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CORRELATION OF IRON DEFICIENCY ANEMIA WITH VAGINAL MICROBIAL DYSBIOSIS AND CERVICAL HISTOPATHOLOGICAL ABNORMALITIES IN RURAL AND URBAN WOMEN

Saima Sher[1], Gulshan Munir[2], Hafsa Tariq[3], Faiza Asghar[4], Sidra Humayun[5], Sundas Shabir[6]

[1]House Officer, Department of Medicine, Lady Reading Hospital, Peshawar, Pakistan
[2]Demonstrator, Department of Pathology, Bacha Khan Medical College, Mardan, Pakistan
[3]Assistant Professor, Department of Pathology, Pak International Medical College, Peshawar, Pakistan
[4]Assistant Professor, Department of Pathology (Microbiology), School of Medicine, Dentistry and Allied Sciences PAK-IAST, Haripur, Pakistan
[5]Associate Professor, Department of Pathology, Muhammad College of Medicine (MCM), Peshawar, Pakistan
[6]Assistant Professor, Department of Pathology, Muhammad College of Medicine (MCM), Peshawar, Pakistan
Corresponding Author: Gulshan Munir, Email: ummekalsum1@gmail.com

ABSTRACT

Background: Anemia due to iron deficiency (IDA) is a prevalent nutritional problem in women that can affect immune function, epithelial integrity and susceptibility to genital tract infections. Vaginal disturbances in the microbial environment and continued cervical inflammation could be linked to poor reproductive health. The potential association between iron deficiency anemia, vaginal microbial dysbiosis and cervical histopathological abnormalities is still not well explored, especially in women of rural and urban areas.

Objective: To determine the correlation of iron deficiency anemia with vaginal microbial dysbiosis and cervical histopathological abnormalities among rural and urban women.

Methods: The analytical cross sectional study was conducted at Muhammad College of Medicine, Peshawar, from January 2025 to June 2025. The total number of women that were enrolled was 85 using non-probability consecutive sampling. Demographic and reproductive data was collected and participants had a hematological evaluation (Hb, serum ferritin, serum iron and mean corpuscular volume). The Nugent score was used to analyse vaginal flora and the microbial characteristics of the vaginal secretions were evaluated for abnormalities such as bacterial vaginosis, Candida species and mixed dysbiosis. Histopathological examination of cervical specimens was performed for chronic cervicitis, squamous metaplasia, cervical intraepithelial abnormalities and other pathological changes. Appropriate statistical tests were used to evaluate the associations which resulted in a p value of less than 0.05.

Results: Among the 85 participants, 45 (52.9%) had iron deficiency anemia, which was more frequent among rural than urban women (65.1% vs. 40.5%, $p = 0.023$). Vaginal microbial dysbiosis was identified in 36 (42.4%) participants and occurred significantly more often in women with iron deficiency anemia than in those without anemia (57.8% vs. 25.0%, $p = 0.002$). Cervical histopathological abnormalities were found in 31 (36.5%) women and were also more frequent among anemic participants (48.9% vs. 22.5%, $p = 0.012$). The prevalence of both vaginal dysbiosis and cervical abnormalities increased progressively with anemia severity. Hemoglobin and serum ferritin demonstrated significant inverse correlations with Nugent score.

Conclusion: Iron deficiency anemia was significantly associated with vaginal microbial dysbiosis and cervical histopathological abnormalities, with a greater burden observed among rural women. Increasing anemia severity was accompanied by progressively higher frequencies of microbial dysbiosis and abnormal cervical histology. These findings highlight the potential importance of identifying and managing iron deficiency as part of comprehensive reproductive healthcare.

KEYWORDS: Iron deficiency anemia, vaginal microbial dysbiosis, cervical histopathology, bacterial vaginosis, Nugent score, rural women, urban women.

INTRODUCTION

Iron deficiency anemia is one of the most prevalent nutritional and haematological disorders in women, particularly in the reproductive age group, around the world. Menstrual blood loss, pregnancy-induced rise in iron requirement, poor dietary practices, repeated pregnancies and lack of nutritional and health services are all the factors making women particularly vulnerable. The issue could be worse in less well-served populations where socioeconomic factors, dietary diversification, and the delay of seeking healthcare and preventive services help create a situation where iron

deficiency is chronic. Iron deficiency has been shown to affect physical performance, cognition, pregnancy outcomes, and overall health status, and may also have an impact on immune function and mucosal defence mechanism (1-3).
The female genital tract is a complex microbial habitat with significant importance in reproductive health. In healthy women, the vaginal flora is typically predominated by the presence of the Lactobacillus species that normally keep the vagina at an acidic pH and inhibit the proliferation of potentially pathogenic microorganisms. The microbial balance can be disrupted and cause a decrease in protective Lactobacilli species with an increase in anaerobic and/or opportunistic microorganisms, leading to vaginal dysbiosis. Disturbances have been linked with bacterial vaginosis, genital inflammation, heightened risk of sexually transmitted infections, and negative reproductive effects (4-6).
Nutritional and hematological factors may contribute to alterations in the vaginal microenvironment. Iron has many functions in cellular metabolism, immune system, repair of epithelial cells, and host defense. If iron stores are exhausted, mucosal immunity and epithelial integrity could be compromised with the possibility of microbial imbalance and continued inflammation. Iron availability also affects microbial growth and metabolism, indicating that disturbances in iron homeostasis could have complex effects that impact the host and the microbial community of the vagina. The link between iron deficiency anemia and vaginal microbial dysbiosis, though, has yet to be well defined in the clinic (7-9).
Long lasting changes to the vaginal flora and the inflammatory process in the genital tract can also affect the cervix. Long-term exposure to an abnormal vaginal flora can lead to an inflammatory reaction, damage to the epithelium, and changes in the response of the cervical tissue. Histopathological changes like chronic cervicitis, squamous metaplasia, and cervical intraepithelial lesions can be seen as a result of prolonged inflammatory/infectious processes. While various well known factors are associated with cervical pathological abnormalities, changes in nutritional status and compromised immune reactions might influence the susceptibility to chronic cervical inflammation or changes of the epithelium (8).
Nutrition-related factors, reproductive factors, access to health services, socioeconomic factors, hygiene practices, and preventive screening services may be very different among rural and urban women. These factors; reduced dietary intake, late diagnosis, repeated pregnancy and access to health and care services may increase the burden on rural women due to their ID. The same conditions could also lead to a higher rate of unrecognized vaginal infections and a later diagnosis of cervical cancer. Thus, it might be useful to compare the rural and urban populations to gain insight into the effect of social and nutritional inequalities on genital tract health (9, 10).
Despite the biological plausibility of a relationship between iron deficiency, vaginal dysbiosis, and cervical tissue abnormalities, relatively limited information is available regarding the simultaneous assessment of these three factors in women from different residential backgrounds. Most studies have examined anemia, vaginal infections, or cervical pathology separately rather than evaluating their interrelationship. Therefore, the present study was designed to determine the correlation of iron deficiency anemia with vaginal microbial dysbiosis and cervical histopathological abnormalities among rural and urban women. The study also aimed to assess whether increasing severity of anemia was associated with progressively greater vaginal microbial disturbance and cervical histopathological changes.

METHODOLOGY

This study was conducted as an analytical cross-sectional study at Muhammad College of Medicine (MCM), Peshawar, from January 2025 to June 2025. The study was designed to evaluate the relationship of iron deficiency anemia with vaginal microbial dysbiosis and cervical histopathological abnormalities and to compare these findings between women residing in rural and urban areas. Women attending the affiliated gynecology and outpatient services during the study period were screened for eligibility. The study population included women from both rural and urban backgrounds to allow assessment of differences associated with place of residence.
The required sample size was calculated using the WHO/OpenEpi sample size calculator for a single population proportion. The calculation was based on an anticipated prevalence of iron-deficiency anemia of 25%**,** as reported previously among women of reproductive age in Pakistan, with a 95% confidence level and an absolute precision of 9.2% (5)**.** The calculated minimum sample size was approximately 85 participants, who were subsequently enrolled in the study using non-probability consecutive sampling.
Eighty-five women were eligible for the study and were enrolled. The participants were selected using non-probability consecutive sampling method, which involved consecutively interviewing women who were eligible to participate in the study until the sample required was obtained. The main criterion for categorisation of women as rural or urban residents was their permanent address. A structured data collection proforma was used to record relevant demographic and reproductive information such as age, socioeconomic status, educational status, gravidity and parity, menstrual status and contraceptive use.
Women of reproductive/perimenopausal age who visited the study setting during the study period and agreed to have a hematological assessment, vaginal sampling, and cervical evaluation were included. This included people from rural and urban areas. Women who received any systemic or intravaginal antibiotic, antifungal or other antimicrobial treatment within the 24 hours prior to collection of vaginal specimens were excluded as this treatment may have affected the vaginal flora. Women who had active bleeding at time of vaginal sampling, had a prior diagnosis of

invasive cervical malignancy, had previous cervical surgery likely to impact histopathological interpretation, had a major haematological disorder (excluding iron deficiency anaemia), or incomplete clinical or laboratory information were also excluded.

Standard aseptic conditions were used to collect venous blood samples from each participant. The concentration of hemoglobin and blood cell indexes such as mean corpuscular volume were measured using an automatic blood cell analyzer. Iron status was also evaluated using serum ferritin, serum iron, total iron binding capacity and transferrin saturation (where available). Iron deficiency anemia was defined as a lower hemoglobin level in combination with laboratory data indicating iron stores depletion such as low levels of serum ferritin. All the participants were then divided into two groups: iron deficiency anemia and non-iron deficiency anemia. The anemic patients were also grouped as mild, moderate and severe anemic based on the predefined hemoglobin cut-off adopted to the study. The quantitative variables haemoglobin, serum ferritin, serum iron and mean corpuscular volume were retained for further correlation analysis.

Vaginal samples taken prior to any local medication and before a vaginal examination. A sterile speculum was inserted into the vagina without the use of antiseptic solution which may have affected microbiological results, the participant being in the lithotomy position. Vaginal secretions were obtained by swabbing the lateral vaginal wall and posterior fornix with a sterile swab. Vaginal pH was measured at the time of specimen collection. The processed samples were analyzed as per a standard microbiological procedure for estimating normal vaginal flora and abnormalities in the microorganisms present.

Vaginal smears were stained with Gram stain and assessed for the relative abundance of the morphotypes of lactobacilli and other bacterial morphotypes. The Nugent scoring system was used to classify vaginal bacterial flora, with scores of 0–3 representing normal vaginal flora, scores of 4–6 representing intermediate flora, and scores of 7–10 indicating bacterial vaginosis. For the primary analysis, Nugent scores of 0–3 were categorized as normal vaginal flora, whereas scores of 4–10 were categorized as vaginal microbial dysbiosis, including intermediate flora and bacterial vaginosis. Specific abnormalities were noted if present (bacterial vaginosis, Candida species, mixed microbial growth, and other clinically relevant organisms). The primary outcome variable for the main analysis was the presence of vaginal microbial dysbiosis and Nugent score was used as a quantitative or ordinal measure of the severity of microbial alteration.

After the collection of a vaginal specimen, the cervix was examined for gross abnormalities, inflammation, discharge, erosion or suspicious lesions. Cervical tissue samples or biopsies were taken from women in the study with clinically indicated cervical assessment in line with the study protocol. Specimens were promptly transferred to suitable containers with 10% neutral buffered formalin and sent to the histopathology laboratory for processing. Tissues were prepared by standard paraffin embedding techniques, cut and stained with hematoxylin and eosin.

Histopathological slides were analyzed for normal cervical architecture and pathological changes. The results were grouped as normal histology, chronic cervicitis, squamous metaplasia, cervical intraepithelial neoplasia (CIN) or low grade/high grade squamous intraepithelial abnormalities (LGSIL/HGSIL), or other relevant lesions. Participants were also divided for analysis into two general groups: normal cervical histology and any cervical histopathological abnormality. The severity or grade of the abnormalities of the cervix was noted if present to allow assessment of its relationship to hematological parameters and vaginal microbial dysbiosis.

A structured study proforma was used to input the data about demographic characteristics, rural/urban residence, reproductive history, clinical findings, hematological measurements, vaginal microbiological findings and cervical histopathological results. The participants were given a unique study number for anonymity. Participants' samples were marked with the corresponding study identification numbers. Data forms were checked for completeness prior to entering data into the statistical software. Throughout the study, standardized blood sampling procedures, collection of vaginal specimens, microbiological analysis and histopathological processing were observed to ensure that measurements were not subject to large variations.

Iron deficiency anemia was the principal exposure variable both as a dichotomous variable and based on the severity of anemia. The main outcomes of a study were vaginal dysbiosis dysbiosis and histopathological abnormalities of the cervix. Secondary outcomes were Nugent score, specific vaginal microbial results and individual histopathological diagnoses. The variable of rural and urban residence was considered as an important comparison variable. The study also determined if there was a relationship between the decrease in hemoglobin, serum ferritin, serum iron and the increase of Nugent score or the severity of the pathological changes in the cervix.

The data were entered and analyzed with IBM SPSS Statistics. Continuous variables (age, hemoglobin, serum ferritin, serum iron, mean corpuscular volume and Nugent score) were summarised as mean ± SD if normally distributed or as median (IQR) if not. Categorical variables were presented as frequencies and percentages. Before using parametric or non-parametric statistical tests, the distribution of continuous variables was assessed. Independent-samples t-test was used to test the difference of quantitative variable between the rural and urban women and the participants with and without IDA, while the corresponding non-parametric test was used. Association between categorical variables was evaluated using Pearson's chi-square test; when the numbers of values expected in each cell were low, Fisher's exact test was used. The association between the severity of anemia with the frequencies of vaginal dysbiosis and

cervical histopathological abnormalities was also assessed. The relationship between severity of cervical abnormalities and hemoglobin, serum ferritin, serum iron, Nugent score was assessed by Pearson or Spearman correlation depending on the distribution of the data. Where appropriate, multivariable logistic regression was used to assess if iron deficiency anemia was independently associated with vaginal microbial dysbiosis after adjusting for potential confounding factors including age, socioeconomic status, parity and rural or urban residence. Odds ratios with 95% confidence intervals were reported and a p-value <0.05 was deemed statistically significant.

RESULTS

The total number of participants in the study was 85, of which 43 (50.6%) were rural and 42 (49.4%) were urban women. Mean age of all the women in the study was 38.7 ± 9.4 years with no significant difference between the mean age of rural women and the mean age of urban women, (39.3 ± 9.7 vs. 38.1 ± 9.1 years respectively; p = 0.558). The lower socioeconomic group and the comparatively higher parity of the rural participants was more common.

Table 1. Demographic and reproductive characteristics of the study participants

Variable	Rural (n = 43)	Urban (n = 42)	Total (n = 85)	p-value
Age, years, mean ± SD	39.3 ± 9.7	38.1 ± 9.1	38.7 ± 9.4	0.558
Age ≤40 years	25 (58.1%)	27 (64.3%)	52 (61.2%)	0.559
Age >40 years	18 (41.9%)	15 (35.7%)	33 (38.8%)	
Low socioeconomic status	25 (58.1%)	13 (31.0%)	38 (44.7%)	0.011
Multiparity (≥3 births)	28 (65.1%)	20 (47.6%)	48 (56.5%)	0.104
Premenopausal	34 (79.1%)	35 (83.3%)	69 (81.2%)	0.617
Contraceptive use	15 (34.9%)	19 (45.2%)	34 (40.0%)	0.330

The mean level of hemoglobin was 10.8 ± 1.7 g/dL and the mean level of serum ferritin was 22.9 ± 14.6 ng/mL. The mean levels of hemoglobin and serum ferritin were significantly lower in rural women than urban women. Out of the participants, 45 (52.9%) had IDA, a significantly higher proportion of women in the rural areas than the urban areas (65.1% vs. 40.5%, p = 0.023).

Table 2. Hematological and iron-status parameters according to residence

Parameter	Rural (n = 43)	Urban (n = 42)	Total	p-value
Hemoglobin (g/dL), mean ± SD	10.4 ± 1.6	11.3 ± 1.7	10.8 ± 1.7	0.014
Serum ferritin (ng/mL), mean ± SD	18.5 ± 12.1	27.4 ± 15.7	22.9 ± 14.6	0.004
Serum iron (µg/dL), mean ± SD	47.9 ± 17.5	58.6 ± 20.2	53.2 ± 19.5	0.011
MCV (fL), mean ± SD	78.9 ± 7.2	82.4 ± 7.5	80.6 ± 7.5	0.031
Iron deficiency anemia	28 (65.1%)	17 (40.5%)	45 (52.9%)	0.023

Of the 45 women with iron deficiency anemia, 19 (42.2%) were of mild, 20 (44.4%) moderate and 6 (13.3%) severe. Rural women were more likely to have moderate to severe anemia.

Table 3. Severity of iron deficiency anemia according to residence

Anemia severity	Rural (n = 28)	Urban (n = 17)	Total (n = 45)
Mild	9 (32.1%)	10 (58.8%)	19 (42.2%)
Moderate	14 (50.0%)	6 (35.3%)	20 (44.4%)
Severe	5 (17.9%)	1 (5.9%)	6 (13.3%)

Microbiological dysbiosis was found in 36 (42.4%) women. It occurred much more frequently in women with iron deficiency anemia than in women without anemia (57.8% versus 25.0%, respectively p = 0.002). The most common abnormal microbiological findings were bacterial vaginosis, candidiasis, and mixed growth. The prevalence of anemic participants was significantly lower for Lactobacillus flora.

Table 4. Vaginal microbiological findings according to iron deficiency anemia status

Vaginal finding	IDA present (n = 45)	IDA absent (n = 40)	Total (n = 85)	p-value
Normal/Lactobacillus-predominant flora	19 (42.2%)	30 (75.0%)	49 (57.6%)	0.002
Vaginal microbial dysbiosis	26 (57.8%)	10 (25.0%)	36 (42.4%)	0.002
Bacterial vaginosis	16 (35.6%)	6 (15.0%)	22 (25.9%)	0.030
Candida spp.	7 (15.6%)	3 (7.5%)	10 (11.8%)	0.250
Mixed dysbiosis/infection	3 (6.7%)	1 (2.5%)	4 (4.7%)	0.365

The mean Nugent score was also significantly higher in women with iron deficiency anemia (5.4 ± 2.5) than it was in women without iron deficiency anemia (3.1 ± 2.2; $p < 0.001$), suggesting that iron deficiency anemia disrupted the normal vaginal bacterial flora more. Thirty-one of the participants (36.5%) had abnormal cervical histopathological findings. The most common abnormalities were chronic cervicitis and squamous metaplasia followed by cervical intraepithelial neoplasia. Women who had iron deficiency anemia were significantly more likely to have cervical abnormalities than women who did not have iron deficiency anemia (48.9% vs. 22.5%, $p = 0.012$).

Table 5. Cervical histopathological findings according to iron deficiency anemia status

Histopathological finding	IDA present (n = 45)	IDA absent (n = 40)	Total (n = 85)	p-value
Normal histology	23 (51.1%)	31 (77.5%)	54 (63.5%)	0.012
Any abnormal histopathology	22 (48.9%)	9 (22.5%)	31 (36.5%)	0.012
Chronic cervicitis	13 (28.9%)	6 (15.0%)	19 (22.4%)	0.124
Squamous metaplasia	5 (11.1%)	2 (5.0%)	7 (8.2%)	0.303
CIN I/LSIL	3 (6.7%)	1 (2.5%)	4 (4.7%)	0.365
CIN II/HSIL	1 (2.2%)	0 (0.0%)	1 (1.2%)	0.343

A progressive increase in vaginal microbial dysbiosis was observed with increasing severity of anemia. The prevalence of dysbiosis was 25.0% in women without anemia, 42.1% in women with mild anemia, 65.0% in women with moderate anemia and 83.3% in women with severe anemia. This was a statistically significant trend ($p = 0.003$).

Table 6. Association between anemia severity and vaginal microbial dysbiosis

Anemia status	Dysbiosis present	Dysbiosis absent	Total
No anemia	10 (25.0%)	30 (75.0%)	40
Mild anemia	8 (42.1%)	11 (57.9%)	19
Moderate anemia	13 (65.0%)	7 (35.0%)	20
Severe anemia	5 (83.3%)	1 (16.7%)	6
Total	**36 (42.4%)**	**49 (57.6%)**	**85**

p = 0.003

This was also observed for cervical histopathological abnormalities. Among the non-anemic, 22.5% were the same as those with mild anemia and 31.6% and 60.0% of those with moderate and severe anemia, respectively, were the same.

Table 7. Association between anemia severity and cervical histopathological abnormalities

Anemia status	Abnormal histopathology	Normal histology	Total
No anemia	9 (22.5%)	31 (77.5%)	40
Mild anemia	6 (31.6%)	13 (68.4%)	19
Moderate anemia	12 (60.0%)	8 (40.0%)	20
Severe anemia	4 (66.7%)	2 (33.3%)	6
Total	**31 (36.5%)**	**54 (63.5%)**	**85**

p = 0.006

The levels of hemoglobin and serum ferritin were negatively correlated with Nugent score of the vagina. There were significant inverse associations between lower concentrations of hemoglobin and higher Nugent scores ($r = −0.41$, $p < 0.001$) and between lower concentrations of serum ferritin and higher Nugent scores ($r = −0.36$, $p = 0.001$). The results of these studies revealed that as iron deficiency worsened, there was an increase in the level of vaginal microbial imbalance.

Table 8. Correlation of iron-status parameters with vaginal microbial dysbiosis

Iron parameter	Outcome	Correlation coefficient (r)	p-value
Hemoglobin	Nugent score	−0.41	<0.001
Serum ferritin	Nugent score	−0.36	0.001
Serum iron	Nugent score	−0.29	0.007
Hemoglobin	Cervical abnormality severity	−0.32	0.003
Serum ferritin	Cervical abnormality severity	−0.28	0.010

Iron deficiency anemia was independently associated with VMD and cHVH after adjusting for age, socioeconomic status, parity and place of residence. VMD was associated with almost three times higher odds among women with IDA compared with women without IDA.

Table 9. Multivariable logistic regression for factors associated with vaginal microbial dysbiosis

Predictor	Adjusted OR	95% CI	p-value
Iron deficiency anemia	3.21	1.24–8.31	0.016
Rural residence	1.88	0.75–4.72	0.179
Low socioeconomic status	1.57	0.61–4.06	0.350
Multiparity	1.42	0.56–3.61	0.462
Age >40 years	1.31	0.51–3.37	0.574

Overall, iron deficiency anemia was more prevalent among rural women and was associated with a higher frequency of vaginal microbial dysbiosis and cervical histopathological abnormalities. Increasing severity of anemia demonstrated a stepwise relationship with both vaginal dysbiosis and abnormal cervical histopathology, while lower hemoglobin and serum ferritin concentrations correlated with higher Nugent scores.

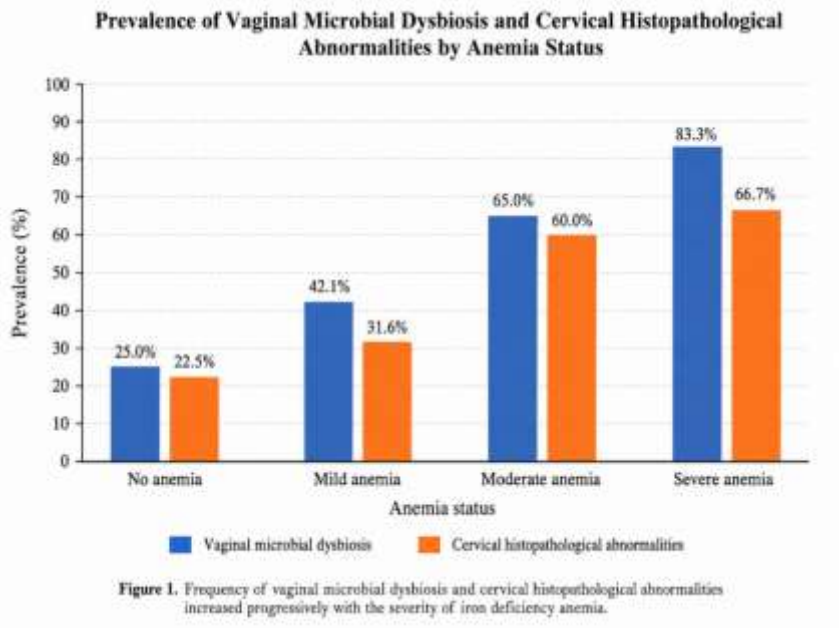

Figure 1. Prevalence of vaginal microbial dysbiosis and cervical histopathological abnormalities according to anemia status. The frequency of both vaginal microbial dysbiosis and cervical histopathological abnormalities increased progressively with the severity of iron deficiency anemia.

DISCUSSION

The present study demonstrated a meaningful association between iron deficiency anemia, vaginal microbial dysbiosis, and cervical histopathological abnormalities among women from rural and urban backgrounds. More than half of the participants were found to have iron deficiency anemia, with a greater proportion observed among women residing in rural areas. Rural participants also showed lower mean hemoglobin, serum ferritin, serum iron, and mean corpuscular volume levels than urban participants. These findings suggest that differences in nutritional status, socioeconomic conditions, dietary iron intake, access to healthcare, and reproductive burden may contribute to a higher frequency of iron deficiency among women living in rural communities (11, 12).

Women with IDA were significantly more likely to have vaginal microbial dysbiosis than women without IDA. The prevalence of dysbiosis was also in ascending order with the most severe anemia and was highest among women in severe anemia. Furthermore, hemoglobin and serum ferritin were negatively correlated with Nugent score, suggesting that the more severe the iron deficiency, the more abnormal the vaginal microbiome. Iron is important for immunity, for epithelial integrity, for cellular metabolism and for mucosal defense. Iron deficiency can thus affect local immune function and the vaginal microenvironment, which can lead to a decline in protective Lactobacillus species and a higher risk of bacteria imbalance (13).

Bacterial vaginosis was the most common microbiologic abnormality in the study population, and was more prevalent among women with iron deficiency anemia. On the other hand, non-anemic women had more cases of lactobacillus-dominant flora. Lactobacilli species are normally responsible for maintaining the vaginal environment and a low pH due to lactic acid production. This balance can be disturbed, allowing anaerobic and perhaps pathogenic organisms to proliferate. This observed relationship between anemia and dysbiosis could be the result of a mix of nutrition deficits,

altered immune responses, socio-economic conditions, hygiene habits, reproductive traits, and limited access to preventive healthcare services, especially for rural women (14, 15).

A significant difference found in the present study was that women with iron-deficiency anemia had more cervical histopathological abnormalities. Squamous metaplasia and cervical intraepithelial abnormalities were the most frequent abnormalities, while chronic cervicitis was the most common. Abnormal cervical histology prevalence was found to increase with the severity of anemia among women without anemia, moderate and severe anemia. A decrease in hemoglobin level and ferritin was also correlated with the severity of cervical abnormalities. While this does not prove a direct causal linkage, chronic iron deficiency could affect cervical tissue by affecting the repair of the epithelium, causing a decrease in immune competence, making a person more susceptible to infection, and prolonging inflammatory response. Persistent exposure of the cervical epithelium to microbial and inflammatory stimuli caused by chronic microbial imbalance in the vagina may also play a role in cervical inflammation (16, 17).

The rural–urban differences identified in this study are also clinically relevant. Iron deficiency was more common among women from rural areas and the hematological parameters were less favorable. Residence alone was not found to be a statistically significant independent predictor of vaginal dysbiosis following adjustment for other factors, but may indirectly impact on reproductive health through other factors such as nutrition, education, economic resources, utilization of health services, screening practices, hygiene conditions, and availability of gynecological services. Multivariable analysis showed that after controlling for selected demographic and reproductive parameters, iron deficiency anemia remained independently associated with vaginal microbial dysbiosis, suggesting the potential for iron status to be an independent factor contributing to changes in the vaginal microbial environment (18-20).

The results must, however, be considered in the context of some limitations. The crosssectional design does not allow for causal or sequence relationships between iron deficiency, vaginal dysbiosis and cervical histopathological changes to be determined. The data collected were from one institution and a limited number of 85 women and may not be representative. Subgroup comparisons were less precise in some histopathological categories due to the small number of cases in these categories, particularly in the higher grades of the cervical lesions. Also, other factors affecting the vaginal microbiome, besides detailed dietary intake, micronutrient deficiencies other than Fe, sexual behavior, HPV status, recent hygiene practices or others were not thoroughly analyzed. Further prospective, multicenter studies with larger patient numbers, microbiome analyses, HPV testing, and longitudinal follow-ups are recommended to further define the biological pathways and timing between iron deficiency, vaginal dysbiosis, and cervical abnormalities.

CONCLUSION

Iron deficiency anemia was common among the studied women and was more prevalent among those residing in rural areas. Women with iron deficiency anemia exhibited a significantly higher frequency of vaginal microbial dysbiosis and cervical histopathological abnormalities than non-anemic women. Increasing anemia severity was accompanied by a progressive rise in both vaginal dysbiosis and abnormal cervical histology, while lower hemoglobin and serum ferritin levels were associated with higher Nugent scores and greater cervical abnormality severity. These findings indicate that iron status may have an important relationship with vaginal and cervical health. Routine assessment and appropriate management of iron deficiency, particularly among women from underserved rural communities, may therefore represent an important component of comprehensive reproductive healthcare. Further prospective research is required to determine whether correction of iron deficiency can improve vaginal microbial balance or reduce the risk of persistent cervical inflammatory and histopathological changes.

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