-C-rich foods. On the same point, 42 (50.6%) of the participants know that coffee and tea decrease iron absorption.

Table 3: Knowledge of the studied participants regarding anemia and iron-rich foods

	Number	Percent
Being familiar with iron deficiency anemia		
Yes	81	97.6%
No	2	2.4%
How can you recognize someone who has anemia?		
Less energy/weakness	23	27.7%
Paleness/pallor	7	8.4%
More likely to become sick (less immunity to infections)	2	2.4%
Other / Don't know	51	61.4%
What are the health risks for infants and young children of a lack of iron in the diet?		
Delay of mental and physical development	41	49.4%
Other	4	4.8%
Don't know	38	45.8%
What are the health risks for pregnant women of a lack of iron in the diet?		
Risk of dying during or after pregnancy	5	6%
Difficult delivery	20	24.1%
Bleeding	15	20.5%
Don't know	41	49.4%
What causes anemia?		
Lack of iron in the diet/eat too little iron	66	79.5%
Sickness/infection	6	7.2%
Heavy bleeding during menstruation	4	4.8%
Other / Don't know	7	8.4%
How can anemia be prevented?		
Eat/feed iron-rich foods/have a diet rich in iron	65	78.3%
Eat/give vitamin-C-rich foods during or right after meals	7	8.4%
¨Take/give iron supplements if prescribed	5	6%
Treat other causes of anemia– seek healthcare assistance	4	4.8%
Don't know	2	2.4%
Can you list examples of foods rich in iron?		
- Organ/meat	50	60.2%
- Liver	16	19.3%
- Fish and seafood	4	4.8%
- legumes	6	7.2%
- Green Vegetables (Spinach)	5	6%
- Molasses	2	2.4%
When taken during meals, certain foods help the body absorb and use iron. What are those foods?		
Vitamin-C-rich foods, such as	26	31.3%
- fresh citrus fruits	14	16.9%
- orange juice	8	9.6%
- lemons juice,	3	3.6%
- bell pepper	32	38.6%
- supplementary drugs		
Foods that decrease iron absorption some beverages decrease iron absorption when taken with meals. Which ones?		
Coffee /Tea	42	50.6%
Milk and milk products	25	13.1%
Don't know	16	19.3%

Table 4 shows how iron-rich foods consuming habits. On the last day, only 16 (19.3%) people consumed food containing unprocessed meat or liver. 44 (53%) of the participants did not consume any iron-rich foods the previous day. Nearly one-quarter of participants 22 (26.5%) consumed citrus fruits or vegetables like lemon or orange, dark green leafy vegetables, bell peppers, or juice made from them. In more than half of the participants 48 (57.8%), citrus is consumed after meals. Nearly two-

thirds of the participants (66.9%) drink coffee or tea. Twenty-three (27.7%) participants drank coffee or tea during the day but not at mealtime

Table 4: Consumption of iron-rich foods

Practice	Number	Percent
Yesterday, during the day and night, did you eat any of the following?		
Unprocessed meat /liver	16	19.3%
Fish and seafood	8	9.6%
Spinach/ Eggplant/ Apple/ Green pepper	7	8.4%
Legumes (lentils)	8	9.6%
Nothing from this	44	53%
Do you usually eat fresh citrus fruits or vegetables, such as [lemon or orange- dark green leafy vegetables, bell peppers], or drink juice made from them?	22	26.5%
Always	57	68.7%
Sometimes	4	4.8%
No		
When do you usually eat fresh citrus fruits?		
Before a meal	23	27.7%
During the meal	12	14.5%
After a meal	48	57.8%
Do you usually drink coffee or tea?		
Yes	58	66.9%
No	25	30.1%
When do you usually drink coffee or tea?		
Two hours or more before a meal	11	13.3%
Right before a meal	2	2.4%
During the meal	10	12%
Right after a meal	18	21.7%
Two hours or more after a meal	19	22.9%
Don't drink around meals	23	27.7%

Table 5 illustrates the attitudes of study participants toward anemia. There were 68 (81.9%) participants who were not sure of the severity of this condition, and only 9 (10.8%) considered it serious. The taste of iron-rich fruits and vegetables is disliked by 50 (60.2%) participants.

Table 5: Attitude of the studied participants regarding anemia and taste of iron-rich foods

	Number	Percent
How seriously do you think anemia is?		
Not serious	6	7.2
Not sure	68	81.9%
Serious	9	10.8%
Do you like the taste of iron-rich fruits and vegetables?		
Dislike	50	60.2%
Like	33	39.8%

Fig. 1 shows the total knowledge score about iron-rich foods. A majority of participants (60.2%) had fair or moderate knowledge of iron-rich foods and anemia, while 15.7% had high or good knowledge. Fig. 2 shows the hemoglobin levels of study participants. Over half of the participants 49 (59%) had low hemoglobin levels, which is surprising. Table 6 shows the correlation between hemoglobin level and knowledge score. Study participants' hemoglobin levels were significantly correlated with their knowledge about iron-rich foods and anemia, P value=0.005. In Table 7, hemoglobin level is shown in relation to the clinical data of the study participants. Clinical data such as chronic diseases, heavy menstrual cycles, and supplementation drugs were significantly correlated with hemoglobin levels.

4. Discussion

Most parts of the world have extensively studied anemia in women and children, but Saudi Arabia's eastern region, particularly, lacks information about its prevalence among university female students.

Eighty-one (97.6%) of the participants in the present study have some information about anemia. A recent study found that 91% of female adolescents had heard about anemia, which is similar to the percentage in this study (Jalambo et al., 2013). The percentage was higher than that found in Palestine, where 71.8% had heard of anemia (Jalambo et al., 2017). The present study showed that only 10.8% of participants considered anemia a serious health issue. However, 43.5% of the anemic female adolescents in the Palestine study knew that anemia was a serious health problem (Jalambo et al., 2017). Understanding the level of study of the students, which is the first level, would help to interpret these results.

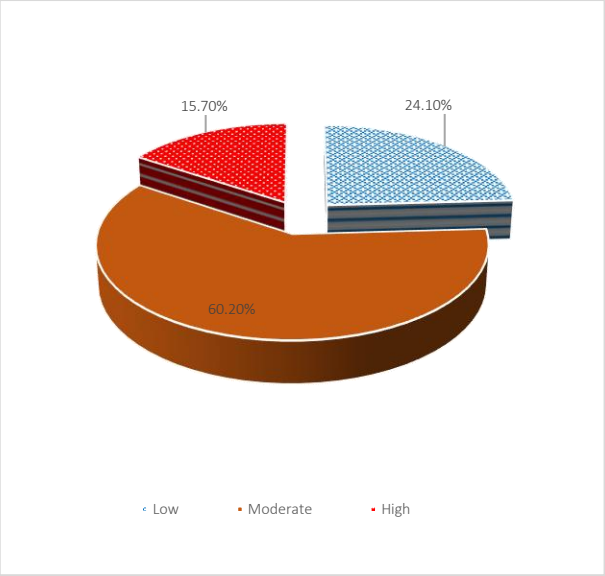

Fig. 1: Knowledge score about Iron-rich foods

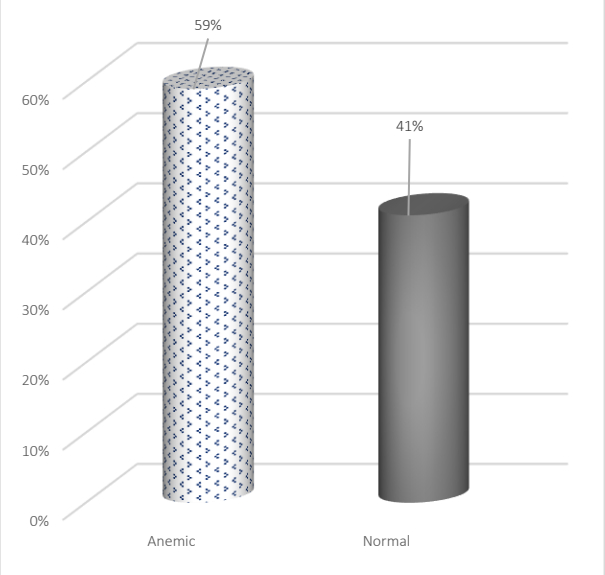

Fig. 2: Hemoglobin levels among study participants

Table 6: Association between hemoglobin level and knowledge score

Knowledge score	Normal Level No=34	Low level No=49	Total No=83	p
Low	6 17.6%	14 28.6%	20 24.1%	0.005*
Moderate	27 79.4%	23 46.9%	50 60.2%	
High	1 2.9%	12 24.5%	13 15.7%	

*: Significant at p = < 0.05

Table 7: Association between Hb level and clinical data of the studied participants

Data		Hb level	
		Mean±SD	p
Chronic disease	Yes	11.7±1.9	0.001*
	No	12.4±1.2	
	Heavy cycle		
	Yes	11.1±1.5	0.001*
	No	12.5±1.2	
	Not sure	12.4±1.2	
Menstrual history	Duration of menstruation (days)		
	Less than 5	12±1.3	0.08
	from 5 to 7	12.01±1.5	
	more than 7	12.9±0.5	
	Length of cycle		
	Less than 21	12.3±1.6	0.09
	from 21 to 35	12.2±1.3	
	more than 35	10	
Hair loss	Yes	11.9±1.4	0.1
	No	12.8±1.3	
	Not sure	12.2±1.3	
Food supplementation	Yes	11.7±1.5	0.02*
	No	12.5±1.2	
BMI category	Underweight	12.2±1.2	0.4
	Normal	12.2±1.4	
	Overweight	12.3±1.8	
	Obese	11	

*: Significant at p = < 0.05

All participants in the present study could list examples of foods rich in iron. It's contrary to a study conducted in Sudan that found 73.4% of participants were unaware of iron sources in food (Elhassan et al., 2013). There is a possibility that the high prevalence rate of listing iron-rich foods is a result of the participants studying chemistry.

According to the present study, nearly 60% of participants knew certain foods increase iron absorption when taken with meals. Comparatively, 64% knew of foods that decreased iron absorption. The results of this study differ from those of the Palestine study, in which only 35.9% of the participants knew that iron absorption could be improved by eating particular foods.

It was found in the present study that 59% of the participants had anemia and low Hb levels. It is consistent with the findings of Al Hassan (2015), which found that (64%) of Taibah University female students were anemic. An additional study in Bangladesh found that 55.3% of the students were anemic (Shill et al., 2014). It is possible that these results are related to the lifestyles and eating habits of Saudi female students. Another explanation could be that Saudi female students drink a lot of tea and coffee, which could contribute to the prevalence of anemia.

The mean Hb level in the present study was 11.06, a little bit low than normal, but higher than the average Hb reported by Taibah University which was 9.8 g/dL (Al Hassan, 2015). Sultan (2007) found that anemia prevalence was 26.7% in Emirati college students whose mean hemoglobin was 12.3 g/dL, compared to 59% in the present study. Another study in Kuwait found that the overall sample had a mean hemoglobin concentration of 12.7 g/dL, and around thirty percent of the girls were anemic, which differs from the results of the present study (Jackson and Al-Mousa, 2000). According to another report, preschool children, adolescent girls, and pregnant and lactating women have anemia rates between 80 and 90%. Anemia is more prevalent among females than males, and it is more prevalent in developing countries than in developed ones (Prasanth, 2017). There could be socioeconomic variations and differences in dietary habits across regions within the same country as well as across different countries, as well as differences in food choices among young adults. According to the present study, 53 percent of participants did not consume any iron-rich foods on the last day of the survey, which may not reflect their usual diet. Approximately 63% of subjects in a Pakistan study were found to have iron deficiency anemia; low iron intake and poor dietary habits may be contributing factors (Zulfiqar et al., 2021). Another Indian study found that IDA occurs when iron intake/absorption/storage is not balanced by iron utilization/loss. For that reason, they have come up with strategies to reduce anemia in India, including fortifying food with iron and educating the general public about iron-rich food sources (Kumar et al., 2022). A high percentage of students (38.6%) used iron supplementation drugs in the present study. Similarly, a study done in Saudi Arabia found that 37.8% were using supplementary drugs (Mousa et al., 2020).

5. Conclusion

In conclusion, based on the findings of this study, anemia among female university students in Saudi Arabia can be classified as a mild public health concern according to the WHO (2021) classification. The research revealed a high prevalence of anemia within the female university student population. Additionally, the consumption of iron absorption-inhibiting foods such as tea and coffee, as well as irregular eating patterns, emerged as potential contributing factors to anemia among the participants. Addressing food and nutritional habits may offer potential avenues for reducing anemia in females. Further investigations are warranted to elucidate the underlying causes of anemia in healthy young women, employing a range of indicators.

Acknowledgment

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Compliance with ethical standards

Ethical consideration

A protocol for this study was approved by the Research and Ethical Committee at King Faisal University, number (KFU-REC/2020-12-18). Confidentiality was maintained regarding the information of each participant.

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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