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Prevalence and Determinants of Iron Deficiency Anemia in Reproductive-Aged Women: A Clinicopathological and Community-Based Study

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ABSTRACT

Background: Iron deficiency anaemia (IDA) is the predominant nutritional condition globally, particularly affecting women of reproductive age who are at heightened risk owing to elevated physiological demands, menstrual losses, and inadequate food intake. In Pakistan, despite supplementing initiatives, the prevalence of iron deficiency anaemia (IDA) remains significant; yet, there is a paucity of research that integrates both clinicopathological and community-based factors.

Objectives: To ascertain the prevalence of iron deficiency anaemia among reproductive-aged women in Punjab, Pakistan, and to investigate the clinical, reproductive, and socio-economic variables related with its incidence.

Methods: Cross-sectional study was performed from January 2024 to January 2025 at Rawal Institute of Health Sciences, Islamabad, Pakistan , including their adjacent villages. A total of 100 non-pregnant women aged 15 to 49 years were recruited using stratified random sampling. Data were gathered by standardised questionnaires addressing socio-demographic variables, food consumption, reproductive history, and health-seeking behaviour. Venous blood specimens were examined for complete blood count and serum ferritin levels. IDA was characterised by haemoglobin levels below 12 g/dL and serum ferritin levels below 15 ng/mL. Statistical analysis included chi-square tests and logistic regression, with $p < 0.05$ deemed significant.

Results: The incidence of iron deficiency anaemia (IDA) was 44%. Women with iron deficiency anaemia had markedly reduced haemoglobin levels (9.6 ± 1.1 g/dL) and ferritin concentrations (8.7 ± 3.2 ng/mL) in comparison to non-anemic women (12.8 ± 1.3 g/dL and 25.3 ± 7.4 ng/mL, $p < 0.001$). Independent factors were poor socio-economic status (OR: 2.94), high parity (≥3) (OR: 3.41), excessive menstrual bleeding (OR: 2.63), and rural location (OR: 2.12), but contraceptive usage had a protective effect (OR: 0.46).

Conclusion: IDA remains highly prevalent among Pakistani women and is strongly influenced by socio-economic deprivation, reproductive factors, and menstrual health. Integrated strategies addressing nutrition, family planning, and community education are urgently needed.

Keywords: Iron deficiency anemia; reproductive-aged women; socio-economic determinants; parity; menstrual health; Pakistan.

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INTRODUCTION

Iron deficiency anaemia (IDA) is the predominant nutritional problem globally and continues to significantly impact the global illness burden, especially among women of reproductive age [1]. The World Health Organisation (WHO) estimates that over 30% of women aged 15 to 49 are anaemic, mostly due to iron deficiency [2]. Although preventable and curable, iron deficiency anaemia (IDA)

continues to have significant repercussions on maternal health, perinatal outcomes, and socio-economic output, particularly in resource-limited environments [3].

Women of reproductive age are particularly susceptible to iron deficiency anaemia (IDA) owing to ongoing physiological iron losses from menstruation, heightened demands during pregnancy and breastfeeding, and the cumulative depletion of iron stores over many pregnancies [4]. If ignored, iron deficiency anaemia (IDA) diminishes physical ability and cognitive function while increasing the risk of problems, including adverse pregnancy outcomes, low birth weight, premature delivery, and perinatal death [5]. The community-level effects of prevalent IDA result in diminished worker productivity and the continuation of intergenerational cycles of starvation and poverty [6].

The South Asian region, including Pakistan, bears a disproportionately high burden of IDA [7]. Factors such as poverty, gender inequity, dietary inadequacies, poor health-seeking behavior, and limited access to healthcare services exacerbate the problem [8]. Pakistan's National Nutrition Survey (2018) reported that nearly half of women of childbearing age were anemic, with iron deficiency as the leading cause [9]. Rural populations, women from lower socio-economic strata, and multiparous mothers are especially at risk [10]. Cultural and dietary practices, such as reliance on cereal-based diets low in bioavailable iron, consumption of tea with meals inhibiting iron absorption, and limited intake of animal-based iron-rich foods, further compound the risk [11].

In addition to nutritional determinants, clinicopathological factors play a significant role. Heavy menstrual bleeding, gynecological disorders, parasitic infestations, and untreated chronic illnesses contribute to chronic iron loss [12]. However, the majority of data on anemia in Pakistan remain either hospital-based or limited to demographic surveys, often without integration of detailed hematological indices such as serum ferritin and red cell indices [13]. This gap hampers the accurate identification of IDA versus other forms of anemia and limits the ability to establish robust clinicopathological correlations.

Community-level determinants are equally important but often underexplored in Pakistani studies [14]. Low literacy levels, lack of awareness regarding iron supplementation, misconceptions about diet, restricted autonomy of women in health-related decisions, and geographic barriers to healthcare contribute to both the onset and persistence of IDA [15]. Furthermore, public health programs in Pakistan have historically focused more on communicable diseases, with micronutrient deficiencies receiving limited sustained policy attention [16]. Although iron-folic acid supplementation programs exist, their coverage and adherence rates remain suboptimal [17].

Given these realities, there is a critical need for studies that combine clinicopathological data with community-based determinants to provide a holistic understanding of IDA among reproductive-aged women in Pakistan [18]. Such evidence can inform targeted interventions, improve screening practices, and strengthen preventive strategies [19]. The present study was therefore designed to assess the prevalence of IDA in reproductive-aged women by integrating hematological and biochemical markers with socio-demographic, reproductive, and dietary factors [20]. This combined clinicopathological and community-based approach aims to generate comprehensive evidence to guide policymakers and healthcare providers in addressing this persistent public health challenge in Pakistan [21].

MATERIALS AND METHODS

This study was designed as a cross-sectional, clinicopathological and community-based investigation conducted over a period of twelve months, from January 2024 to January 2025. It was carried out in Rawal Institute of Health Sciences, Islamabad, Pakistan which caters to both urban and semi-rural communities. To ensure wider representation, the hospital-based cohort was supplemented by a community-based sample drawn from peri-urban and rural localities linked with these hospitals. This setting was chosen to provide a comprehensive understanding of iron deficiency anemia (IDA) among reproductive-aged women, reflecting both clinically presenting cases and those undiagnosed at the community level.

The study population included women of reproductive age, defined as 15 to 49 years, who were non-pregnant and non-lactating at the time of enrollment. To be eligible, participants were required to have been permanent residents of the community for at least twelve months and to provide informed consent for both interviews and venous blood sampling. Women with chronic systemic diseases such as renal failure, chronic liver disease, and malignancy, as well as those with known hemoglobinopathies including thalassemia or sickle cell anemia, were excluded. Additional exclusion criteria included a history of recent blood transfusion or iron supplementation within the past three months. Pregnant women were excluded to avoid the confounding effects of gestational anemia.

The sample size was calculated using a single proportion formula with an assumed prevalence of IDA of 50% in reproductive-aged women as reported in the Pakistan National Nutrition Survey of 2018, with a 95% confidence level and a 10% margin of error for feasibility. The minimum required sample was 96 participants; however, to strengthen statistical power and allow for possible non-response, the final target sample size was set at 100. Participants were recruited using a stratified random sampling approach. Fifty women were selected from the outpatient clinics of the two hospitals, specifically those attending for reasons unrelated to hematological

disorders, while fifty were drawn from surrounding communities using random household visits conducted by trained female health workers.

Data collection was carried out using a structured questionnaire that was pre-tested and refined before the study. The questionnaire, administered in Urdu or Punjabi, gathered socio-demographic details such as age, marital status, education, occupation, income, and place of residence. It also included a dietary assessment based on a 24-hour recall and a food frequency checklist to evaluate intake of iron-rich foods and inhibitors of iron absorption such as tea. Reproductive history was carefully recorded, including age at menarche, menstrual patterns, history of heavy menstrual bleeding, number of pregnancies, parity, history of lactation, and contraceptive use. Health-seeking behaviors, including prior iron supplementation, antenatal care, deworming, and general medical consultations, were also documented.

Every participant received a concise clinical assessment that including body mass index measurement, pallor evaluation, and a comprehensive physical examination. Venous blood specimens were collected under aseptic conditions. Approximately five millilitres of blood were obtained, with two millilitres allocated to EDTA tubes for haematological analysis and three millilitres designated for serum separation in plain tubes. Automated haematology analysis (Sysmex XN series) was used to do complete blood counts, recording indices including haemoglobin concentration, hematocrit, mean corpuscular volume, mean corpuscular haemoglobin, and mean corpuscular haemoglobin concentration. Serum ferritin concentrations were quantified by enzyme-linked immunosorbent assay (ELISA), with internal quality controls maintained throughout the procedure. Iron deficiency anaemia was diagnosed when haemoglobin levels fell below 12 g/dL and serum ferritin levels were less than 15 ng/mL, in line with World Health Organisation standards.

Ethical consent for the research was secured from the Institutional Review Boards. Informed written permission was acquired from all participants, whereas for illiterate women, agreement was secured verbally in the presence of a literate witness. Data confidentiality was maintained by issuing unique codes to participants rather than using personal identifiers. Women diagnosed with anaemia were advised and directed to relevant hospital departments for treatment and follow-up care.

Data were inputted and analysed with SPSS version 25. Descriptive statistics were used to encapsulate socio-demographic factors, reproductive history, and haematological data, with means and standard deviations shown for continuous variables and frequencies and percentages for categorical variables. Chi-square tests were used for categorical variables and independent t-tests for continuous variables to compare women with and without IDA. Binary logistic regression was used to uncover independent causes of IDA, calculating odds ratios and 95% confidence intervals. A p-value below 0.05 was deemed statistically significant for all inferential analyses.

RESULTS

The trial included 100 women of reproductive age, with comprehensive clinical, laboratory, and socio-demographic data accessible for analysis. The total prevalence of iron deficiency anaemia (IDA), defined by haemoglobin levels below 12 g/dL and serum ferritin levels below 15 ng/mL, was 44% (44 out of 100 subjects). This signifies that around fifty percent of the women in this cohort were impacted by clinically and biochemically validated iron deficiency anaemia (IDA).

Socio-Demographic Characteristics: The socio-demographic distribution of participants is shown in Table 1. The mean age of participants was 29.3 ± 7.6 years, with the largest proportion (41%) belonging to the 21–30 year age group. IDA prevalence was highest among women aged 31–40 years (54.5%), compared to 37.5% in women aged 21–30 years. Rural women were more frequently affected (53.1%) compared with their urban counterparts (37.1%). Socio-economic status emerged as a strong determinant, as women from low-income households (<30,000 PKR per month) had a prevalence of 62.5%, significantly higher than those in higher income brackets ($p = 0.01$). Educational attainment showed a gradient effect: 59.1% of illiterate women were anemic compared with 28.6% of women with higher secondary education and above.

As demonstrated in Table 1, women from rural and low-income backgrounds were disproportionately affected by IDA. Educational attainment appeared protective, with lower prevalence in women who had attained higher levels of education. These findings highlight the strong influence of community-level socio-economic and cultural determinants on the burden of anemia.

Reproductive and Clinical Determinants: Reproductive factors were strongly associated with IDA (Table 2). Women with high parity (≥3 pregnancies) had a prevalence of 61.1%, compared to 29.8% among women with two or fewer pregnancies ($p = 0.01$). Similarly, 65.2% of women reporting heavy menstrual bleeding were anemic, significantly higher than those with normal flow ($p = 0.02$). Contraceptive use was found to be a protective factor; women using hormonal contraception had lower anemia prevalence (27.3%) compared with non-users (49.2%).

Table 2 underscores that reproductive factors play a central role in the pathophysiology of IDA among Pakistani women. High parity and heavy menstrual bleeding were major contributors, while contraceptive use appeared protective, likely due to its role in reducing menstrual blood loss.

Hematological and Biochemical Findings: The hematological profiles are presented in Table 3. Women

with IDA had significantly lower mean hemoglobin (9.6 ± 1.1 g/dL) compared with non-anemic women (12.8 ± 1.3 g/dL, p <0.001). Mean corpuscular volume (MCV) was also markedly reduced (72.1 ± 6.4 fL vs. 85.6 ± 5.2 fL, p <0.001). Serum ferritin levels were significantly lower in the IDA group (8.7 ± 3.2 ng/mL vs. 25.3 ± 7.4 ng/mL, p <0.001), confirming true iron deficiency rather than anemia of chronic disease.

These findings confirm that IDA in this population followed the classic microcytic hypochromic pattern, with reduced red cell indices and depleted ferritin stores, providing strong clinicopathological evidence.

Multivariate Logistic Regression Analysis: To identify independent determinants of IDA, binary logistic regression was performed (Table 4). Low socio-economic status (OR: 2.94; 95% CI: 1.2–6.7; p = 0.01), high parity ≥3 (OR: 3.41; 95% CI: 1.5–7.8; p = 0.01), heavy menstrual bleeding (OR: 2.63; 95% CI: 1.1–6.1; p = 0.03), and rural residence (OR: 2.12; 95% CI: 1.0–4.5; p = 0.04) were identified as independent predictors of IDA. Contraceptive use was protective (OR: 0.46; 95% CI: 0.2–0.9; p = 0.04).

Table-1: Socio-demographic characteristics of study participants (n = 100)

Variable	Total (n=100)	IDA Present n=44 (%)	IDA Absent n=56 (%)	p-value
Age group (years)				
15–20	12	4 (33.3)	8 (66.7)	0.21
21–30	41	15 (36.6)	26 (63.4)	
31–40	33	18 (54.5)	15 (45.5)	
41–49	14	7 (50.0)	7 (50.0)	
Residence				0.04*
Urban	62	23 (37.1)	39 (62.9)	
Rural	38	21 (55.3)	17 (44.7)	
Socio-economic status				0.01*
<30,000 PKR/month	40	25 (62.5)	15 (37.5)	
30,000–60,000 PKR/month	37	14 (37.8)	23 (62.2)	
>60,000 PKR/month	23	5 (21.7)	18 (78.3)	
Education				0.03*
Illiterate	22	13 (59.1)	9 (40.9)	
Primary–Secondary	48	23 (47.9)	25 (52.1)	
Higher Secondary+	30	8 (26.7)	22 (73.3)	

**p <0.05 statistically significant.*

Table-2: Reproductive and clinical determinants of IDA among participants

Variable	Total (n=100)	IDA Present n=44 (%)	IDA Absent n=56 (%)	p-value
Parity				0.01*
≤2 pregnancies	57	17 (29.8)	40 (70.2)	
≥3 pregnancies	43	27 (62.8)	16 (37.2)	
Menstrual bleeding pattern				0.02*
Normal	66	23 (34.8)	43 (65.2)	
Heavy	34	21 (61.8)	13 (38.2)	
Contraceptive use				0.04*
Users	22	6 (27.3)	16 (72.7)	
Non-users	78	38 (48.7)	40 (51.3)	

*p <0.05 statistically significant.

Table-3: Hematological and biochemical parameters of participants

Parameter	IDA Group (n=44)	Non-IDA Group (n=56)	p-value
Hemoglobin (g/dL)	9.6 ± 1.1	12.8 ± 1.3	<0.001*
Hematocrit (%)	30.7 ± 3.6	37.6 ± 4.2	<0.001*
MCV (fL)	72.1 ± 6.4	85.6 ± 5.2	<0.001*
MCH (pg)	22.8 ± 2.7	28.4 ± 3.1	<0.001*
MCHC (g/dL)	31.0 ± 1.9	33.6 ± 1.7	<0.001*
Serum ferritin (ng/mL)	8.7 ± 3.2	25.3 ± 7.4	<0.001*

p <0.05 statistically significant.

Table-4: Logistic regression analysis of determinants of IDA

Determinant	Odds Ratio (OR)	95% CI	p-value
Low socio-economic status	2.94	1.2–6.7	0.01*
High parity (≥3)	3.41	1.5–7.8	0.01*
Heavy menstrual bleeding	2.63	1.1–6.1	0.03*
Rural residence	2.12	1.0–4.5	0.04*
Contraceptive use	0.46	0.2–0.9	0.04*

**p <0.05 statistically significant.*

Regression analysis confirmed that socio-economic deprivation, reproductive burden, and menstrual factors were the dominant drivers of IDA, independent of age and educational level. Interestingly, contraceptive use retained a significant protective effect after adjusting for confounders, emphasizing the indirect but important role of family planning services in reducing anemia burden in Pakistani women.

DISCUSSION

This research illustrates that iron deficiency anaemia (IDA) continues to be a frequent disease among reproductive-aged women in Pakistan, with over half of the participants afflicted, despite being otherwise healthy and non-pregnant throughout the evaluation period [1]. The results reflect worldwide estimates indicating that anaemia mostly affects women in low- and middle-income countries, while also highlighting the specific socio-economic, reproductive, and cultural aspects influencing the epidemiology of iron deficiency anaemia in Pakistan [2].

The 44% prevalence seen in our research correlates with the National Nutrition Survey of Pakistan (2018), which indicated anaemia in almost half of women of reproductive age, and corresponds with previous South Asian studies reporting prevalence rates between 40% and 55% [3,4]. Our work enhances clinicopathological accuracy by validating iron deficiency anaemia (IDA) by the assessment of haemoglobin and serum ferritin levels, therefore differentiating genuine iron deficiency from alternative anaemias, such as anaemia of chronic illness or hemoglobinopathies, prevalent in the area [5]. The observed microcytic hypochromic red cell indices, together with significantly decreased ferritin levels, strongly indicate that iron deficiency is the primary cause of anaemia in these women [6].

The socio-demographic determinants identified reflect structural inequities. Women from rural settings and lower socio-economic households had significantly higher prevalence of IDA, reinforcing the role of poverty, limited dietary diversity, and restricted access to healthcare services in perpetuating nutritional deficiencies [7]. These associations are consistent with global analyses, including the Lancet Nutrition Series, which emphasized the link between poverty, food insecurity, and anemia in women [8]. In Pakistan, cereal-based diets dominate, and animal-source foods, which are rich in bioavailable heme iron, are often unaffordable for low-income families [9]. Additionally, cultural practices such as tea consumption with meals further reduce non-heme iron absorption [10]. The gradient effect of education observed in our data also supports the role of health literacy and empowerment, as women with higher levels of education were less likely to be anemic [11]. This suggests that beyond economic factors, awareness and behavioral choices are equally critical [12].

Reproductive and gynecological determinants emerged as central contributors. High parity (≥3 pregnancies) was associated with a threefold higher risk of IDA, consistent with international findings that repeated pregnancies deplete maternal iron stores and predispose women to cumulative nutritional deficits [13,14]. Heavy menstrual bleeding, reported by over one-third of participants, was another independent determinant, reflecting the chronic iron loss associated with menorrhagia [15]. These findings highlight the dual burden faced by Pakistani women, where both physiological demands and pathological menstrual patterns converge to worsen anemia risk [16]. Importantly, contraceptive use was protective, with significantly lower prevalence among users, particularly those on hormonal contraception, which is known to reduce menstrual blood loss [17]. This emphasizes that strengthening family planning services and counseling may serve as indirect but powerful strategies for reducing IDA in reproductive-aged women [18].

The multivariate regression analysis confirmed that socio-economic deprivation, high parity, and heavy menstrual bleeding remained independent predictors of IDA even after adjustment for confounders [19]. These findings reinforce the need for multipronged interventions that address not only nutritional supplementation but also reproductive health services and broader socio-economic inequalities [20]. Previous interventions in Pakistan, such as iron–folic acid supplementation programs, have had limited success due to poor adherence, supply chain issues, and inadequate community education [21]. Our findings suggest that unless these systemic barriers are addressed and combined with strategies targeting reproductive determinants, progress against IDA will remain slow [22].

The implications of our study extend beyond individual health outcomes. IDA in women of reproductive age is linked to poor pregnancy outcomes, including increased maternal morbidity, low birth weight, and impaired cognitive development in offspring [23]. At the community level, anemia reduces women's productivity, perpetuates cycles of poverty, and contributes to intergenerational malnutrition [24]. These broad consequences position IDA not only as a clinical concern but also as a critical public health and development challenge [25].

Our study has several strengths. By combining hospital and community cohorts, and by employing both hematological indices and biochemical confirmation, we provide robust evidence of true IDA prevalence [26]. The integration of socio-demographic, reproductive, and behavioral determinants allows for a holistic understanding of risk factors [27]. However, certain limitations should be acknowledged. The sample size, though adequate for

statistical analysis, was modest, and larger multicentric studies are needed for generalizability across provinces [28]. Dietary assessment relied on recall, which may be subject to reporting bias [29]. Additionally, serum ferritin can be elevated in chronic inflammation; although overt chronic disease cases were excluded, subclinical inflammation could not be entirely ruled out [30].

Despite these limitations, our findings contribute valuable insights into the epidemiology of IDA in Pakistan and provide a framework for interventions [31]. Addressing IDA requires a multi-sectoral approach: improving dietary quality through food fortification and supplementation, expanding access to family planning and reproductive health services, integrating menstrual health into public health programs, and tackling poverty and gender inequities that underpin nutritional disparities [32]. Lessons from successful large-scale interventions in other low-income settings, such as fortification of staple foods with iron and combined supplementation programs, should be adapted to the Pakistani context [33].

CONCLUSION

Iron deficiency anemia remains highly prevalent among reproductive-aged women in Pakistan, affecting nearly half of the studied cohort. The determinants are multifactorial, with socio-economic deprivation, rural residence, high parity, and heavy menstrual bleeding as the most significant contributors, while contraceptive use emerged as a protective factor. These findings highlight that IDA is not solely a nutritional issue but a complex clinicopathological and community-based problem requiring integrated strategies. Preventive approaches must include nutritional supplementation and dietary education, reproductive health and family planning services, and structural measures to reduce poverty and improve women's education. Tackling IDA in Pakistani women will not only improve maternal and child health outcomes but also contribute to breaking cycles of malnutrition and poverty at the community level.

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Authors' contributions: NW: study conception and supervision; SK: methodology and analysis; RKL: data collection and statistics; GA: literature review and drafting; HA: laboratory work and data support; IJ: community surveys and proofreading. All authors approved the final manuscript.

Data Availability Statement: The data used in this study are available upon reasonable request from the corresponding author, subject to ethical and institutional guidelines.

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