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Cross-Sectional Analysis of Probable Causative Factors Leading to Iron Deficiency Anemia in Primigravida During Their First Trimester

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ABSTRACT

Anemia is a common nutritional deficiency that impacts approximately 1.6 billion individuals globally, representing around 25% of the world's population. **Objectives:** To assess the prevalence of factors associated with anemia due to iron deficiency in primigravida females during their first trimester. **Methods:** A descriptive, cross-sectional study was conducted at Agha Khan University Hospital, Karachi, from January 4 to July 3, 2019.The study aimed to screen pregnant women during their first antenatal visit in the Outpatient Department for eligibility based on the inclusion criteria. Data were recorded using a structured proforma. Effect modifiers were controlled by stratifying age in years and gestational age in weeks, with comparisons between stratified groups made using Chi-square analysis. **Results:** Mean ± SD of age and gestational age in primigravida females was 27.50 ± 5.36 years and 7.93 ± 2.07 weeks, respectively. Mean ± SD of height, weight and BMI was 156.44 ± 5.81 cm, 65.90 ± 10.84 kg and 28.84 ± 4.10 kg/m2, respectively. In frequency of associated factors, advanced maternal age was found to be responsible for iron deficiency anemia in 27 (55.10%) women, underweight in 2(4.08%), low educational status in 7 (14.28%) and low socioeconomic status was 13 (26.53%) women. **Conclusions:** It was concluded that in the Pakistani population, the prevalence of iron deficiency anemia is high among pregnant women. Maternal anemia is significantly linked to maternal age and low socioeconomic status. The results emphasize the critical need to raise awareness among pregnant women and their families regarding the significance of antenatal care.

INTRODUCTION

Anemia is a serious worldwide health issue. Anemia is characterized by hemoglobin (Hb) levels that are below the normal range, according to the World Health Organization (WHO) [1].Anemia is thought to afflict one-fourth of the world's population, with cases amongst women, pregnant mothers, young girls, and children under five years old rising quickly [2].The prevalence of anemia in all age categories was 26.7% worldwide in 2022, with 1.68 billion cases. In 2021, dietary shortages of iron, hemoglobinopathies, hemolytic anemias, and other neglected tropical illnesses were the primary contributors of anemia-related Years Lived with Disability (YLDs), which together accounted for 84.7% (84.1-85.2) of anemia YLDs [3]. Patients with anemia commonly exhibit nonspecific

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symptoms like fatigue, weakness, and lethargy. In more severe cases, symptoms may include syncope, shortness of breath, and decreased exercise tolerance [4]. It was observed that a significant proportion of women between 20 to 26 weeks of pregnancy experienced mild to moderate anemia [5]. Another study observed that pregnant women and those with multiple children were found to be at higher risk of anemia. Additionally, women with busy schedules were more susceptible to the condition. These results highlight how dietary practices, choices regarding life, and the pregnant situation all contribute to the growth of anemia [6]. Garanet *et al.*, indicated that rural women have a high chance of anemia. Therefore, there is a need to enhance strategies aimed at preventing anemia among pregnant women in rural areas [7]. Anemia is not a diagnosis but a manifestation of an underlying condition, with various diseases causing it through different mechanisms, leading to decreased oxygen-carrying capacity of the blood, tissue hypoxia, and a significant rise in medical care costs [8]. Such a high frequency of anemia among expectant women can be attributed to the fact that pregnancy is the starkest biological change and the greatest physiological stress that a woman encounters during her life. According to World Health Organization (WHO) statistics, based on national surveys from 1993 to 2005, not only does a total of 42% of the women worldwide encounter anemia during their pregnancy, but it also accounts for 20% of the maternal deaths as well [5]. About 320 mg of iron are needed by the growing baby and placenta in a normal singleton pregnancy, 450 mg are needed to promote the growth of the mother's red blood cell mass, and 150 mg is needed to make up for blood loss after birth [9]. Furthermore, baby neurocognitive impairments may be associated with maternal iron insufficiency [13]. The need for iron increases significantly during pregnancy [14]. For proper iron balance, an adult female who is not pregnant has to absorb about 0.8 mg of iron each day from her digestive system. But the body's need for iron increases throughout pregnancy, reaching around 8 milligrams per day by the third trimester [15, 16]. Keeping in view all these implications of iron deficiency anemia, this study aims to determine the associated factors of IDA in primigravida females during their first trimester. By identifying the factors associated with IDA in primigravida females during their first trimester, the study aims to enhance early detection and intervention, potentially improving maternal and fetal health outcomes and informing strategies to prevent and manage IDA in this high-risk group. To be best of our knowledge and based on literature search we observed that all previous studies included females of all three trimesters regardless of parity and gravida, no prior data is available which focused the cohort of primigravida females during their first trimester in context of our population, although very few international literatures are available for the same.

This study aims to measure the associated factors of IDA in our community because international data is not applicable in our population due to differences in lifestyle, geographical location, genetics, and environmental changes; therefore, this study was help in modifying treatment and management options in early stages of pregnancy.

METHODS

The study was a descriptive cross-sectional design conducted at the Department of Obstetrics and Gynecology, Agha Khan University Hospital, Karachi, from January 4, 2019, to July 3, 2019, following approval of the research proposal by CPSP (CPSP Letter number CPSP/REU/OBG-2016-175-7256). The sample size was calculated using the WHO sample size calculator version 2.0, considering a margin of error of 6%, a 95% confidence level, and a frequency of 17.6% for advanced maternal age associated with iron deficiency anemia (IDA), resulting in an estimated sample of 155 women. [12] Non-probability, consecutive sampling technique was used for participant selection. In this study, a primigravida is defined as a woman in her first pregnancy. The first trimester is considered the gestational age from the day of the last menstrual period to 13 weeks of gestation, as assessed from the ultrasound report. Anemia is characterized by a reduction in hemoglobin concentration, leading to a corresponding decrease in hematocrit levels. Iron deficiency anemia (IDA) is diagnosed if a woman exhibits any three of the following criteria: hemoglobin levels less than 11 g/dL, ferritin levels less than 12 µg/ml, transferrin saturation below 15%, or a mean corpuscular volume (MCV) less than 80 femtoliter. The study also assessed several factors associated with IDA: advanced maternal age refers to women aged 35 years or older at the time of enrollment; underweight BMI is defined as a body mass index (BMI) between 15 and 18.5 kg/m^2, measured at the time of presentation; low educational status refers to no formal education or education up to the fifth standard; and low socioeconomic status was defined as a family income of 25,000 PKR or less per month. The inclusion criteria consisted of primigravida women aged between 18 and 49 years, with a singleton pregnancy confirmed through ultrasound, a gestational age of less than 13 weeks, and a diagnosis of IDA as per operational definition. Women who refused to participate or had a known cause of anemia other than IDA before pregnancy confirmation were excluded. After obtaining informed consent, data were collected from eligible women during their first antenatal visit at the outpatient department. Socio-demographic characteristics and potential factors associated with IDA were documented as per the operational definition. Routine antenatal screening was performed, and data

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confidentiality was ensured by assigning codes instead of names and keeping the data password-protected. The collected data were entered into SPSS-21, and descriptive statistics, including mean ± SD for age, gestational age, height, weight, and BMI, were calculated. Factors associated with IDA, such as advanced maternal age, underweight BMI, low socioeconomic status, and low educational status, were reported in frequencies and percentages.Effect modifiers were controlled by stratifying age in years and gestational age in weeks, with comparisons between stratified groups made by Chi-square analysis.A p-value of <0.05 was considered statistically significant.

RESULTS

This current research included 155 participants to evaluate the prevalence of determinants of iron deficiency anemia (IDA) in primigravida females during their first trimester. The participant's average age was 27.50 ± 5.36 years with C.I (26.65-28.36), with a mean gestational age of 7.93 ± 2.07 weeks, with C.I (7.60-8.26) weeks. The average height was 156.44 ± 5.81 cm with C.I (155.52-157.36), and the mean weight was 65.90 ± 10.84 kg with C.I (64.18-67.62).The typical BMI was 28.84 ± 4.10 kg/m2 with C.I (28.19-29.49). The results summarize the descriptive statistics for age, gestational age, height, weight, and BMI in the study population (n=155). It includes the mean, 95% confidence interval for all.These statistics provide a clear overview of the central tendencies and variability of the key variables in the study (Table 1).

Table 1: Descriptive Statistics of Demographic and Anthropometric Variables

Descriptive Statistic	Age (Years)	Gestational Age (Weeks)	Height (cm)	Weight (kg)	BMI (kg/m^2)
Mean	27.5097	7.9355	156.4452	65.9032	28.8471
95% C.I for Mean (Lower Bound)	26.6590	7.6062	155.5227	64.1822	28.1957
95% C.I for Mean (Upper Bound)	28.3604	8.2648	157.3676	67.6243	29.4985
5% Trimmed Mean	27.4677	7.9767	156.2204	65.5197	28.6900
Median	27.0000	8.0000	156.0000	67.0000	28.0000
Variance	28.745	4.307	33.794	117.646	16.852
SD	5.36144	2.07545	5.81327	10.84649	4.10512
Minimum	18.00	4.00	145.00	43.00	20.00
Maximum	40.00	12.00	172.00	111.00	44.00
Range	22.00	8.00	27.00	68.00	24.00
Interquartile Range	8.00	4.00	8.00	12.00	5.00
Skewness	0.158	-0.116	0.442	0.631	0.737
Kurtosis	-0.803	-0.970	-0.093	1.703	0.998
Standard Error	0.43064	0.16670	0.46693	0.87121	0.32973

Regarding the frequency of associated factors, advanced maternal age was established to be a major contributor to iron deficiency anemia in 27 (55.10%) women, underweight in 2 (4.08%), low educational status in 7 (14.28%), and low socioeconomic status in 13 (26.53%) women (Table 2).

Table 2: Frequency of Associated Factors with IDA in Primigravida Female During the First Trimester (n=49)

Associated Factors	Frequency (%)
Advanced Maternal Age	27 (55.10%)
Under Weight BMI	2 (4.08%)
Low Educational Status	7 (14.28%)
Low Socioeconomic Status	13 (26.53%)

*The table includes data from the entire cohort of patients, specifically primigravida female attending the Obstetrics and Gynecology outpatient department at Agha Khan University Hospital.

A highly significant variation in the prevalence of IDA was observed between age groups (18-30 years versus >30 years), resulting in a p-value<0.001. However, no notable difference was detected between the gestational age groups (1-7 weeks versus 8-13 weeks), with a p-value=0.260 (Table 3).

Table 3: Stratification of Age Group and Gestational Age Group with Associated Factors of IDA (n=49)

Age Group (Years)	18-30	>30	p-value
Advanced Maternal Age	2 (4.1%)	25 (51.0%)	<0.001
Underweight BMI	2 (4.1%)	0 (0%)	
Low Educational Status	5 (10.2%)	2 (4.1%)	
Low Socioeconomic Status	9 (18.4%)	4 (8.2%)	
Gestational Age Group (Weeks)	**1-7**	**8-13**	0.260
Advanced Maternal Age	14 (28.6%)	13 (26.5%)	
Underweight BMI	1 (2.0%)	1 (2.0%)	
Low Educational Status	1 (2.0%)	6 (12.2%)	
Low Socioeconomic Status	4 (8.2%)	9 (18.4%)	

Applied Chi-square table

The analysis revealed that advanced maternal age was the most significant factor associated with iron deficiency anemia (IDA) in the study population. Among the various parameters assessed, advanced maternal age was

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identified as the most commonly associated factor, with 27 (55.10%) of the women with IDA falling into this category. This finding underscores the critical role of maternal age in the prevalence of IDA, suggesting that older age may increase the risk of developing this condition during pregnancy. While other factors, such as low socioeconomic status, underweight BMI, and low educational status, were also associated with IDA, advanced maternal age emerged as the strongest predictor in this population.

DISCUSSION

IDA is a significant global health issue, especially among pregnant women, due to the elevated iron requirements during pregnancy.Anemia affects over a quarter of the global population, and one of the main causes of anemia in expectant mothers is a lack of iron.In our study, 27.5% of the women were found to be anemic, with a similar proportion (27.5%) suffering from IDA. This is in contrast to previous studies in Bahrain, where 41.9% had anemia and 40% had IDA [17].The improvement in the prevalence of IDA in Bahrain may be attributed to recent improvements in healthcare services and the provision of free iron supplementation to pregnant women. Other factors, such as better sanitation, improved living standards, and enhanced food quality, may have contributed to this reduction.None of the pregnant women in our study exhibited severe anemia, which is consistent with findings from a similar study conducted in Egypt, where the prevalence of severe anemia (hemoglobin level of less than 7 g/dl) was found to be 3% only [18]. In our study, women with lower educational levels had significantly lower serum ferritin, indicating a lack of awareness about proper nutrition, particularly regarding iron-rich foods. This result with line Wiafe *et al.*, in which the authors divided the factors into two categories: direct factors, like food consumption habits, transmission of malaria, worm invasion, female gender, and bleeding, and indirect factors, like income level, rural living, the number of children, religion, and barefoot strolling.Higher learning was found to be a major factor in this study [19].In another study conducted in Ghana, similar results were found, with education level being a significant contributor and risk factor for anaemia during pregnancy.The authors further emphasized the importance of continuous education for pregnant women to mitigate anaemia risks [20].We also found that women with a history of more than two pregnancies or deliveries had a higher prevalence of IDA, which aligns with Feyissa *et al.*, where significant association between short inter-birth intervals (SIBI) and anemia was found, showing an 181% increase in anemia with SIBI (OR of 2.81; 95% CI: 1.30–4.31) compared to optimal birth intervals.Additionally, SIBI was significantly associated with gestational diabetes mellitus and antenatal or postnatal depression, but no significant association was observed with preeclampsia [21]. Furthermore, IDA was more common among women in their third trimester, likely due to the increased iron demands as gestational age advances [22-24].We found that advanced maternal age was a significant risk factor, accounting for 27% of cases of iron deficiency anemia. This finding is consistent with a study conducted in Indonesia, which also revealed a significant relationship between maternal age and anemia, with a p-value of 0.046, indicating statistical significance [25].Most dietary interventions have proven effective in treating iron-deficiency anemia. While many randomized controlled trials have focused on increasing iron and/or vitamin C intake, combining both strategies appear to be the most effective approach. Additionally, vitamin D shows potential as a therapeutic option, although further research is needed to confirm these findings. Based on these insights, dietary interventions for anemic female patients should prioritize increasing both iron and vitamin C intake [26]. Calcium supplementation negatively affects iron absorption, with a dose-dependent reduction in absorption observed at levels commonly found in normal diets [27]. In a study conducted by Lynch S, it was found that increased dairy consumption may have a small negative impact on iron absorption, particularly during pregnancy if iron supplements are not taken [28].Recent studies have shown that in iron-deficient women, oral iron doses ≥60 mg, and ≥100 mg in women with iron-deficiency anemia (IDA), increase serum hepcidin levels, which peak at 24 hours and subside by 48 hours. To optimize iron absorption, iron should be given on alternate days, with morning doses recommended to enhance absorption due to the circadian increase in hepcidin.A pooled analysis indicates that higher total iron absorption occurs when double the daily iron dose is taken on alternate days.Therefore, the optimal regimen for women with iron deficiency or mild IDA is providing 60–120 mg of iron as a ferrous salt with ascorbic acid on alternate days in the morning [29].Several studies have documented the positive impact of iron supplementation on improving hemoglobin levels during pregnancy, which is in line with the results of our study [29-31].Prophylactic iron supplementation is likely to lead to a significant decrease in maternal anemia during pregnancy [32-34].Georgieff *et al.*, in their study, suggested that prophylactic iron supplementation is expected to substantially reduce the incidence of maternal anemia during pregnancy [35]. In a study conducted by Banerjee *et al.*, it was concluded that intermittent oral iron supplementation at a median dose of 120 mg/day shows similar effectiveness to daily oral iron supplementation at a median dose of 60 mg/day in raising hemoglobin levels among pregnant women, while also significantly reducing adverse events [36].Oral iron has low absorption, which makes it frequently useless for the prevention and management of a shortage of iron deficiency, according to

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a different study by Benson *et al.* Furthermore, it commonly results in gastrointestinal issues that might impair pregnant women's quality of life.There are currently options for intramuscular iron compositions that come in single or multiple doses. Pregnant women who do not respond well to oral iron supplements should give newer intravenous formulations serious consideration since there is growing evidence that they are secure and safe throughout the second and third trimesters[31]. In low- and middle-income countries (LMICs), intravenous ferric carboxymaltose may be a viable and long-term treatment for anemia caused by a shortage of iron during childbearing.Yet, only a small percentage of people who have a greater socioeconomic level and full medical insurance coverage are expected to benefit from the IVON trial's recommendations until serum ferritin tests and intravenous ferric carboxymaltose become generally available and reasonably priced. In conclusion, the most practical and successful treatment for anemia during pregnancy in LMICs is probably oral iron administration, where the majority of women face economic challenges and lack health insurance coverage [37].In our study, the mean maternal age was 27.50 ± 5.36 years, and the mean gestational age was 7.93 ± 2.07 weeks.Among the associated factors, advanced maternal age was found to be responsible for IDA in 27 (55.10%) of the women, with underweight BMI affecting 2 (4.08%), low educational status affecting 7 (14.28%), and low socioeconomic status affecting 13 (26.53%) women.A highly significant difference was observed when comparing the age groups of 18-30 years and >30 years ($p<0.001$), but no significant difference was found between gestational age groups (1-7 weeks) and (8-13 weeks) ($p=0.260$).Our findings align with those of national and international studies.The strength of our study lies in the use of consecutive sampling, which was ideal for our design and sample selection, given the strict inclusion and exclusion criteria.The use of clear and objective definitions for both predictor and outcome variables helped minimize potential biases. However, the sample size and the clinic-based setting may limit the external applicability of our results. The institution where this study was conducted serves a diverse patient population from various demographics and socioeconomic backgrounds across the country.Therefore, while the sample was drawn from a single clinic, the diversity of the patient population strengthens the relevance of our findings.

CONCLUSIONS

It was concluded that anemia is significantly prevalent among pregnant women in our population. Maternal anemia is linked to maternal age and low socioeconomic status.The findings indicate the urgent need for educating expectant mothers and their families regarding the significance of prenatal care.Future research should include randomized studies with larger sample sizes and multiple study centers across Pakistan to validate the findings of the present study.

Authors Contribution

Conceptualization: AA[1]
Methodology: AA[1], SI, AA[2]
Formal analysis: ZAP
Writing review and editing: FAB, NZ, LU
All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

All the authors declare no conflict of interest.

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