Vol. 2 No. 4 (2025)

ONLINE ISSN :3007-309X
PRINT ISSN :3007-3081

Journal of Medical & Health Sciences Review

A CROSS-SECTIONAL STUDY ON ANEMIA PREVALENCE, RISK FACTORS, NUTRITIONAL PRACTICES AND THE EFFICACY OF IRON-FORTIFIED FLOUR

Mahnoor Alam[1], Ayesha Bibi[1*], Azhar Ali[2], Muhammad Owais Khan[3], Nadia Sharif[4], Rakshinda Sadiq[4], Shakoor Wisal[5], Muhammad Ali[6], Khan Niaz Khan[7], Lubna[5]

[1]Department of Human Nutrition and Dietetics, Women University Mardan, KP, Pakistan
[1]Email: mnooralam2002@gmail.com , [*1]Email: ayeshabb2009@yahoo.com
[2]Zayed Military Hospital, Al. Ain, UAE, [2]Email: dr_azhar86@yahoo.com
[3]Frontier Medical and Dental College Abbottabad, KP, Pakistan, [3]Email: owaisrio2005@gmail.com
[4]Department of Biotechnology, Women University Mardan, KP, Pakistan
[4]Email: dnadiasharif@wumardan.edu.pk , [4]Email: rakhshinda_sadiq@wumardan.edu.pk
[5]Department of Human Nutrition and Dietetics, Bacha Khan University Charsadda, KP, Pakistan
[5]Email: swisal@bkuc.edu.pk [5]Email: lubnagul12wum@gmail.com
[6]Institute of Biotechnology and Microbiology, Bacha Khan University Charsadda, KP, Pakistan
[6]Email: drali@bkuc.edu.pk
[7]Department of Biology, Edwardes College Peshawar, KP, Pakistan, [7]Email: knk.edwardian@gmail.com

ARTICLE INFO:
Keywords:
Anemia, fortification, food frequency, Diet, Nutrition
Primary author:
Mahnoor Alam, Department of Human Nutrition and Dietetics, Women University Mardan, KP, Pakistan,
Email:
mnooralam2002@gmail.com
Corresponding Author:
Ayesha Bibi, Department of Human Nutrition and Dietetics, Women University Mardan, KP, Pakistan,
Email:
ayeshabb2009@yahoo.com
Article History:
Published on December 17, 2025

ABSTRACT
Anemia is characterized by low iron levels in the human body is a prevalent global health issue, particularly in less developed countries. The objectives of the study were to Investigate the prevalence of anemia (IDA) among different age groups in district Mardan and examine management strategies employed by Participants. A well-defined questionnaire was used to collect the information from 100 participants. The questionnaire consists of Sociodemographic information, bleeding disorder, family history, symptoms of anemia, and management strategies used. Rapid Iron Spot Test Kits from Nuclear Institute for Food and Agriculture (NIFA) were used to test the iron content in wheat flour. Information about dietary consumption was assessed with the help of the Food Frequency Questionnaire. Results showed that anemia was most prevalent in unmarried females with fatigue being the most common symptom. The major cause of anemia was less incorporation of iron-rich foods in their diet. Consumption of iron-rich foods, Vitamin-C-rich foods, iron supplements, and education & awareness on iron deficiency anemia and its management would be effective in reducing anemia.

INTRODUCTION

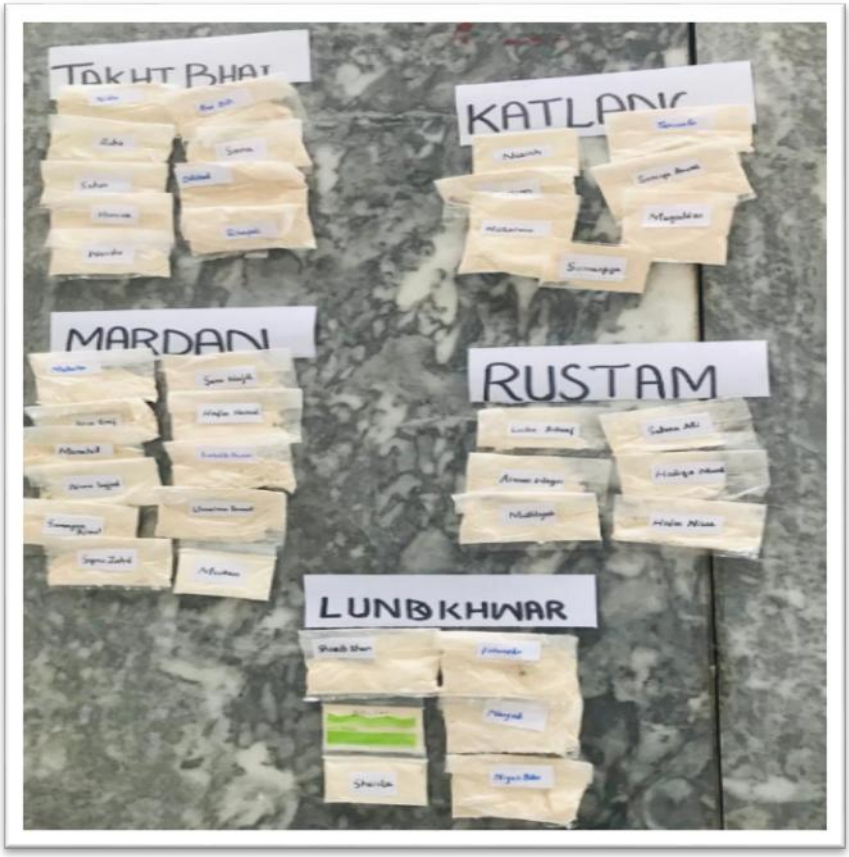
Anemia is worldwide public health concern, particularly in less developed countries [1]. It is distinguished by low hemoglobin (Hb) values (<11.0 g/dL), which signify dysfunctional or limited red blood cells with reduced oxygen-carrying capacity. A range of factors including infectious disorders (malaria, helminth infections, and other infections like tuberculosis and HIV/AIDS), inadequate dietary intake, hemoglobinopathies, and other micronutrient deficiencies such as iron, vitamin B12, and B9 results in anemia [2]. Iron deficiency anemia (IDA), is the most prevalent type of anemia and is caused by low iron levels, which is caused by poor diet quality, malabsorption, increased physiological requirements (growth, menstruation, pregnancy, internal bleedings, menorrhagia, intravascular hemolysis), gastrointestinal resection, gastritis, celiac disease, anemia, and gastritis), or pathological blood loss [3-5]. Individuals in low- and middle-income countries may be more susceptible to infections and have higher levels of systemic inflammation, which can both increase iron loss and decrease iron absorption and utilization [6]. Anemia is a major public health concern in Pakistan. About 5.7% of Pakistani children under five years are severely anemic. Compared to girls, boys have a slightly greater prevalence of anemia. Anemia affects children more frequently in rural settings than in urban areas. The prevalence of anemia has been continuously high. It increased to 53.7% in 2018. In Pakistan, 56.6% of teenage girls suffer from anemia, with 0.9% have severe anemia [7]. The standard method to diagnose anemia is to measure blood hemoglobin levels [6]. The management and prevention strategies of anemia are diverse and include dietary modification to increase the amount and bioavailability of iron in the diet, iron supplementation through tablets, syrups, or drops, blood transfusion (in cases of extremely severe anemia), biofortification through conventional plant breeding, to increase the iron content or its bioavailability in edible plants and vegetables [8]. Biofortification of basic crops like wheat has emerged as a viable, affordable, and effective rural-based approach to counter Anemia in recent years [9]. The World Health Organization (WHO) strongly advises fortifying wheat flour with highly bioavailable iron. In the general population over the age of two, fortifying wheat flour with iron, either in combination with or without other micronutrients, decreased the risk of anemia by 27% [10].

Research has highlighted specific populations at high risk of anemia. Munro *et al*. (2023) highlighted the serious effects of heavy monthly bleeding on anemia and iron deficiency in women of reproductive age, which can have an impact on the neurodevelopment of the fetus and the women's quality of life [11]. A study by Khan *et al.* highlighted that iron deficiency is the most common cause of anemia in pregnant Pakistani women, linking it with low birth weight, hemorrhaging after delivery, developmental delays, and stillbirth [12]. Dad *et al.* studied the impact of iron-fortified wheat flour on the hemoglobin levels of women of reproductive age in Buner, KPK, Pakistan [13]. The study entails that the introduction of iron-fortified wheat flour in the diet for three months would be a useful strategy to reduce iron deficiency anemia among women. This study aims to investigate the prevalence of anemia, specifically IDA, among various age groups in District Mardan. Furthermore, it seeks to examine the nutritional practices and management strategies employed by the population, with a particular focus on the efficacy of iron-fortified flour as a public health intervention.

MATERIALS AND METHODS

A quantitative, community-based cross-sectional study was conducted to assess the prevalence of anemia, associated risk factors, nutritional practices, and the use of iron-fortified wheat flour. The study was carried out in District Mardan, Khyber Pakhtunkhwa, Pakistan, covering five tehsils: Lund Khwar, Mardan, Takht Bhai, Katlang, and Rustam. The study population comprised individuals diagnosed with anemia residing in the selected tehsils. A total of 100 anemic respondents were enrolled in the study.

Participants were selected using a judgmental (purposive) sampling technique, ensuring inclusion of individuals who met the study criteria and were willing to participate. This approach was adopted to specifically capture information from individuals affected by anemia for an in-depth assessment of risk factors and management practices. Data was collected using a well-structured and pre-designed questionnaire. The questionnaire captured information on sociodemographic characteristics, general health status, family history of anemia, presence of bleeding disorders, and common clinical symptoms associated with anemia. To assess dietary patterns and nutritional practices, a Food Frequency Questionnaire (FFQ) was administered to evaluate the frequency of consumption of iron-rich foods, vitamin C rich foods, and other relevant dietary components influencing iron absorption. To evaluate the efficacy and usage of iron-fortified wheat flour, household wheat flour samples were collected from respondents. The iron content of these samples was analyzed using Rapid Iron Spot Test Kits obtained from the Nuclear Institute for Food and Agriculture (NIFA). The test results were used to determine the presence or absence of iron fortification in commonly consumed wheat flour. Collected data were coded, entered, and analyzed using Excel to assess frequency percentage of anemia prevalence, identify associated risk factors, and evaluate dietary practices and iron fortification status.



RESULTS AND DISCUSSION

In this study 100 participants from five tehsils of district Mardan were analyzed that were 27% male and 73% female. The participants' age distribution was as follows: 58% were in the age group of 16-25 years, 28% in the age of 26-35 years,7% in 36-45 years, and 7% in the age group above 45 years. Regarding occupation, 51% were unemployed, 26% were housewives, and 23% belonged to other occupations (teacher, technician,

employee). Regarding marital status, 36% were married and 64% were unmarried as shown in Table 1.

Table 1 Gender, age, occupation, and marital status of participants

Variables	Categories	Percentage
Gender	Male	27%
	Female	73%
Age	16-25 years	58%
	26-35 years	28%
	36-45 years	7%
	Above 45 years	7%
Occupation	Student	51%
	Housewife	26%
	Others	23%
Marital Status	Married	36%
	Unmarried	64%

The study revealed that 73% of females aged 16 to 50 had anemia, with the highest prevalence (58%) observed among students aged 16 to 25. Different experiences that lead to diagnoses of anemia include fatigue (37%), weakness (26%), pale skin (21%), and shortness of breath 16% as shown in Figure 1. In this study, 37% of respondents had a bleeding disorder, 19% among married women were pregnant or lactating, 47% had diseases other than anemia, and 58% have made changes in their diet and lifestyle to cure anemia as mentioned in Figure 2. In the present study, 58% of the population altered their diet and lifestyle following a diagnosis of anemia. A single-blinded, randomized controlled trial conducted by Alshwaiyat *et al*., 2023 over three months showed a considerable increase in the participants' hemoglobin levels, attributed to a diet-induced weight loss of 7.4 kg [14]. Different symptoms experienced by respondents have multiple symptoms at a time. It shows that about 86% had fatigue, 80% had weakness, 73% had pale skin, 67% had shortness of breath, 62% had headache, 66% had cold hands and feet, 60% had brittle nails while 44% had chest pain (Figure 3).

The current studies reveal that 86% of participants experienced fatigue, while 80% reported weakness. A cohort study by Weckmann *et al*., 2023 reported that fatigue was the highest reported symptom at 30%, and weakness followed closely at 29% [15]. In the current study, 62% of anemic patients reported experiencing headaches. A case-control study conducted by Saleem et al., 2023 at the Emirates Military Hospital in Rawalpindi, Pakistan, found that participants with a hemoglobin level of 9.85 g/dl had a higher percentage of headaches at 57.14% [16]. The results of the present study revealed that only 24% of the participants had received blood transfusions, 67% noticed an improvement in their anemia status since they started treatment, 31% experienced side effects from treatment, and 81% were taking iron supplements as mentioned in Figure 4.

The findings of the current study indicate that 81% of participants who used iron supplements experienced a positive effect on symptoms, amounting to 67%. Additionally, Rogez *et al*., 2024 reported that the use of iron supplements for three months also had a positive effect on symptoms, with a percentage of 52 [17]. Different percentages were observed for the consumption of vitamin C-rich foods by respondents that were daily consumption 15%, several times a weak 36%, once a weak 19%, and rarely 30% as shown in Figure 5. The current study indicates that only 15% of respondents included Vitamin C-rich foods in their daily diet. Sibenthal *et al*., 2023

reported that consuming an iron dose with orange juice instead of coffee or breakfast in the morning led to approximately a fourfold increase in iron absorption, resulting in an additional absorption of around 20 mg of iron per dose [18].

From the study, it was found that 45% of respondents were facing challenges in managing their anemia, 49% had a family history of anemia, and 56% squeezed lemon on foods. While 42% of the flour samples taken from the homes of respondents were fortified with iron when tested with the Rapid NIFA Iron Spot Test Kit (Figure 6).

In this study 46% of respondents consumed mutton/beef once a week and 1% never consumed it, 50% of participants rarely consumed fish, 45% consumed egg daily, only 9% consumed poultry daily, and 28% of respondents never consumed organ meat as shown in Figure 7.

Recent research suggests that participants' dietary habits may be a factor in the prevalence of iron-deficiency anemia. A study conducted by Alam et al.,2023 found that approximately 57% of adolescent girls had inadequate food consumption [19]. In the present study, it was revealed that merely 27% of the participants included meat in their daily diet. A study conducted by Twum-Dei et al., 2024 indicated that women who incorporated meat, fish, and dark leafy vegetables into their diet achieved a high diversity score ($p=0.031$ and $p=0.049$), leading to an improved status regarding anemia [20]. In the study, only 29 % of participants consumed milk and 20% yogurt/cheese daily. The consumption of plain flour was followed by 25% while that of rye bread was only 3%, and 25% consumed chocolates once a week while 16% never consumed chocolates (Figure 8).

In the study conducted, 48% of respondents consumed spinach once a week, only 2% consumed kidney beans and 1% lentils daily. Dried fruit consumption was 18% daily while 45% consumed fruits daily (Figure 9). In this study, the hemoglobin levels of participants were analyzed. Different percentages of hemoglobin levels at various ranges were observed that are follows as 7mg/dl (10%), 8mg/dl (14%), 9mg/dl (13%), 10 mg/dl (24%), 11mg/dl (20%), 11.5 mg/dl (6%), and 12 mg/dl (10%) respectively (Figure 10).

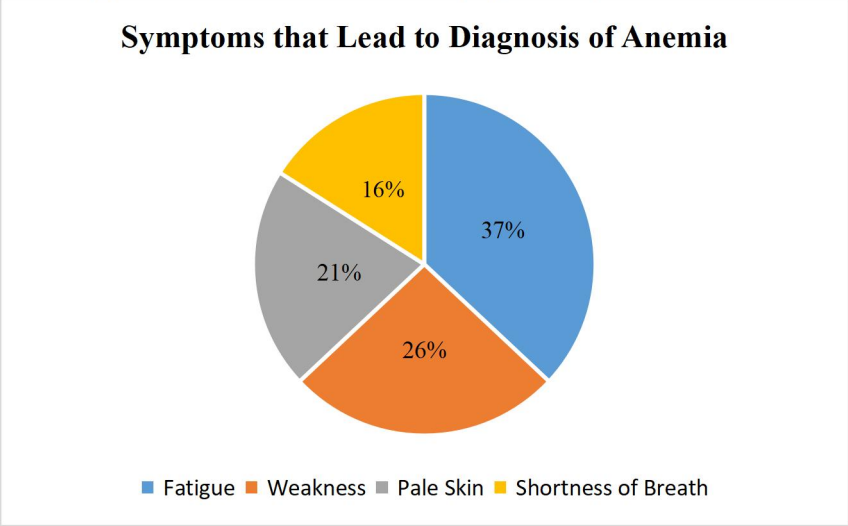


Figure 1. Indicates percentages of symptoms that lead to the diagnosis of anemia

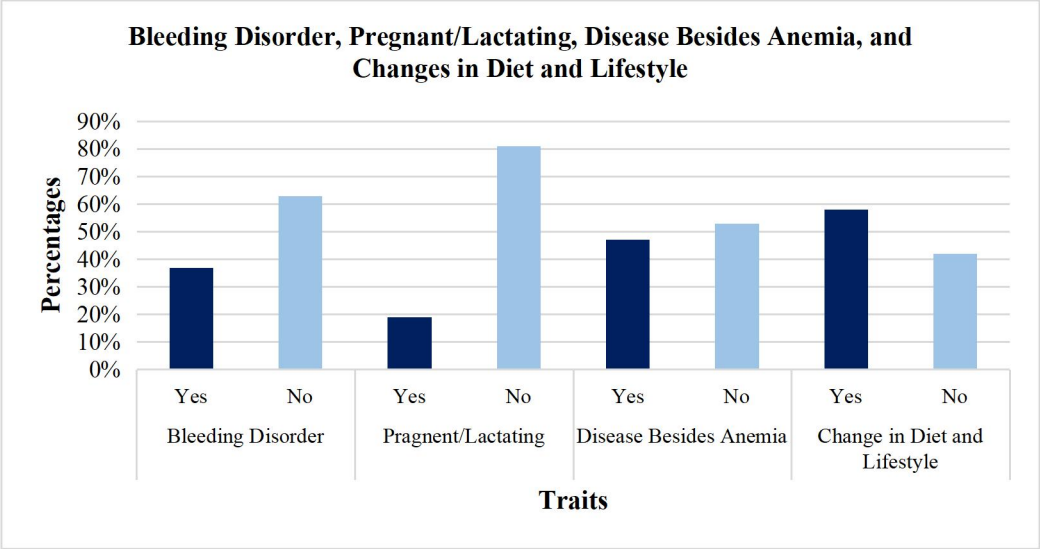


Figure 2. Percentages of bleeding disorders, pregnant/lactating women, diseases besides anemia, and changes in diet and lifestyle among respondents from district Mardan

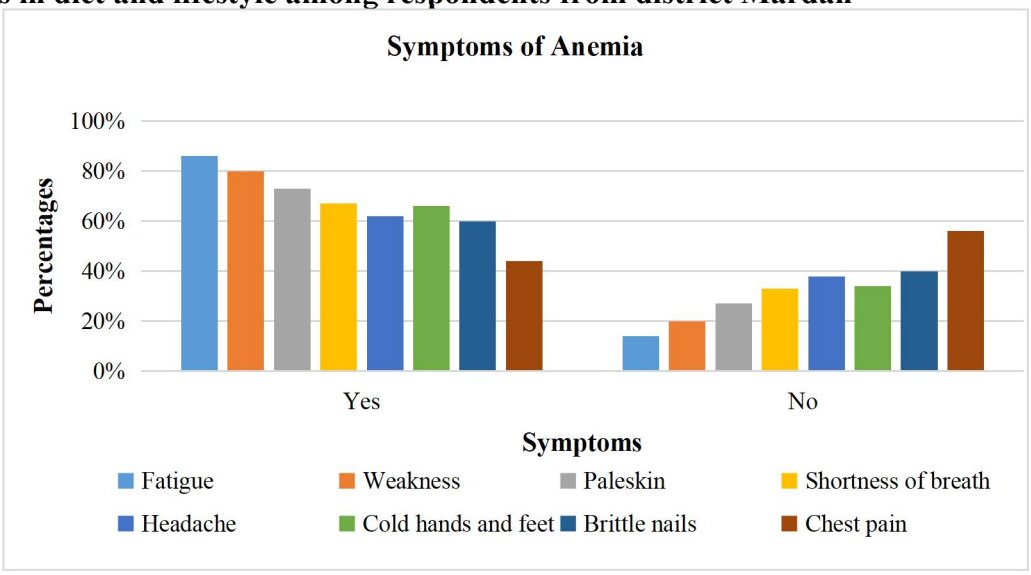


Figure 3. Indicates percentages of symptoms of anemia among respondents from District Mardan

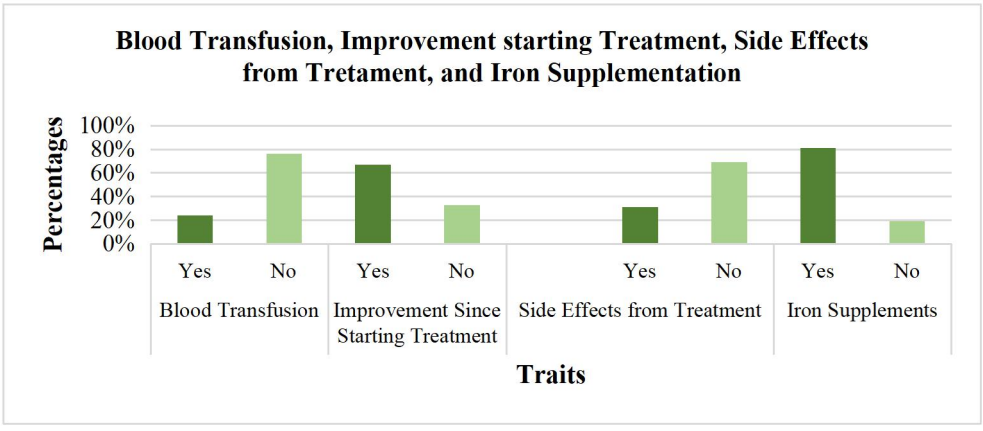


Figure 4. Indicates percentages of Blood transfusions, improvements since starting treatment, side effects from treatment, and iron supplementation among respondents from district Mardan

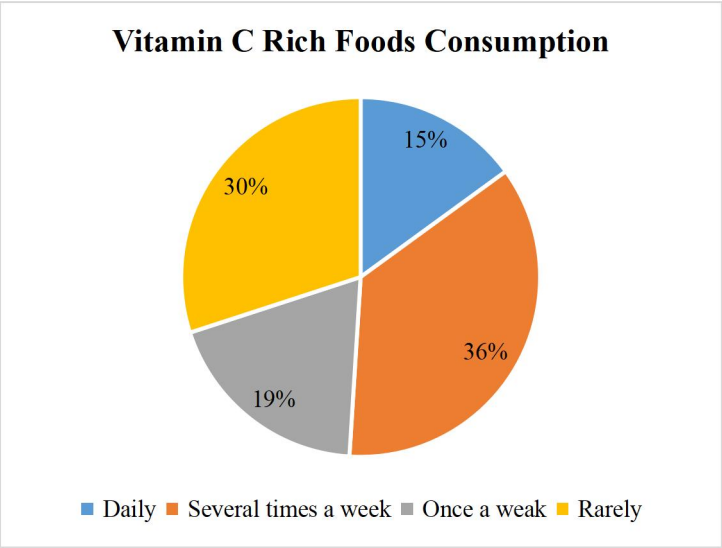


Figure 5. indicates percentages of consumption of vitamin C-rich foods among respondents from district Mardan

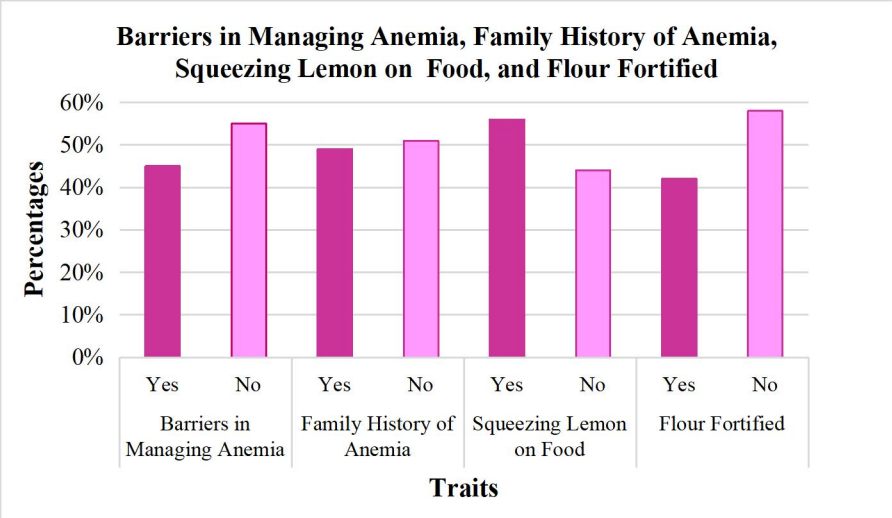


Figure 6. Indicates percentages of barriers in managing anemia, family history of anemia, squeezing lemon on food, and flour fortified among respondents from district Mardan

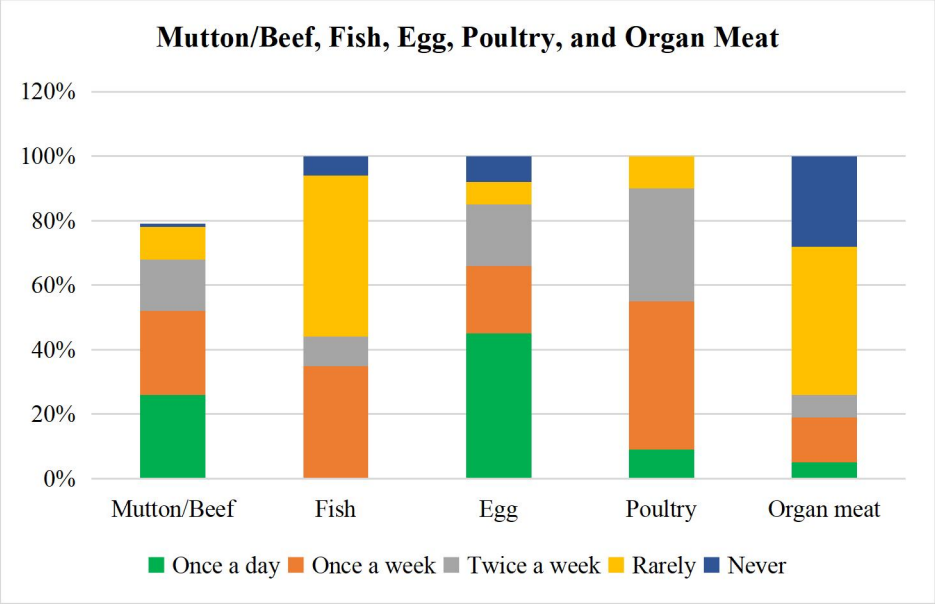


Figure 7. Indicates consumption of mutton/beef, fish, poultry, egg, and poultry among participants from district Mardan

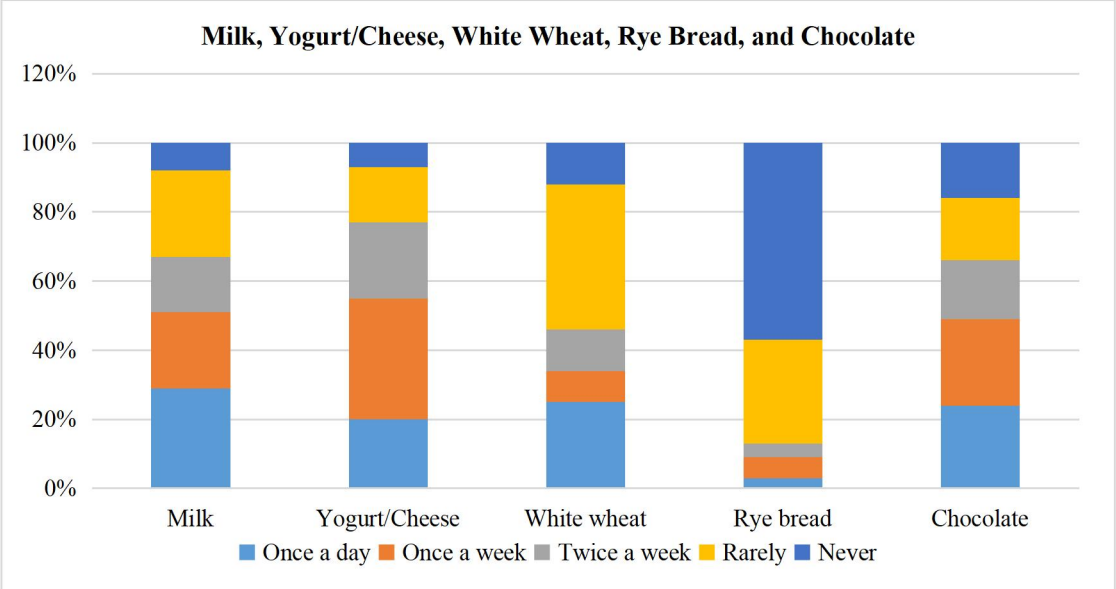


Figure 8. Indicates percentages of milk, yogurt/cheese, white wheat, rye bread, and chocolates among respondents from District Mardan

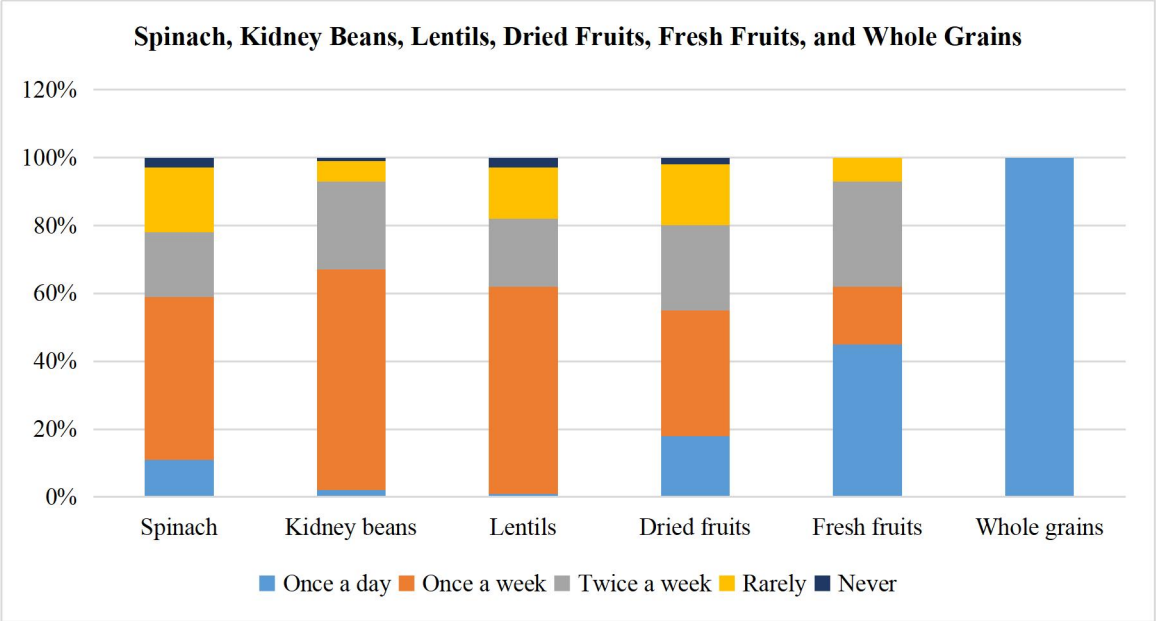


Figure 9. Indicates percentages of consumption of spinach, kidney beans, lentils, dried fruits, fresh fruits, and whole grains among respondents from district Mardan

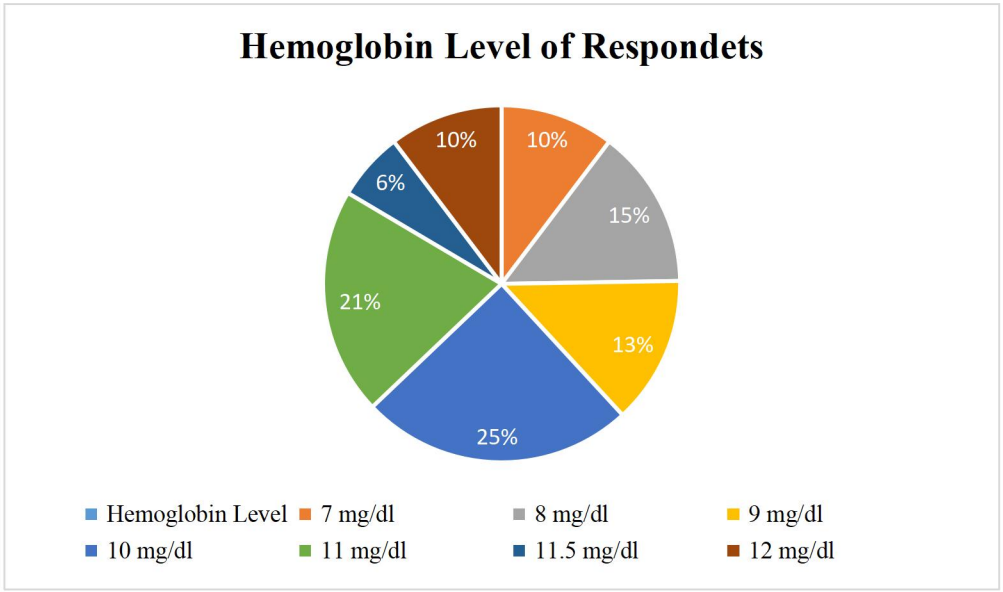


Figure 10. Indicate percentages of hemoglobin levels at various ranges among respondents from district Mardan

CONCLUSION

Iron deficiency anemia is the most prevalent condition in women and is particularly common in those between the ages of 16-25 years, the majority of whom are unmarried. Most participants reported fatigue as their primary anemia-related symptom, with varying percentages also reporting weakness, pale complexion, shortness of breath, headache, chilly hands and feet, and chest pain. In addition to taking medicine and receiving blood transfusions, many of them have changed their diet and lifestyle to manage anemia. In terms of eating habits, they regularly eat whole wheat flour. But a smaller portion of them consumed beef or mutton daily, poultry. Less than half consumed spinach once a week while almost half of the population hardly ever consumed organ meat. The consumption of dried fruits was also not satisfactory daily, with a weekly consumption peak of 37%. Additionally, just 45% of fresh fruit consumption reached the daily required portions. More than half of individuals did not use wheat flour enriched with iron. Consumption of vitamin C-rich foods was also very low daily.

RECOMMENDATIONS

It is imperative to provide a multifaceted approach to treat the high prevalence of iron deficiency anemia among young, single women, as indicated by research findings. This involves contemplating the use of iron supplements for those unable to fulfill their daily iron requirements through diet alone, advocating regular physical activity that helps to manage overall health and alleviate symptoms of anemia, and undertaking education and awareness campaigns to highlight the importance of balanced nutrition and iron in the body, additionally, encouraging the use of fresh fruits and vegetables that are high in vitamin C to improve iron absorption and a diet rich in iron-containing foods including lean red meat, chicken, fish, lentils, and iron-fortified cereals Finally, promoting routine visits to medical professionals to evaluate iron levels and overall health will help with early anemia detection and management, eventually improving young women's health.

REFERENCES

1. Safiri, S., et al., *Burden of anemia and its underlying causes in 204 countries and territories, 1990-2019: results from the Global Burden of Disease Study 2019.* J Hematol Oncol, 2021. **14**(1): p. 185.
2. Habib, A., et al., *Prevalence and Risk Factors for Iron Deficiency Anemia among Children under Five and Women of Reproductive Age in Pakistan: Findings from the National Nutrition Survey 2018.* Nutrients, 2023. **15**(15).
3. Briguglio, M., et al., *The central role of iron in human nutrition: from folk to contemporary medicine.* Nutrients, 2020. **12**(6): p. 1761.
4. Ahmad, A.M.R., et al., *Synergistic effect of galacto oligosaccharides and iron fortificants on serum iron, ferritin, transferrin and total iron binding capacity levels in anemic rats.* Pakistan journal of pharmaceutical sciences, 2019. **32**(5 (Supplementary)): p. 2205-2213.
5. Anis, R.A., et al., *Effect of iron-fortified wheat flour on hemoglobin levels among women of reproductive age group in Mansehra, KPK, Pakistan.* Cellular and Molecular Biology, 2023. **69**(2): p. 26-30.
6. Field, M.S., P. Mithra, and J.P. Peña-Rosas, *Wheat flour fortification with iron and other micronutrients for reducing anaemia and improving iron status in populations.* Cochrane Database of Systematic Reviews, 2021(1).
7. Survey, N.N., *KEY FINDINGS REPORT*, Ministry of National Health Services, R.a. Coordination, and G.o. Pakistan, Editors. 2018, UNICEF Pakistan: Pakistan.
8. Rahman, M.J., et al., *Impact of mobile health-based nutritional education on hemoglobin levels in anemic adolescent girls in rural Bangladesh: a randomized controlled trial.* BMC Public Health, 2025. **25**(1): p. 2567.
9. Chekraverthy, B.K., H.A. Pardhe, A.V. RAVI KIRAN, and K. NAGAPPAN, *Nutritional Strategies for Treating Iron Malnutrition:*

Implications on Nutrikinetic Approaches. Current Research in Nutrition & Food Science, 2023. **11**(1).
10. Lopez de Romaña, D., et al., *Review of intervention products for use in the prevention and control of anemia.* Annals of the New York Academy of Sciences, 2023. **1529**(1): p. 42-60.
11. Muntaha, H.A.A.N., Ali Muhammad Qasim., *Frequency of Iron Deficiency in Females having Normal Haemoglobin level Complaining of Fatigue.* Indus Journal of Bioscience Research, 2025. **3**(7): p. 204-210.
12. Khan, H.A., et al., *Exploring the relationship between anemia in pregnancy and infant mortality: a narrative review.* IJS Global Health, 2024. **7**(3): p. e0412.
13. Dad, F., et al., *Effect of iron fortified wheat flour consumption on the hemoglobin status of adolescent girls in district Buner.* American Journal of Food Science and Health, 2017. **3**(1): p. 1-6.
14. Alshwaiyat, N.M., Ahmad, A., & Al-Jamal, H. A. N., *Effect of diet-induced weight loss on iron status and its markers among young women with overweight/obesity and iron deficiency anemia: a randomized controlled trial.* Frontiers in nutrition, 2023. **10,** : p. 1155947.
15. Weckmann, G., S. Kiel, J.-F. Chenot, and A. Angelow, *Association of anemia with clinical symptoms commonly attributed to anemia—analysis of two population-based cohorts.* Journal of clinical medicine, 2023. **12**(3): p. 921.
16. Saleem, M.I., Haqnawaz, K., Jadoon, S. B., Khan, S., Khan, J., Pervaiz, A., & Habib, M. F, *Association Between Iron Deficiency Anemia and Chronic Daily Headache..* Journal of Health and Rehabilitation Research, , 2023. **3**(2): p. 676-681.
17. Rogez, J., Urbanski, G., Vinatier, E., Lavigne, C., Emmanuel, L., Dupin, I., ... & Lacombe, V.. *Iron deficiency in pernicious anemia: Specific features of iron deficient patients and preliminary data on response to iron supplementation.* . Clinical Nutrition, , (2024). **43**((4), 1025-1032.).
18. von Siebenthal, H.K., D. Moretti, M.B. Zimmermann, and N.U. Stoffel, *Effect of dietary factors and time of day on iron absorption from oral iron supplements in iron deficient women.* American journal of hematology, 2023. **98**(9): p. 1356-1363.
19. Alam, N., S.K. Roy, T. Ahmed, and A.S. Ahmed, *Nutritional status, dietary intake, and relevant knowledge of adolescent girls in rural Bangladesh.* Journal of health, population, and nutrition, 2010. **28**(1): p. 86.
20. Twum-Dei, B., R. Aryeetey, and L.N.E. Aduku, *Dietary diversity and preferences among pregnant women and its association with anaemia.* Nutrition & Food Science, 2024. **54**(4): p. 805-820.