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Maternal Knowledge and Adherence to Iron–Folic Acid Supplementation as Factors Associated with Anemia among Pregnant Women

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Abstract: **Background**: Gestational anemia continues to represent a prominent public health hurdle owing to its harmful impacts on maternal and neonatal health. Even with the regular supply of IFA supplementation during prenatal care, anemia rates remain elevated, showing that maternal awareness and supplement compliance may be important behavioral factors associated with the condition. **Objective**: This study aimed to evaluate the independent associations of maternal awareness and IFA supplement compliance with anemia status among pregnant women. **Methods**: An observational cross-sectional investigation was executed involving 66 pregnant women visiting prenatal clinics at Pinang Jaya Primary Health Center, Bandar Lampung, Lampung, Indonesia. Maternal awareness and IFA compliance were gauged through structured surveys, whereas anemia was established via hemoglobin assessment. Data evaluation utilized Chi-square tests alongside multivariable binary logistic regression to compute adjusted odds ratios and 95% confidence intervals. **Results**: The prevalence of anemia reached 57.6%. Following adjustment for maternal age, parity, pregnancy trimester, and employment, individuals with weak awareness exhibited 4.26 times greater odds of anemia relative to those with proper understanding (AOR = 4.26; 95% CI: 1.31 to 13.81; p = 0.016). Likewise, non-compliant participants experienced 4.29-fold higher odds of anemia compared to compliant peers (AOR = 4.29; 95% CI: 1.31 to 13.99; p = 0.016). **Conclusion**: Inadequate maternal awareness and non-adherence to IFA supplementation were independently associated with gestational anemia. As this was a cross-sectional study, these findings reflect associations rather than causal relationships. Embedding behavior-focused nutritional instruction along with adherence support into routine prenatal care may help strengthen maternal anemia prevention efforts across primary care environments.

Keywords: anemia; adherence; iron–folic acid supplementation; maternal knowledge; pregnant women

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Introduction

Gestational nutritional issues, notably maternal anemia, persist as a prominent public health hurdle, especially across developing regions. Global health authorities estimate that over one third of expectant mothers experience this condition, with iron shortage serving as the primary driver (WHO, 2024). Biological adjustments during gestation heavily elevate iron demands to sustain fetal development, placental growth, and circulatory expansion, making women vulnerable when dietary intake and body reserves fall short. This disorder correlates with adverse birth events, such as premature delivery, restricted fetal growth, low birth weight, bleeding complications, infections, and elevated maternal mortality (WHO, 2024). These repercussions highlight that preventing maternal anemia remains a vital international priority.

Within the national context, Indonesia continues to confront a high prevalence of maternal anemia despite running a nationwide IFA supplementation program through routine antenatal care. National health survey data indicate that more than a quarter of expectant mothers suffer from anemia, even though the vast majority receive the target number of IFA tablets (Kementerian Kesehatan Republik Indonesia, 2025). While this reflects wide distribution coverage, the continued presence of the condition shows that simply supplying supplements is not enough for optimal nutritional results. This gap points to the critical role of behavioral factors in determining whether women take their supplements regularly throughout pregnancy.

Daily IFA supplementation stands out as a cost-effective method to prevent deficiency during pregnancy, with global guidelines advising daily use to keep hemoglobin levels stable and lower health risks (WHO, 2016). Still, success relies heavily on patient compliance. Local prospective cohort findings reveal that women consuming high quantities

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of IFA tablets face a much lower risk of anemia than those with lower intake levels (Sartika et al., 2024). Furthermore, incorporating nutrition education into antenatal care boosts compliance, raises hemoglobin levels, and lowers anemia risks, showing that behavioral support is vital (Engidaw et al., 2025). Even so, consistency varies due to hurdles like digestive side effects, forgetfulness, misconceptions, poor counseling, and weak family backing (Atmadani et al., 2024). It is also important to note that maternal anemia is shaped by several non-behavioral determinants, including inadequate dietary iron intake, low pre-pregnancy body mass index, parasitic or systemic infection, low socioeconomic status, and a prior history of anemia (Patel et al., 2018; Parks et al., 2019). While these factors are well documented, the present study focuses specifically on maternal knowledge and IFA adherence as two modifiable behavioral factors that can be directly addressed through antenatal counseling and health education.

Maternal awareness acts as another core behavioral factor by dictating how expectant mothers gauge health threats and act on clinical advice. Individuals possessing sound understanding regarding the triggers, impacts, safeguards, and advantages of IFA supplementation exhibit a higher tendency to follow clinical advice and embrace healthier lifestyles. This connection finds support in the Health Belief Model, which argues that awareness shapes perceived vulnerability, perceived seriousness, perceived upsides, perceived hurdles, and self-efficacy, ultimately guiding protective routines. Because these belief constructs are theorized to operate through two sequential behavioral expressions, first the cognitive recognition of risk reflected in maternal knowledge, and second the enacted preventive behavior reflected in adherence, the present study selected maternal knowledge and IFA adherence as its two primary variables, corresponding to these two stages through which the Health Belief Model predicts anemia-preventive behavior will unfold. Aligned with this theoretical model, Irawati et al. (2024) observed that perceived vulnerability, perceived seriousness, perceived upsides, and self-efficacy showed strong links to a pregnant woman's capacity to avoid anemia. Furthermore, systematic findings indicate that maternal awareness ranks among the top drivers of IFA supplement compliance during gestation, stressing the value of educational efforts within prenatal care routines (Sendeku et al., 2020).

Although awareness and compliance connect closely, they form distinct dimensions of health action. Awareness establishes the mental groundwork for grasping why prevention matters, whereas compliance demonstrates the actual conversion of that awareness into routine habits. Crucially, compliance also responds to drivers outside of awareness, such as counseling standards, household backing, personal drive, perceived discomforts, and service availability (Atmadani et al., 2024). Consequently, well-informed expectant mothers may still skip daily tablets, whereas others with lower initial awareness might remain compliant due to robust counseling or helpful home settings. These trends imply that maternal awareness and compliance shape maternal anemia through distinct yet cooperative behavioral routes.

When viewed collectively, current data show that maternal awareness and compliance should not be treated as isolated behavioral elements, but rather as supportive factors that independently shape maternal anemia via varied mechanisms. Grabbing hold of their relative weight is vital for shaping better prenatal nutrition plans, because efforts aimed at raising awareness differ from those needed to secure long-term IFA supplement compliance.

Despite growing literature on maternal awareness, IFA supplement compliance, and maternal anemia, notable knowledge gaps remain. Most past research evaluated awareness or compliance separately, depended largely on unadjusted bivariate tests, or looked at compliance itself instead of maternal anemia as the core endpoint. For example, a recent Indonesian cohort study demonstrated that adequate IFA supplementation was associated with lower anemia risk (Sartika et al., 2024), yet it did not adjust for maternal knowledge or examine the two behavioral factors jointly within a single multivariable model. Therefore, whether maternal awareness and compliance are independently associated with maternal anemia after controlling for maternal traits remains poorly understood, especially within Indonesian primary care environments (Yulindar & Siman, 2024). Closing this research gap matters because pinpointing behavioral factors that are independently associated with anemia may provide a stronger basis for tailored prenatal education and counseling strategies.

This study took place at Pinang Jaya Primary Health Center, Bandar Lampung, where maternal anemia remains a pressing health concern among clinical attendees. As a primary healthcare facility executing the national IFA supplementation program, this location offers a relevant context for studying behavioral factors associated with maternal anemia in routine practice. Hence, this work aimed to determine whether maternal awareness and IFA supplement compliance are independently associated with anemia among pregnant women after adjusting for background traits through multivariable logistic regression. As this study employed a cross-sectional design, it can identify statistical associations but cannot establish temporal sequence or causal relationships between these behavioral factors and anemia status; this limitation is taken into account throughout the interpretation of the findings. We hypothesized that inadequate maternal awareness and poor IFA supplement compliance would each be independently associated with higher odds of maternal anemia during gestation.

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Method

This analytical observational investigation deployed a cross-sectional framework across the operational zone of Pinang Jaya Primary Health Center, Bandar Lampung, Lampung, Indonesia, spanning December 2025 to January 2026. The research enrolled 66 expectant mothers gathered via accidental (consecutive) sampling, in which all pregnant women attending routine antenatal visits during the data collection period were invited to participate; this approach was chosen because a complete sampling frame of the eligible population was not available in advance and because it allowed recruitment to align with routine clinical flow at the health center. As the sample size was determined by the number of eligible attendees during the study period rather than by an a priori power calculation, the resulting estimates carry relatively wide confidence intervals, and the potential for selection bias and reduced generalizability is acknowledged and discussed further in the Strengths and Limitations section. Eligible participants were pregnant women of any gestational age and trimester attending antenatal care at the health center who possessed complete hemoglobin documentation in their Maternal and Child Health handbook, had no known chronic hematological disorder or acute illness requiring referral at the time of recruitment, and consented to participate regardless of prior IFA supplementation history. Women with incomplete questionnaire responses or missing laboratory values were excluded.

Primary data were gathered via structured questionnaires, whereas hemoglobin measurements and obstetric details were pulled from Maternal and Child Health handbooks and prenatal care archives. Maternal anemia was established following World Health Organization guidelines as hemoglobin below 11.0 g/dL. Awareness regarding anemia and IFA supplementation was evaluated through a 10-item questionnaire adapted from previously used maternal anemia knowledge instruments in Indonesian antenatal populations (Fatriani, 2021; Fatriani & Daeli, 2023), covering the causes, consequences, prevention, and benefits of IFA supplementation; item content was reviewed by the research team for face and content validity prior to data collection. Compliance with IFA supplementation was gauged using a 12-item self-report checklist assessing tablet consumption frequency, dosage, and regularity over the preceding period; because this measure relied on participant self-report, it is potentially subject to recall bias and social desirability bias, which may have led to overestimation of actual adherence, a limitation considered further below. Following established scoring benchmarks, awareness was classified as good or poor, and compliance as adherent or non-adherent. Maternal age, parity, occupation, gestational age, and trimester served as control variables. The survey tools exhibited high internal reliability, yielding Cronbach's alpha values of 0.996 for the awareness inventory and 0.987 for the compliance scale; because such very high values can also reflect item redundancy rather than solely strong internal consistency, particularly for dichotomously scored items, this finding is interpreted with caution and is noted as an instrument-related limitation.

Data evaluation utilized IBM SPSS Statistics version 26.0. Summary metrics outlined participant attributes. Connections linking independent variables to maternal anemia were checked via Chi-square tests and displayed as crude odds ratios alongside 95% confidence intervals. Maternal knowledge and IFA adherence were retained in the multivariable model a priori based on the study's theoretical framework (the Health Belief Model) regardless of their bivariate significance, while maternal age, parity, trimester, and occupation were included as covariates based on biological and clinical plausibility reported in previous literature rather than on statistical selection criteria. These factors were then introduced into a multivariable binary logistic regression model to compute adjusted odds ratios alongside 95% confidence intervals. Significance was fixed at $p < 0.05$. Institutional clearance was granted by the Research Ethics Committee of STIKes Panca Bhakti Lampung (No. 009/UE.STIKes/XI/2025), and written consent was secured from every participant.

Results and Discussion

A total of 66 expectant mothers took part in this investigation. The median maternal age stood at 28 years (IQR: 26 to 29), alongside a median parity level of 1 (IQR: 1 to 2). The median gestational age registered at 22.5 weeks (IQR: 16 to 27), while the average hemoglobin concentration reached 10.66 plus or minus 1.77 g/dL. Most participants were unemployed (87.9%) and were in the second trimester of pregnancy (59.1%). More than half of the respondents had poor knowledge regarding iron–folic acid (IFA) supplementation (54.5%), were non-adherent to IFA tablet consumption (63.6%), and were diagnosed with anemia (57.6%), a prevalence higher than the national average reported for Indonesian pregnant women (Kementerian Kesehatan Republik Indonesia, 2025) and within the upper range reported across Indonesian primary healthcare studies summarized by Yulindar and Siman (2024), suggesting a comparatively high anemia burden at this facility relative to other primary care settings. The detailed characteristics of the participants are presented in Table 1.

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Table 1. Characteristics of the Participants (n = 66)

Characteristic	Value
Maternal age (years), Median (IQR)	28 (26–29)
Parity, Median (IQR)	1 (1–2)
Gestational age (weeks), Median (IQR)	22.5 (16–27)
Hemoglobin level (g/dL), Mean ± SD	10.66 ± 1.77
Occupation, n (%)	
Not working	58 (87.9)
Working	8 (12.1)
Trimester, n (%)	
First trimester	11 (16.7)
Second trimester	39 (59.1)
Third trimester	16 (24.2)
Maternal knowledge, n (%)	
Good	30 (45.5)
Poor	36 (54.5)
Adherence to IFA supplementation, n (%)	
Adherent	24 (36.4)
Non-adherent	42 (63.6)
Maternal anemia, n (%)	
Non-anemia	28 (42.4)
Anemia	38 (57.6)

Continuous variables are presented as mean ± standard deviation (SD) for normally distributed data and median (interquartile range [IQR]) for non-normally distributed data. Categorical variables are presented as frequency (percentage). Chi-square testing was utilized to evaluate the connections linking maternal attributes with anemia standing. Compliance with IFA supplementation demonstrated a strong connection to anemia status. Expectant mothers failing to follow the IFA regimen exhibited 3.72 times greater odds of anemia compared to individuals adhering to the suggested supplementation guidelines (COR = 3.72; 95% CI: 1.30 to 10.67; p = 0.025).

Inadequate awareness regarding anemia also showed a positive connection to the condition. Participants with poor understanding faced roughly 2.97 times higher odds of anemia relative to those possessing solid awareness (COR = 2.97; 95% CI: 1.08 to 8.18). Although this link exhibited an upward pattern, it failed to achieve formal statistical significance within the unadjusted evaluation (p = 0.059). Detailed findings appear in Table 2.

Table 2. Bivariate Analysis of Factors Associated with Maternal Anemia

Variable	Non-anemia n (%)	Anemia n (%)	COR	95% CI	*P-value*
Maternal knowledge					
Good	17 (56.7)	13 (43.3)	1.00 (Reference)	—	—
Poor	11 (30.6)	25 (69.4)	2.97	1.08–8.18	0.059
Adherence to IFA supplementation					
Adherent	15 (62.5)	9 (37.5)	1.00 (Reference)	—	—
Non-adherent	13 (31.0)	29 (69.0)	3.72	1.30–10.67	0.025

The prespecified behavioral factors and clinically plausible covariates were incorporated into the multivariable logistic regression framework to estimate their independent associations with gestational anemia. The concluding model integrated maternal awareness, IFA supplement compliance, maternal age, parity, pregnancy trimester, and work status.

The aggregate logistic regression setup reached statistical significance via Likelihood Ratio testing at p = 0.021. With 38 anemia events and six variables in the model, the events-per-variable (EPV) ratio was approximately 6.3, below the commonly recommended threshold of 10 EPV; this indicates a risk of model overfitting and instability, and the relatively wide confidence intervals observed for the adjusted odds ratios should be interpreted in this light. The framework accounted for only 16.6% of the variance in anemia status through a McFadden Pseudo R^2 of 0.166, indicating that the majority of variability in anemia status, roughly 83%, remains unexplained by the variables included in this model and is likely attributable to unmeasured factors such as dietary iron intake, nutritional status, and infection. The model demonstrated moderate discriminative ability, indicated by an AUC of 0.753; this finding should

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not be interpreted as evidence of strong predictive performance, and the model is better suited to identifying associated factors than to individual-level risk prediction.

Following control for potential confounding elements, inadequate maternal awareness stayed independently linked to anemia. Expectant mothers possessing weak awareness faced 4.26 times greater odds of anemia relative to individuals with solid understanding (AOR = 4.26; 95% CI: 1.31 to 13.81; p = 0.016). Equally, failing to maintain IFA supplement compliance showed an independent connection to anemia. Non-compliant women experienced 4.29-fold higher odds of developing the condition compared to compliant peers (AOR = 4.29; 95% CI: 1.31 to 13.99; p = 0.016). Maternal age, parity, pregnancy trimester, and work status failed to exhibit significant links to anemia after adjusting for remaining factors. Complete results from the multivariable logistic regression appear in Table 3.

Table 3. Multivariable Logistic Regression Analysis of Factors Associated with Maternal Anemia

Variable	β	AOR	95% CI	p-value
Poor maternal knowledge	1.449	4.26	1.31–13.81	0.016
Non-adherence to IFA supplementation	1.456	4.29	1.31–13.99	0.016
Maternal age	0.137	1.15	0.93–1.42	0.208
Parity	0.007	1.01	0.48–2.12	0.986
Trimester	0.274	1.32	0.47–3.67	0.601
Occupation	–0.517	0.60	0.08–4.26	0.606

Model statistics: Likelihood Ratio test (p = 0.021); McFadden Pseudo R^2 = 0.166; Area Under the ROC Curve (AUC) = 0.753. Crucially, maternal awareness shifted from a borderline non-significant association in the bivariate analysis (p = 0.059) to a statistically significant association after adjustment (p = 0.016). This pattern is consistent with confounding or suppression, whereby imbalances in covariates such as trimester distribution or occupation across knowledge categories may have partially masked the crude association; controlling for these factors likely reduced residual variance and yielded a more precise estimate of the association between maternal knowledge and anemia. This shift should be interpreted as a statistical adjustment effect rather than evidence of a stronger causal relationship.

This study found that inadequate maternal awareness and non-adherence to IFA supplementation were independently associated with anemia among pregnant women. After adjusting for age, parity, gestational trimester, and employment, women with poor awareness and those who were non-adherent to the supplementation routine had approximately fourfold higher odds of anemia compared with their counterparts. These findings suggest that behavioral factors are associated with gestational anemia over and above demographic and obstetric characteristics, although the cross-sectional design means the direction of this relationship cannot be confirmed. Even though IFA supplements are regularly distributed via prenatal clinics, maternal anemia persists as a major public health issue globally and in Indonesia, suggesting that mere supplement supply may be insufficient without adequate understanding and steady compliance (WHO, 2024; Kementerian Kesehatan Republik Indonesia, 2025). Given the established link between gestational anemia and adverse delivery outcomes, such as premature birth, low birth weight, and elevated maternal illness, strategies may benefit from addressing behavioral factors alongside regular supplementation (Patel et al., 2018; Parks et al., 2019).

Awareness remained independently associated with anemia after adjusting for confounders, emphasizing its potential role as a foundational element of preventive health behavior. Women who understand the causes, impacts, and prevention of anemia may show a greater readiness to use IFA supplements properly, adopt healthier dietary practices, and use prenatal services effectively. The elevated adjusted association observed here suggests that maternal knowledge is associated with anemia status independently of demographic and obstetric characteristics, although the cross-sectional design does not permit conclusions about the direction of this relationship.

This view finds backing in accumulating data showing that nutritional literacy stands as a core prerequisite for effective anemia prevention. A recent review highlighted that prenatal nutrition instruction markedly enhances IFA compliance while lowering gestational anemia (Engidaw et al., 2025). Similarly, better awareness consistently aligns with stronger supplementation compliance and healthier preventive actions via enhanced risk perception, perceived advantages, and self-efficacy (Saragih et al., 2022; Irawati et al., 2024). Comparable trends have emerged within Indonesia as well. Past local research carried out in Bandar Lampung indicated that numerous expectant mothers still exhibited major knowledge deficits regarding iron deficiency anemia and supplements despite routine clinical visits, and that access to reliable health guidance substantially boosted maternal literacy (Fatriani, 2021; Fatriani & Daeli, 2023). Collectively, these findings show that reinforcing maternal awareness serves as the primary stepping stone toward upgrading preventive actions and mitigating gestational anemia.

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Non-adherence to IFA supplementation was independently associated with higher odds of anemia, consistent with the premise that regular tablet intake is important for meeting heightened gestational iron demands. Established physiological literature describes that plasma volume expansion, fetal development, placental growth, and enhanced red blood cell production substantially elevate maternal iron needs that routine food intake alone typically cannot satisfy (WHO, 2016; Peña-Rosas et al., 2015). It should be noted that the present study did not directly measure these physiological parameters; this biological explanation is drawn from established literature rather than from data collected in this study and is offered here only as plausible context for the observed association between adherence and anemia status.

Current results find support in data from systematic reviews and cross-country investigations identifying weak compliance as a important modifiable factor associated with maternal anemia (Sendeku et al., 2020; Saragih et al., 2022). Research carried out across Ethiopia, Somaliland, and alternative developing regions consistently illustrates that substandard guidance, false beliefs regarding iron pills, anxiety over discomforts, forgetfulness, and weak household backing lower supplement compliance (Hardido et al., 2023; Lencha et al., 2023; Mohamed et al., 2024; Temesgen et al., 2024). Indonesian data display a matching trend, where counseling standards, family backing, and maternal literacy heavily dictate compliance (Atmadani et al., 2024). Moreover, community-based instruction carried out in Bandar Lampung successfully enhanced maternal awareness regarding anemia prevention and proper pill intake, implying that structured health instruction can upgrade compliance within routine prenatal care (Fatriani et al., 2025). Together, these insights show that boosting compliance demands more than securing supplement supplies; it requires reinforcing behavioral backing through strong counseling, recurring instruction, and family involvement.

An essential contribution of this work lies in showing that maternal awareness and compliance were independently associated with anemia within a single multivariable framework. This finding suggests that these behavioral factors may operate through complementary pathways: awareness elevates mothers' comprehension of anemia prevention and may support healthy choices, whereas compliance represents the conversion of that understanding into steady protective habits. Hence, strategies centering solely on supplement distribution may be unlikely to yield optimal reductions in maternal anemia without concurrently upgrading maternal literacy and steady compliance.

These outcomes advocate for expanding prenatal care past routine tablet supply by embedding structured nutritional instruction, tailored guidance, compliance tracking, household involvement, and practical tips for handling supplement-related discomforts. This framework aligns with global guidelines for a positive gestational journey (WHO, 2016) and finds backing in local findings showing that educational efforts upgrade maternal awareness, compliance, and anemia prevention routines (Fatriani, 2021; Fatriani et al., 2025). Such behavioral tactics can heavily boost the impact of national IFA supplementation programs in mitigating maternal anemia.

This study has several strengths. Hemoglobin levels were assessed objectively using laboratory measurement, lowering outcome misclassification, while multivariable logistic regression allowed the isolation of independent associations between maternal awareness, adherence, and anemia after adjusting for key maternal characteristics. Evaluating these two behavioral factors concurrently yields a clearer picture of their associations with gestational anemia in a primary care setting. Nonetheless, several limitations should be acknowledged. The cross-sectional design prevents causal or temporal conclusions, and reliance on self-reported questionnaire data for both maternal knowledge and IFA adherence may introduce recall bias and social desirability bias, potentially leading to overestimation of adherence levels. The use of accidental sampling at a single primary healthcare facility with a relatively small sample size may limit generalizability to other populations and settings, and the resulting events-per-variable ratio raises the possibility of model overfitting, as noted above. Furthermore, key factors like dietary iron consumption, nutritional standing, parasitic illness, inflammation, and household income standing were left unmeasured and may represent residual confounding. Upcoming multicenter prospective research with larger, power-calculated samples, objective adherence measures, and these additional factors is warranted. Despite these limitations, current insights provide observational evidence supporting maternal awareness and IFA supplement adherence as relevant priorities for strategies aimed at mitigating gestational anemia among pregnant women, pending confirmation through longitudinal or interventional research.

Conclusion

Inadequate maternal awareness and non-adherence to IFA supplementation were independently associated with higher odds of anemia among pregnant women in this cross-sectional study. These findings support, but do not by themselves prove, that strengthening maternal health education and deploying adherence-support strategies within routine prenatal care could help reduce anemia; whether improving these factors would directly reduce

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anemia incidence requires confirmation through longitudinal or interventional studies. Future prospective investigations engaging larger and more varied populations are recommended to validate these findings and clarify the temporal relationship linking maternal knowledge, IFA adherence, and anemia.

Declaration of Generative AI

This manuscript was authored independently without the use of generative AI or automated content-generation tools. The authors retain full accountability for the accuracy, integrity, and original creation of all presented content.

Authors' Contribution

All authors contributed equally to the research design, data collection, analysis, and manuscript preparation. Each author has thoroughly reviewed and approved the final version submitted for publication.

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The authors declare no personal, financial, or professional conflicts of interest regarding the research presented in this article. No competing interests affected the execution of the study or the interpretation of the results.

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Data Availability

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request. Access to the data will be provided in accordance with institutional guidelines and participant privacy considerations.

Informed Consent

Informed consent was formally obtained from all individual participants prior to their inclusion in the study. All procedures performed involving human subjects adhered strictly to ethical standards and institutional protocols.

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