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ORIGINAL RESEARCH **OPEN ACCESS**

Oral iron adherence and associated factors among pregnant women with anemia in central Peru

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ABSTRACT

Background: Adherence to oral iron is an important component of anemia management during pregnancy, but it varies with individual circumstances and access to care. **Objective:** To assess adherence and associated patient, socioeconomic, treatment, and health-service factors among pregnant women with anemia in Pichanaki, Peru. **Methods:** An analytical cross-sectional study included 163 women in their second or third trimester. Data were collected between August and October 2024 using a questionnaire covering ten candidate factors and the four-item Morisky–Green questionnaire. Adherence required all four responses to be consistent with medication-taking recommendations. Associations were evaluated using Pearson's chi-square test. **Results:** Overall, 85 women were adherent (52.1%; 95% confidence interval, 44.5–59.7%) and 78 were nonadherent (47.9%). Age of 31 years or older, second-trimester pregnancy, monthly income of at least 1,025 Peruvian soles, higher education, favorable perceived treatment effectiveness, reported treatment tolerance, home visits, and timely access to care were associated with adherence (all $p < 0.001$). Iron preparation ($p = 0.408$) and reported adverse effects ($p = 0.801$) were not significantly associated with adherence. **Conclusions:** Approximately half of the participants met the adherence criterion. The observed associations identify patient groups and aspects of treatment experience and service access that warrant attention in antenatal follow-up. They represent unadjusted cross-sectional associations and do not establish causal effects.

Keywords: Medication Adherence; Pregnancy; Anemia; Iron; Prenatal Care; Cross-Sectional Studies.

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Introduction

Anemia remains a substantial burden during pregnancy. A pooled analysis of population-representative data estimated that 36% of pregnant women worldwide had anemia in 2019, with progress insufficient to meet international reduction targets [1]. Its clinical importance extends beyond a low hemoglobin concentration: a large cohort study associated anemia severity with adverse maternal and fetal outcomes, including preterm birth and severe postpartum hemorrhage [2]. These findings support attention to both the diagnosis of anemia and the delivery of effective antenatal treatment.

Oral iron is widely used during pregnancy, although anemia and iron deficiency are distinct clinical entities and treatment decisions require appropriate assessment [3]. A recent Cochrane review found that daily oral iron supplementation may reduce maternal anemia and iron deficiency at term and probably reduces iron-deficiency anemia at term [4]. The potential benefit of prescribing iron depends partly on whether women can take it consistently. Understanding adherence therefore requires consideration of daily treatment experience, comprehension of recommendations, and continuity of access to care.

Evidence on prenatal supplementation describes a combination of behavioral, socioeconomic, and service-related influences. A systematic review identified education, consumption monitoring, reminders, and reliable supplement provision as potentially useful approaches to improving adherence [5]. Another synthesis found that adherence estimates and associated factors varied across populations and measurement methods [6]. Studies from Ethiopia have linked adherence with antenatal attendance, counseling, and knowledge of anemia or supplementation [7,8]. Mixed-methods research in India additionally identified misconceptions, unpleasant treatment experiences, and sociocultural influences that can separate supplement availability from actual consumption [9].

Peruvian evidence also indicates that receiving iron does not ensure adequate adherence. A study involving 404 pregnant women in four cities reported adequate consumption in 29.5%, using a threshold based on the amount of iron consumed relative to the expected amount. Adequate antenatal attendance was associated with better adherence, whereas women prescribed iron for anemia treatment had lower adherence than those receiving preventive supplementation [10]. These findings justify examining local care contexts and distinguishing therapeutic adherence from general supplement coverage.

In Pichanaki, a district in the central Peruvian Amazon, assessment of several domains within the same antenatal population can help identify where follow-up and counseling may be most relevant. The objective of this study was to estimate adherence to oral iron among pregnant women with anemia and examine its associations with patient characteristics, socioeconomic conditions, perceived treatment effectiveness and tolerance, iron preparation and adverse effects, and health-service factors. This local analysis was intended to inform the organization of antenatal support for women already receiving treatment.

Materials and methods

Study design and setting

An observational, analytical, cross-sectional study was conducted at a public hospital in Pichanaki, Chanchamayo province, Junín, Peru. The research execution period extended from August 1 to October 12, 2024. Participants were assessed once, without an investigator-assigned treatment intervention. Reporting was organized according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendations for cross-sectional studies [11].

Participants and sampling

The study included pregnant women with anemia receiving oral iron who were in their second or third trimester and agreed to participate through written informed consent. Women with systemic disease, a diagnosed mental disorder, or withdrawal from participation were excluded. The formulations represented in the sample were ferrous sulfate and iron polymaltose.

Sample-size planning used a reference population of 298 pregnant women recorded by the hospital between January and May 2023, a 95% confidence level, an anticipated adherence proportion of 64.16%, and an absolute precision of 5 percentage points. The finite-population formula yielded a minimum of 162 participants after rounding upward; 163 women were included in the analysis. Selection used simple random sampling from the admissions list of eligible women. Each woman constituted one unit of analysis.

Variables and measurement

The outcome was self-reported adherence to oral iron, measured with the four-item Morisky–Green questionnaire [12]. Responses were dichotomous. Women were classified as adherent when all four responses were consistent with the prescribed medication-taking behavior; at least one response indicating nonadherence classified the participant as nonadherent. This outcome describes reported medication-taking behavior at the assessment rather than a longitudinal measure of treatment persistence.

Ten categorical factors were assessed with a study-specific questionnaire. Patient characteristics were age (15–30 years or 31 years and older) and gestational trimester (second or third). Socioeconomic factors were monthly income (less than 1,025 or at least 1,025 Peruvian soles) and educational attainment (primary or secondary education, grouped together, or higher education). These categories followed the study instrument.

Treatment experience included perceived effectiveness, classified as good or poor according to the woman's perception of improvement, and treatment tolerance, classified as tolerates or does not tolerate. The tolerance item addressed difficulty taking oral iron every day; it therefore reflected the woman's experience of daily treatment. Iron preparation was classified as ferrous sulfate or iron polymaltose. Reported adverse effects were recorded separately as present or absent, with the questionnaire referring to symptoms such as diarrhea, constipation, or nausea.

Health-service factors comprised receipt of home visits during treatment and perceived opportunity to receive care. Response categories were receives or does not receive home visits, and timely care or no opportunity to receive care. These were participant-reported service experiences, not measures of visit frequency or objectively timed waiting periods.

Data collection and instrument review

The hospital administration and admissions service were approached to coordinate access to the study population and participant selection. The study-specific questionnaire and adherence questionnaire were administered to the selected women, and responses were entered into an electronic database using IBM SPSS Statistics version 27.

Content review involved three experts: one methodologist and two professionals with master's degrees in public health. The consolidated assessments yielded an Aiken's V of 0.99 for each instrument. A pilot application involved 20 pregnant women before the main data collection. The factors questionnaire was analyzed as a set of separate categorical variables rather than as a summed psychometric scale.

Statistical Analysis

Categorical variables were summarized as counts and percentages. Overall adherence was calculated using all 163 participants, with a 95% Wilson confidence interval. For each factor, tables present the distribution in the full sample and within the adherent and nonadherent groups; the respective percentage denominators are 163, 85, and 78. Percentages are shown to one decimal place. Within-category adherence proportions used in the narrative were calculated as adherent women divided by the total number in that category.

Associations were assessed using Pearson's chi-square test for the ten 2×2 contingency tables, with one degree of freedom and no continuity correction. All expected cell frequencies exceeded five. Calculations were verified from the tabulated counts using Python 3.12 and SciPy 1.17.0. The significance threshold was 0.05. P-values below 0.001 are presented as $p < 0.001$, and other p-values are reported to three decimal places. Analyses were bivariate and exploratory; the reported associations are unadjusted.

Ethical considerations

Study execution was authorized by the Graduate School governing council under Resolution No. 0293-2024-UNSM/EPG-CD, dated July 31, 2024. Written informed consent was obtained from participating women, participation was voluntary, and questionnaire information was handled confidentially for research purposes. The research followed the ethical principles of respect for persons, beneficence, and justice and the Declaration of Helsinki applicable during study conduct [13]. Results are presented in aggregate form without participant identifiers.

Results

All ten factor-specific cross-tabulations included 163 women: 85 adherent (52.1%; 95% confidence interval, 44.5–59.7%) and 78 nonadherent (47.9%).

Women aged 31 years or older accounted for 83 participants (50.9%), and 84 women (51.5%) were in their second trimester. Adherence was observed in 79 of 83 women aged 31 years or older (95.2%), compared with 6 of 80 women aged 15–30 years (7.5%). It was also more frequent in the second trimester (82/84; 97.6%) than in the third trimester (3/79; 3.8%). Both associations were significant ($p < 0.001$). All 85 adherent women had monthly income of at least 1,025 Peruvian soles and higher education; adherence within these categories was 66.9% (85/127) and 68.5% (85/124), respectively. Income and education were each associated with adherence ($p < 0.001$) (Table 1).

53.2% (42/79) among those reporting none ($p = 0.801$) (Table 2).

Home visits were reported by 126 women (77.3%), while 123 (75.5%) reported timely care. All adherent women belonged to both of these favorable service categories. Within the group receiving home visits, 85 of 126 women (67.5%) were adherent; within the timely-care group, 85 of 123 (69.1%) were adherent. No adherence was recorded among the 37 women who did not receive home visits or among the 40 who reported no opportunity to receive care. Each health-service factor was associated with adherence ($p < 0.001$) (Table 3).

Table 1. Patient and socioeconomic characteristics according to oral iron adherence among pregnant women with anemia (N = 163).

Factor and category	Total (n = 163) n (%)	Adherent (n = 85) n (%)	Nonadherent (n = 78) n (%)	χ^2	p-value
Age				125.502	<0.001
15–30 years	80 (49.1)	6 (7.1)	74 (94.9)		
31 years and older	83 (50.9)	79 (92.9)	4 (5.1)		
Gestational trimester				143.610	<0.001
Second trimester	84 (51.5)	82 (96.5)	2 (2.6)		
Third trimester	79 (48.5)	3 (3.5)	76 (97.4)		
Monthly income				50.351	<0.001
Less than 1,025 Peruvian soles	36 (22.1)	0 (0.0)	36 (46.2)		
At least 1,025 Peruvian soles	127 (77.9)	85 (100.0)	42 (53.8)		
Educational attainment				55.867	<0.001
Primary or secondary education	39 (23.9)	0 (0.0)	39 (50.0)		
Higher education	124 (76.1)	85 (100.0)	39 (50.0)		
Total	**163 (100.0)**	**85 (100.0)**	**78 (100.0)**		

Values are n (column %). Denominators are 163 for the total sample, 85 for adherent women, and 78 for nonadherent women; percentages within each factor sum to 100% in each column, subject to rounding. χ^2: Pearson chi-square statistic, with one degree of freedom. Each p-value compares the two categories of the corresponding factor. All analyses are unadjusted.

A favorable perception of treatment effectiveness was reported by 127 women (77.9%), and 120 (73.6%) reported tolerating treatment. Adherence was present in 85 of 127 women reporting good effectiveness (66.9%) and in none of the 36 reporting poor effectiveness. Among women who reported tolerating treatment, 84 of 120 (70.0%) were adherent, compared with 1 of 43 (2.3%) who did not tolerate it. Both factors were associated with adherence ($p < 0.001$). In contrast, adherence did not differ significantly by iron preparation: 48 of 87 women receiving ferrous sulfate (55.2%) and 37 of 76 receiving iron polymaltose (48.7%) were adherent ($p = 0.408$). The corresponding proportions were 51.2% (43/84) among women reporting adverse effects and

Discussion

Approximately half of the pregnant women with anemia met the study's adherence criterion. Eight of the ten examined factors showed statistically significant bivariate associations: age, gestational trimester, income, education, perceived effectiveness, reported tolerance, home visits, and opportunity to receive care. Iron preparation and reported adverse effects did not show significant associations. The findings indicate that adherence in this population was related to several aspects of the woman's circumstances and care experience, rather than being adequately described by the prescribed formulation alone.

Table 2. Perceived treatment effectiveness, tolerance, iron preparation, and adverse effects according to oral iron adherence (N = 163).

Factor and category	Total (n = 163) n (%)	Adherent (n = 85) n (%)	Nonadherent (n = 78) n (%)	χ^2	p-value
Perceived treatment effectiveness				50.351	<0.001
Good	127 (77.9)	85 (100.0)	42 (53.8)		
Poor	36 (22.1)	0 (0.0)	36 (46.2)		
Treatment tolerance				58.100	<0.001
Tolerates treatment	120 (73.6)	84 (98.8)	36 (46.2)		
Does not tolerate treatment	43 (26.4)	1 (1.2)	42 (53.8)		
Iron preparation				0.684	0.408
Ferrous sulfate	87 (53.4)	48 (56.5)	39 (50.0)		
Iron polymaltose	76 (46.6)	37 (43.5)	39 (50.0)		
Reported adverse effects				0.064	0.801
Present	84 (51.5)	43 (50.6)	41 (52.6)		
Absent	79 (48.5)	42 (49.4)	37 (47.4)		
Total	**163 (100.0)**	**85 (100.0)**	**78 (100.0)**		

Values are n (column %). Denominators are 163 for the total sample, 85 for adherent women, and 78 for nonadherent women; percentages within each factor sum to 100% in each column, subject to rounding. χ^2: Pearson chi-square statistic, with one degree of freedom. Each p-value compares the two categories of the corresponding factor. All analyses are unadjusted. Treatment tolerance refers to reported difficulty taking oral iron daily; adverse effects were assessed separately.

Table 3. Home visits and opportunity to receive care according to oral iron adherence (N = 163).

Factor and category	Total (n = 163) n (%)	Adherent (n = 85) n (%)	Nonadherent (n = 78) n (%)	χ^2	p-value
Home visits during treatment				52.161	<0.001
Receives home visits	126 (77.3)	85 (100.0)	41 (52.6)		
Does not receive home visits	37 (22.7)	0 (0.0)	37 (47.4)		
Opportunity to receive care				57.765	<0.001
Timely care	123 (75.5)	85 (100.0)	38 (48.7)		
No opportunity to receive care	40 (24.5)	0 (0.0)	40 (51.3)		
Total	163 (100.0)	85 (100.0)	78 (100.0)		

Values are n (column %). Denominators are 163 for the total sample, 85 for adherent women, and 78 for nonadherent women; percentages within each factor sum to 100% in each column, subject to rounding. χ^2: Pearson chi-square statistic, with one degree of freedom. Each p-value compares the two categories of the corresponding factor. All analyses are unadjusted.

The adherence proportion of 52.1% was higher than the 29.5% reported in the four-city Peruvian study and close to the 56.5% observed by Tefera et al. in Ethiopia [8,10]. These figures should not be treated as directly interchangeable estimates of the same outcome. The Peruvian multicity study used reported iron consumption relative to expected consumption, whereas this study applied a four-question behavioral classification. Differences in inclusion of preventive versus therapeutic supplementation, recruitment settings, and adherence definitions can materially affect the estimated prevalence [6].

Other recent studies illustrate this variation: Saeed et al. reported 79.0% adherence in eastern Sudan, Seidu et al. reported 84.5% in northern Ghana, and Yismaw et al. reported 34.9% in northwest Ethiopia [14-16]. These comparisons place the present estimate within a broad range of reported experience, but they do not establish that one service performs better than another. Comparable populations, measurement instruments, and observation periods are needed for meaningful benchmarking.

The large differences by age and trimester deserve particular attention. Lower adherence among younger women is consistent with the age-related pattern described by Hardido et al. in southern Ethiopia [17]. However, the Sudanese study did not find associations with maternal age or gestational age [14]. The present second-versus-third-trimester comparison is between different women assessed once; it does not demonstrate that an individual woman's adherence declines as pregnancy progresses. Age and trimester may also be related to prior pregnancy experience, treatment duration, socioeconomic circumstances, or access to care. The bivariate design does not separate these possible explanations.

The concentration of adherence among women with higher income and education is consistent with evidence that treatment behavior is situated within social and household conditions. A multicountry analysis linked adherence with education, household decision-making capacity, and antenatal care [18], while research among a pastoral population in Ghana identified household economic circumstances and knowledge as relevant correlates [19]. Yismaw et al. likewise found an association with maternal education [16]. In this study, the absence of adherent women in the lower-income and primary-or-secondary-education categories describes the observed sample; it should not be generalized as an absolute barrier to adherence in all women with those characteristics. Practical counseling should remain accessible across educational and economic groups.

Perceived effectiveness and treatment tolerance were strongly associated with adherence. A woman who perceives improvement or experiences less difficulty taking daily medication may be more able or willing to continue treatment, although adherence itself may also influence her perception of benefit. Qualitative findings from Botswana and mixed-methods evidence from India identify treatment beliefs, perceived burdens, supply problems, and adverse experiences as important components of supplementation behavior [9,20]. In the present questionnaire, tolerance referred to difficulty taking oral iron every day. Its association with adherence should therefore be interpreted in light of the conceptual overlap between the two measures, rather than as evidence of an independently demonstrated pharmacological mechanism.

Reported adverse effects were not significantly associated with adherence, even though perceived tolerance was. This distinction is clinically plausible because experiencing a symptom and finding a daily regimen difficult to maintain are related but different experiences. Findings from northern Ghana and rural India show that adverse effects and their management can be relevant in other settings [9,15]. The current nonsignificant comparison does not establish that adverse effects are unimportant, and the formulation comparison does not establish equivalence between ferrous sulfate and iron polymaltose. Treatment selection should continue to be informed by clinical assessment, patient experience, and the evidence for anemia management [3].

The associations with home visits and timely care support closer examination of service continuity. Counseling and antenatal contact have also been associated with adherence in studies using multivariable analyses, including those of Solomon et al. and Shumi et al. [7,21]. Spatial and multilevel analyses have linked adherence with proximity to services and antenatal attendance [22], while Ejara et al. identified proximity and information from health extension workers as relevant factors [23]. Nevertheless, home visits may be directed toward selected patients, and timely access may coexist with other advantages. The present findings cannot quantify the independent effect of either service feature.

For antenatal practice, the results suggest useful points for assessment: whether the woman understands the

treatment, perceives benefit, can incorporate it into daily routines, experiences symptoms, and has continuing access to support. Intervention evidence provides a basis for testing specific strategies. A randomized trial of telephone support reported improved oral iron–folic acid adherence among pregnant women with anemia [24], and a community-based educational study improved knowledge and attitudes toward supplementation [25]. Together with the broader intervention review, these studies support evaluating tailored counseling and follow-up locally, with adherence and hematologic outcomes measured prospectively [5].

The study's strengths include examination of ten factors across several domains, use of a defined adherence classification, and complete factor-specific tabulations for the analyzed sample. Its cross-sectional design limits temporal interpretation and leaves the direction of associations unresolved. Self-reported adherence and service experiences are susceptible to recall and social-desirability bias. Recruitment from a single facility limits transferability, and the unadjusted analyses cannot establish whether the associated factors act independently. Several very strong associations and categories with no adherent participants further warrant cautious interpretation. Prospective multicenter studies should use repeated adherence assessment, relevant clinical outcomes, and prespecified multivariable analyses to evaluate these relationships.

Conclusions

Among 163 pregnant women with anemia in Pichanaki, 52.1% met the self-reported oral iron adherence criterion. Adherence was associated with older maternal age, second-trimester pregnancy, higher income and education, favorable perceived effectiveness, reported treatment tolerance, home visits, and timely access to care. Iron preparation and reported adverse effects were not significantly associated with adherence. These unadjusted findings identify aspects of patient support and service access for closer attention during antenatal follow-up; they do not establish causal or independent effects.

Author Contributions Statement (CrediT)

YMG: Conceptualization, Methodology, Investigation, Data curation, Writing – original draft, and Project administration. VSGS: Methodology, Investigation, Formal analysis, Validation, Visualization, and Writing – review and editing. Both authors critically reviewed the intellectual content and approved the final manuscript for publication. They are responsible for its scientific content and integrity.

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Conflict of Interest

The authors declare no financial or non-financial competing interests related to the conduct, interpretation, or publication of this research.

Data Availability

The data supporting this study are not publicly shared because they concern participants' health and treatment experiences. Requests for deidentified data may be addressed to the corresponding author and will be considered subject to participant confidentiality and applicable institutional authorization.

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