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Evaluation of the prevalence of iron deficiency in girls at the university stage in Al-Bayda City, Libya

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Abstract:

One of the most prevalent dietary deficiencies among female college students is iron deficiency (ID), which has a detrimental impact on general health, focus, and physical activity. Low serum ferritin levels (SFLs) are usually a sign of this disease. The present investigation aims to examine the relationship between ID, healthy nutrition, caffeine consumption, and the menstrual cycle among girls at the university stage in Al-Bayda City, Libya. This study was conducted from April 1 to May 30 in 2025. It targeted female university students whose ages ranged from 18 to 22 years. Blood samples were collected from the 223 participants after obtaining their consent, and with responded to the questionnaire, which included questions related to nutrition, caffeine consumption, and menstrual cycle patterns. The samples were then transferred to the laboratory for measurement of SFLs. This study revealed that 73% of university female students were iron-deficient, while 27% were non-deficient, with SFLs markedly lower in the iron-deficient group compared to the non-deficient group. Age was not significantly associated with ID. Moreover, the statistics revealed a significant relationship between dietary habits and ID among the participants. Additionally, results showed energy drink intake was significantly higher in the deficient group. Also, no significant differences were found in tea or coffee and cycle regularity and ID among the participants. The findings of this study indicate that ID is a common health concern among female university students, and several other factors emerged as strong predictors of ID, reinforcing the

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importance of confirming clinical suspicion with laboratory assessments like SFLs
Keywords: Iron deficiency; nutrition; ferritin; university girls.

تقييم انتشار نقص الحديد لدى الفتيات في المرحلة الجامعية بمدينة البيضاء، ليبيا

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الملخص:

يُعد نقص الحديد أحد أكثر حالات نقص التغذية شيوعًا بين طالبات الجامعات، والذي يؤثر سلبًا على الصحة العامة والتركيز والنشاط البدني. وعادةً ما يكون انخفاض مستويات الفيريتين في المصل علامة على هذا المرض. يهدف هذا البحث إلى دراسة العلاقة بين نقص الحديد والتغذية الصحية واستهلاك الكافيين والدورة الشهرية لدى الفتيات في المرحلة الجامعية بمدينة البيضاء، ليبيا. أُجريت هذه الدراسة في الفترة من 1 أبريل إلى 30 مايو عام 2025. واستهدفت طالبات جامعيات تتراوح أعمارهن بين 18 و22 عامًا. جُمعت عينات دم من 223 مشاركة بعد الحصول على موافقتهن، وأجبن على استبيان تضمن أسئلة تتعلق بالتغذية واستهلاك الكافيين وأنماط الدورة الشهرية. ثم نُقلت العينات إلى المختبر لقياس مستويات الفيريتين في المصل. كشفت هذه الدراسة أن 73% من طالبات الجامعات يعانين من نقص الحديد، بينما لم يُعانِ 27% منهن من نقص الحديد، مع انخفاض ملحوظ في مستويات الفيريتين في المصل لدى المجموعة التي تعاني من نقص الحديد مقارنةً بالمجموعة التي لا تعاني من نقص الحديد. لم يُلاحظ ارتباطٌ كبيرٌ بين العمر ونقص الحديد. علاوةً على ذلك، كشفت الإحصائيات عن علاقةٍ كبيرةٍ بين العادات الغذائية ونقص الحديد لدى المشاركين. كما أظهرت النتائج ارتفاعًا ملحوظًا في استهلاك مشروبات الطاقة لدى المجموعة التي تعاني من نقص الحديد. ولم تُلاحظ أيُّ فروقٍ كبيرةٍ في تناول الشاي أو القهوة أو انتظام الدورة الشهرية ونقص الحديد لدى المشاركات. وتشير نتائج هذه الدراسة إلى أن نقص الحديد يُمثل مشكلةً صحيةً شائعةً بين طالبات الجامعات،

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كما برزت عواملٌ أخرى عديدةٌ كمؤشراتٍ قويةٍ لنقص الحديد، مما يُعزز أهمية تأكيد الاشتباه السريري من خلال الفحوصات المخبرية، مثل مستويات الفيريتين في المصل.
الكلمات المفتاحية: نقص الحديد؛ التغذية؛ الفيريتين؛ الفتيات الجامعيات.

Introduction:

Anemia is a widespread public health issue that has significant effects on social and economic advancement as well as human health in both industrialized and developing nations (Chaparro & Suchdev, 2019). Although it can happen at any stage of life, pregnant women and small children are more likely to experience it (Al-Sayes *et al*., 2011; Abufarua *et al.*, 2018). A decrease in either erythrocytes or hemoglobin (Hb) is known as anemia. Accordingly, iron deficiency anemia (IDA) happens when a shortage of iron (Fe) is the source of the decrease in erythrocytes and hemoglobin. Since iron deficiency (ID) happens alone, body iron stores are either diminished or depleted, which is usually shown by a drop in serum ferritin (Cancado *et al.*, 2025). Moreover, blood cells' Fe serves a number of physiological purposes, including delivering O_2 to cells and preserving iron homeostasis (Barua *et al.*, 2023).

One of the most important heavy metals for human nutrition and a necessary component of human life is Fe (Chaudhary *et al.*, 2022). A nutritional ID occurs when the body does not get enough bioavailable iron from the diet to meet its needs for development and pregnancy, as well as to replenish iron lost through menstruation, the gastrointestinal tract, and the skin (Lynch, 2011). Moreover, two types of dietary iron can be found in food: heme and nonheme. Heme iron (HI) is exclusively found in animal products such as meat, fish, and poultry, whereas non-HI can be found in meat, fruits, vegetables, dry beans, nuts, and grain goods. Additionally, HI is more effectively absorbed from the gut than non-HI iron (Chaudhary *et al.*, 2022). On the other hand, Hb levels are typically the only method used for ID screening in impoverished nations (McLean *et al.*, 2009). Because there is a significant overlap in Hb concentrations between healthy and ID people, sensitivity is low. This is particularly true if the cutoff values used to diagnose anemia are not suitably adjusted for factors such as age, gender, pregnancy, ethnicity, smoking, and altitude (Nestel, 2002). Furthermore, numerous vital bodily processes, such as oxygen transport, adenosine triphosphate (ATP) generation, DNA synthesis, mitochondrial activity, and cell defense against oxidative

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damage, depend on iron (Atamna *et al.,* 2002; McCann & Ames, 2007).

The most common hematologic condition, particularly in women, is IDA (Gari, 2008), affecting approximately 2.15 billion people worldwide (FAO/WHO, 1992). Besides, up to 11% of teenage females in the US had IDA according to an assessment of the condition's prevalence (McCann & Ames, 2007). Dietary iron absorption is thought to be five to ten %, but when Fe stores are reduced, it increases three to five times (Halterman *et al.,* 2001). Moreover, the prevalence of anemia among women of reproductive age is 30.2%; 468.4 million of these women suffer from anemia. Africa (47.5%) and South-East Asia (35.7%) have the highest prevalences (Al-Sayes *et al.,* 2011). Additionally, if left untreated, young females who follow vegetarian diets or eat a lot of phytate-rich foods (legumes, whole grains) may find it difficult to achieve their Fe needs, which could eventually result in IDA (Pawlak *et al.,* 2016). At the same time, caffeine, which is mostly consumed through coffee, tea, energy drinks (EDs), and soft drinks, can further impair iron absorption. For example, a cup of coffee decreased iron absorption from a meal by 39%, while tea, a strong inhibitor of iron absorption, decreased it by 64% (Morcke *et al.*, 1983).

Contrarily, menstruation is a normal physiological process that results in blood loss on a regular basis. Because menstruating women need more Fe to make up for this loss, Fe insufficiency is a prevalent issue among them (Onuoha & Fayiah, 2024). Although 80 mL or more of blood loss was the traditional definition, an increase in menstrual blood loss increases the risk of ID, which can lead to IDA. Women who are menstruating will unavoidably lose more blood; while bleeding, this often adds up to an additional 1 to 2 mg per day (Dasharathy *et al.,* 2012; Jain *et al.,* 2022).

In order to effectively prevent, screen for, and treat ID in young women, a thorough understanding of the interactions between food, caffeine consumption, and menstrual blood loss is necessary. Therefore, this study aims to examine the connection between ID, a healthy diet, caffeine intake, and the menstrual cycle in university girls between the ages of 18 and 22, understanding how ID and irregular menstrual cycles may be caused by inadequate nutrition and excessive caffeine consumption.

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Materials and Methods:
Study Design:
From April 1 to May 30, 2025, the city of Al-Bayda served as the site of this investigation. It was directed at female university students between the ages of 18 and 22. Following their consent and completion of the questionnaire below, blood samples were drawn from the subjects.

Menstrual cycle patterns, caffeine intake, and nutrition were all covered in the questionnaire. After that, the samples were brought to the lab so that the SFLs could be determined.

Statistical analysis:
The collected data were analyzed using Minitab 17 statistical software. If there was no overlap between the 95% CI, the proportional differences were deemed statistically significant. Furthermore, to ascertain whether there was a significant difference in the dietary practices of the population under study between the IDA and normal groups, the Chi-square test was employed.

Results:
This study, which involved 223 female university students between the ages of 18 and 22, was carried out from early April until the end of May. ID individuals (positive, n = 162; 73%) and non-deficient individuals (negative, n = 61; 27%) were the two groups into which the participants were divided.

Table 1 shows the distribution of ID according to age among the study participants. Out of 223 female students, 162 (73%) were classified as ID (positive group) and 61 (27%) were non-deficient (negative group). In the positive group, 37 participants (22.83%) were 18 years old, 23 (14.19%) were 19 years old, 33 (20.37%) were 20 years old, 31 (19.13%) were 21 years old, and 38 (23.45%) were 22 years old. In the negative group, 15 participants (24.59%) were 18 years old, 6 (9.83%) were 19 years old, 13 (21.31%) were 20 years old, 15 (24.59%) were 21 years old, and 12 (19.67%) were 22 years old. The Pearson Chi-square test showed no statistically significant association between age and ID status ($\chi^2 = 1.773$, DF = 4, P = 0.778), indicating that age did not play a determining role in ID among the participants, and that the high prevalence of ID (73%) was consistent across all age groups.

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Table 1: Age distribution of study participants and their association with ID.

Age (Years)	Positive cases. No. (%)	Negative cases. No. (%)
18	37(22.83)	15 (24.59)
19	23(14.19)	6(9.83)
20	33(20.37)	13(21.31)
21	31(19.13)	15(24.59)
22	38(23.45)	12 (19.67)
Total	162(100)	61(100)

Pearson Chi-Square = 1.773, P-Value = 0.778

Table 2 shows the association between dietary habits and ID. The Chi-square test revealed a significant relationship between dietary habits and ID among the participants. Regarding the question about considering one's diet, 21.3% of the negative group (those without ID) reported considering their diet, compared to only 4.3% in the positive group (those with ID). Additionally, 62.9% of the positive group answered "sometimes" considering their diet, compared to 67.2% of the negative group. This difference was statistically significant ($\chi^2 = 22.679$, DF = 2, P = 0.000).

Regarding the consumption of essential nutrients, 47.5% of the negative group reported regularly consuming these nutrients, compared to only 20.3% of the positive group. Meanwhile, 32% of the positive group reported not consuming essential nutrients, compared to 21.3% of the negative group. This difference was also statistically significant ($\chi^2 = 17.471$, DF = 2, P = 0.000).

Concerning iron supplement intake, the positive group had a significantly lower percentage of supplement users (14.1%) compared to the negative group (29.5%). Furthermore, 63.5% of the positive group reported not taking supplements, compared to 39.3% of the negative group, while 22.2% of the positive group reported sometimes taking supplements versus 31.1% in the negative group. The Chi-square test confirmed a statistically significant difference between the groups ($\chi^2 = 13.414$, DF = 2, P = 0.001).

These results indicate that dietary habits —consuming essential nutrients, and taking iron supplements — are strongly associated with the presence of ID among the female students.

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Table 2: Comparison of the positive group (n = 162) and the negative group (n = 63) in terms of dietary habits, including responses to three lifestyles.

Nutrition System	Groups	Yes No. (%)	No No. (%).	Sometimes No. (%)	Pearson Chi-Square	p-value
Consider your diet	Positive	7(4.3)	53 (32.7)	102(62.9)	22.679	0.000
	Negative	13(21.3)	7(11.4)	41(67.2)		
Consuming essential nutrients	Positive	33(20.3)	52(32)	77(47.5)	17.471	0.000
	Negative	29(47.5)	13(21.3)	19(31.1)		
Take iron supplements	Positive	23(14.1)	103(63.5)	36(22.2)	13.414	0.001
	Negative	18 (29.5)	24(39.3)	19 (31.1)		

Table 3 presents a comparison of caffeine and beverage consumption between positive and negative cases of ID, as determined by the Chi-square test and P-value.

Regarding the question about regular consumption of coffee or tea, 37.6% of the positive group and 24.5% of the negative group reported drinking these beverages regularly. Those who do not drink periodically accounted for 19.7% in the positive group and 24.5% in the negative group, while 42.5% of the positive group and 50.8% of the negative group reported drinking sometimes. No statistically significant difference was observed between the two groups for this question ($\chi^2 = 3.760$, $P = 0.153$).

For energy drink consumption, the percentage was higher in the positive group (50.6%) compared to the negative group (37.7%). Conversely, 15.4% of the positive group and 34.4% of the negative group reported not consuming energy drinks, while 33.9% of the positive group and 27.8% of the negative group reported occasional consumption. This difference in energy drink consumption was statistically significant ($\chi^2 = 9.847$, $P = 0.007$).

Regarding the third question about participants’ knowledge that caffeine reduces iron absorption, 61.1% of the positive group and 65.5% of the negative group answered “Yes,” compared to 38.2% and 34.4% who answered “No,” with a very small percentage (0.61%) responding “I don’t know.” The P-value was not reported

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for this question due to a small sample size or insufficient data to provide a clear P-value result (χ^2 = 1.419).
These results indicate that energy drink consumption is significantly associated with ID, while regular consumption of coffee or tea and knowledge of caffeine's effect on iron absorption did not show statistically significant differences between the groups.

Table 3: Comparison of caffeine and beverage consumption between positive and negative cases.

Caffeine and Beverages	Groups	Yes No.(%)	No No.(%)	Sometimes No.(%)	Pearson Chi-Square	p-value
Do you drink coffee or tea regularly?	Positive Negative	61(37.6) 15(24.5)	32(19.7) 15(24.5)	69(42.5) 31(50.8)	3.760	0.153
Do you consume energy drinks?	Positive Negative	82(50.6) 23(37.7)	25(15.4) 21(34.4)	55(33.9) 17(27.8)	9.847	0.007
Did you know that caffeine reduces iron absorption?	Positive Negative	99(61.1) 40(65.5)	62(38.2) 21(34.4)	1(0.61) 0	1.419	---

Table 4 shows the association between menstrual cycle characteristics and ID status using the Chi-square test and p-value.
Regarding the question of whether menstrual cycles are regular, 69.1% of the positive group (ID) answered "Yes" compared to 78.6% in the negative group (non-ID). Those who answered "No" were 26.5% in the positive group and 21.3% in the negative group, while the response "Sometimes" was 4.32% in the positive group and absent in the negative group. The association between menstrual cycle regularity and ID was not statistically significant (χ^2 = 5.426, P = 0.066), indicating no strong correlation.
For the question "Do you consider your menstrual cycles to be long?", 49.3% of the positive group answered "Yes" compared to 29.5% in the negative group; "No" responses were 8.64% vs. 22.9%, and "Sometimes" responses were 41.9% vs. 47.5%, respectively. This association was statistically significant (χ^2 = 11.090, P =

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0.004), indicating a strong correlation between perceiving long menstrual cycles and ID.

Regarding the question "Do you suffer from heavy menstrual bleeding?", 40.1% of the positive group answered "Yes" compared to 26.2% of the negative group; "No" answers were 22.2% vs. 26.2%, and "Sometimes" answers were 37.6% vs. 47.5%. This association was not statistically significant ($\chi^2 = 4.466$, P = 0.107), meaning heavy menstrual bleeding was not conclusively linked to ID in this study.

Therefore, the table indicates that long menstrual cycles are significantly associated with ID, while menstrual cycle regularity and heavy bleeding showed no statistically significant association with ID in this sample.

Table 4: Association between menstrual cycle characteristics and ID status.

Menstrual cycles	Groups	Yes No. (%)	No No. (%)	Sometimes No. (%)	Pearson Chi-Square	p-value
Are your menstrual cycles regular?	Positive Negative	112(69.1) 48(78.6)	43(26.5) 13(21.3)	7(4.32) 0	5.426	0.066
Do you consider your menstrual cycles to be long?	Positive Negative	80(49.3) 18(29.5)	14(8.64) 14(22.9)	68(41.9) 29(47.5)	11.090	0.004
Do you suffer from heavy menstrual bleeding?	Positive Negative	65(40.1) 16(26.2)	36(22.2) 16(26.2)	61(37.6) 29(47.5)	4.466	0.107

Table 5 shows a comparison of ID-related symptoms between positive cases (those with ID) and negative cases (those without ID) using the Chi-square test and p-values.

A total of 83.3% of the positive group reported frequently feeling tired compared to 78.6% of the negative group. Although this percentage was higher among the ID participants, the difference was not statistically significant ($\chi^2 = 0.520$, P = 0.471), indicating that fatigue is common in both groups and may not be a specific indicator of ID.

Dizziness was reported by 76.5% of the positive group compared to 49.1% of the negative group. This difference was statistically

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significant (χ^2 = 16.817, P = 0.000), suggesting a strong association between dizziness and ID.

About 74.0% of the positive cases reported difficulty concentrating, compared to 60.6% of the negative group. The difference was close to the significance level (χ^2 = 3.852, P = 0.050), indicating that poor concentration may be linked to ID.

Paleness of the face was the most distinctive symptom, observed in 66.6% of the positive group, while it was not reported at all (0%) in the negative group. This highly significant difference (χ^2 = 39.521, P = 0.000) suggests that facial paleness is a strong clinical sign of ID.

Regarding previous diagnosis with anemia, 72.8% of the positive group reported having been previously diagnosed, compared to 63.9% of the negative group. However, this difference was not statistically significant (χ^2 = 1.877, P = 0.171), indicating that a past diagnosis of anemia does not necessarily reflect current ID status.

These results indicate that symptoms such as dizziness and facial paleness have a statistically significant association with ID and can be considered important clinical indicators. In contrast, symptoms like frequent fatigue, difficulty concentrating, and a previous anemia diagnosis did not show a statistically strong association in this sample, suggesting they are less reliable as standalone indicators of ID without laboratory confirmation.

Table 5: Comparison of ID-related symptoms between positive and negative cases.

Symptoms	Groups	Yes No. (%)	No No. (%)	Pearson Chi-Square	p-value
Do you frequently feel tired?	Positive Negative	135 (83.3) 48(78.6)	27(16.6) 13(21.3)	0.520	0.471
Do you experience dizziness?	Positive Negative	124(76.5) 30(49.1)	38(23.4) 31(50.8)	16.817	0.000
Do you have difficulty concentrating?	Positive Negative	120(74.0) 37(60.6)	42(25.9) 24(39.3)	3.852	0.050
Do you experience paleness in your face?	Positive Negative	108(66.6) 61(100)	54(33.3) 0	39.521	0.000
ever been diagnosed with anemia?	Positive Negative	118(72.8) 39 (63.9)	44(27.1) 23(36.0)	1.877	0.171

Table 6 illustrates a comparison of serum ferritin levels (SFLs) between positive (iron-deficient, ID) and negative (non-iron-

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deficient, non-ID) cases using the Independent Samples T-test. Data are presented as mean, standard deviation (SD) and standard error of the mean (SE mean)

In the positive group, which represents 73% of the total sample (n = 162), the mean ferritin level was 9.24 ng/mL, with a standard deviation of 4.54 and a standard error of 0.36. These values indicate a clear depletion of iron stores in this group.

In contrast, the negative group, accounting for 27% of the sample (n = 61), showed a markedly higher mean ferritin level of 48.6 ng/mL, with a standard deviation of 35.3 and a standard error of 4.5, suggesting sufficient or elevated iron stores.

The Independent Samples T-test revealed a highly significant difference between the two groups (T-value = -8.68, P = 0.000), which is well below the 0.05 threshold. This indicates that the difference in serum ferritin levels between iron-deficient and non-deficient participants is statistically significant and unlikely to be due to random variation.

Table 6: Comparison of SFLs between positive and negative cases. Data are presented as mean, standard deviation (SD), and standard error of the mean (SE mean).

Ferritin	No. (%)	Mean	SD	SE mean	P-value	T-Value
Positive cases.	162 (73)	9.24	4.54	0.36	0.000	-8.68
Negative cases.	61 (27)	48.6	35.3	4.5	0.000	-8.68

Discussion:

The current study evaluated the prevalence of ID in female university students and its correlation with a number of demographic, lifestyle, menstrual, and clinical parameters. Seventy-two percent of the subjects had ID, suggesting that the study community had a significant prevalence of this nutritional condition. ID is known to be a common health issue among young women, and this frequency is consistent with studies from comparable groups (Alzaheb & Al-Amer, 2017). This study supports a study among Saudi female university students that found a high frequency of ID, which was linked to poor eating habits, drinking too much tea, and experiencing large blood loss during menstruation.

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Iron status and lifestyle factors, especially eating habits, were strongly correlated. The likelihood of being iron-deficient was much higher among participants who did not think their food was healthy (only 4.3% of the positive group thought their diet was bad compared to 21.3% in the negative group, P = 0.000). The importance of nutritional intake in sustaining appropriate iron levels is further demonstrated by the fact that 47.5% of participants who were not deficient routinely ingested important nutrients, compared to just 20.3% of those who were. Iron supplementation is crucial for preventing ID, as seen by the significantly reduced iron supplement use in the ID group (14.1% vs. 29.5%, P = 0.001). These results are in line with earlier research that focused on how diet quality and supplementation affect iron status (Lynch, 2011; Mesías *et al.*, 2013). Moreover, this study also aligns with studies that have been done when the body does not get enough bioavailable iron from the diet to meet its needs for growth and pregnancy, as well as to replace iron lost through menstruation, the gastrointestinal tract, the skin, urine, and nutritional ID (Lynch, 2011). Furthermore, the monotonous and unbalanced diets that many teenagers currently consume may limit their intake of minerals and/or their bioavailability, leading to ID (Mesías *et al.*, 2013).
In terms of caffeine and beverage consumption, students with ID consumed considerably more EDs (50.6% vs. 37.7%, P = 0.007), suggesting that certain beverage choices may have a deleterious impact on iron status or absorption. Studies show that regular coffee and tea consumption affects iron absorption in the gastrointestinal tract and reduces the amount absorbed, but it does not necessarily result in a deficiency in blood iron, reflecting either the body's compensatory mechanism or the influence of other factors (Güneç, 2023). Regular coffee or tea consumption and knowledge about caffeine’s effect on iron absorption, however, did not significantly differ between groups (P = 0.153 and not reported, respectively). This study is in line with earlier investigations that discovered comparable outcomes concerning beverage intake and its impact on iron absorption. The ability of tea and coffee polyphenols to inhibit Fe absorption is inversely connected with their total number. When compared to a water control meal, drinks containing 20–50 mg of total polyphenols per serving decreased Fe absorption from the bread meal by 50–70%, while drinks containing 100–400 mg of total polyphenols per serving decreased Fe absorption from the bread meal by 60–90%. The degree to which polyphenols prevent the

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intestines from absorbing iron may vary depending on their type and amount (Duda-Chodak & Tarko, 2023).

Regarding EDs, there was a negative correlation found between their intake and blood iron levels, suggesting that energy drink usage may be a direct cause of ID. Factors related to menstruation influence the risk of ID. This could be because EDs are a class of liquid beverage that contains caffeine (Alsunni, 2015). To provide the user with an "energy boost," EDs combine stimulants and energy boosters. The primary component of the majority of EDs is caffeine. According to Alsunni (2011), they usually contain 80–150 mg of caffeine per 8 oz, which is comparable to 5 oz of coffee or two 12-oz cans of caffeinated soda. Also, in another study, the EDs caused ID in rats when administration of some types of EDs for 4 weeks (Khayyat *et al.*, 2014).

The perception of having long menstrual cycles was associated with ID, with 49.3% of ID women reporting long cycles, compared to 29.5% of non-ID women (P = 0.004), even though menstrual cycle regularity did not show a significant association with iron deficiency (P = 0.066). Although women with ID reported heavier menstrual bleeding more frequently, this difference was not statistically significant (P = 0.107). These findings provide credence to the theory that ID is exacerbated by menstrual blood loss (Peuranpää *et al.*, 2014; Munro *et al.*, 2023). This study supports earlier investigations that produced comparable findings about Heavy menstrual bleeding (HMB), which is the term used to describe menstrual blood loss of a volume significant enough to adversely impact a woman's physical health (Munro *et al.*, 2023). A total blood loss during each menstrual cycle that continuously exceeds 80 milliliters is referred to as HMB (Mansour *et al.*, 2021). Heavy menstrual flow is one of the main causes of IDA and ID. ID, which is brought on by monthly menstrual iron losses without adequate dietary iron supplementation, is indicated by low blood ferritin levels (Peuranpää *et al.*, 2014).

Clinically, the iron-deficient group experienced considerably higher rates of dizziness, trouble concentrating, and facial paleness (Aspuru *et al.*, 2011), supporting their usefulness as symptomatic indications of ID (P < 0.05). Notably, paleness was a prominent clinical indication that was evident in 66.6% of deficient persons but absent in the non-deficient group. On the other hand, there was no significant difference in the groups’ prior diagnoses of anemia (P = 0.171) or recurrent fatigue (P = 0.471), indicating that these

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symptoms might not be specific for the current iron shortage in the absence of biochemical confirmation. This is consistent with recent research showing that certain symptoms are similar to problems with overall health and should be confirmed by laboratory testing (Al Hassan, 2015).

There was a significant difference in SFLs across the groups; the ID group had a mean ferritin of 9.24 ng/mL, whereas the non-deficient group had 48.6 ng/mL (P = 0.000). Ferritin is a dependable biomarker for determining iron status, as evidenced by the significant difference. Depleted iron stores are shown in 72% of participants' low ferritin levels. These results reinforce serum ferritin's function as a crucial biomarker for determining the body's iron status and support the theory that iron shortage is significantly linked to a marked decrease in SFLs (Knovich *et al.*, 2008).

IDA, which is typified by a microcytic hypochromic blood image, is caused by a decrease in the RBC count and Hb content (Ballinger, 2007). Disrupted hematopoiesis, erythrocyte destruction, a decrease in the rate of erythrocyte synthesis, and/or an increased clearance from circulation could all be responsible for the depression in RBC count and Hb content observed in this study. The hyperactivity of the bone marrow, which results in the generation of RBC with compromised integrity that are readily destroyed in circulation, may be the cause of the decrease in haematocrit, RBC, and Hb, according to Karmarker *et al.* (2000). In addition to a drop in RBC count, a fall in Hb concentration may also result from compromised bone marrow hemogenesis (Abdel Aziz and Zabut, 2011). These alterations could be linked to the degeneration of RBC, pathological alterations in blood-forming organs, or both (Abdel Aziz and Zabut, 2011; Khayyat *et al.*, 2014).

Overall, this study highlights the multifaceted nature of ID in young women, encompassing dietary habits, menstrual factors, and lifestyle choices. The findings support targeted nutritional education, menstrual health monitoring, and increased access to iron supplementation as key strategies to reduce the high prevalence of ID in this vulnerable population.

Conclusion:

The results of this study show that low ferritin levels, which signal depleted iron stores, are present in over 70% of participants, indicating that ID is a frequent health concern among female university students. Age did not substantially correlate with ID, but

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a number of other factors, such as eating an imbalanced diet, taking few supplements, drinking EDs, and having heavy or lengthy periods, were found to be major predictors. Clinical symptoms, including pallor, lightheadedness, and difficulty focusing, were found to be important markers of ID, emphasizing the significance of using laboratory tests, such as blood ferritin levels, to validate clinical suspicion.

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