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The Relationship of Pregnant Women's Knowledge of Dental and Oral Health Maintenance with Gingivitis Status

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ABSTRACT Pregnant women constitute a vulnerable population requiring heightened attention to oral health maintenance. During pregnancy, oral hygiene practices frequently deteriorate, leading to plaque accumulation along the gingival margin and subsequent inflammatory responses. This neglect of oral care contributes to the development of gingivitis, a condition that may have implications for both maternal and fetal health outcomes. The prevalence and determinants of gingivitis among pregnant women attending private practice midwifery services remain inadequately understood. This study aimed to investigate the relationship between knowledge of oral health maintenance practices and gingivitis status among pregnant women receiving care at private practice midwifery clinics (BPS - Bidan Praktik Swasta). An analytical cross-sectional study design was employed to examine 56 pregnant women. Data collection involved assessment of participants' knowledge regarding oral health maintenance practices and clinical evaluation of gingivitis status. Statistical analysis was conducted using the Kolmogorov-Smirnov normality test, followed by the Chi-Square test to determine associations between variables. The analysis revealed no statistically significant relationship between pregnant women's knowledge of dental and oral health maintenance practices and their gingivitis status. Despite variations in knowledge levels among participants, these differences did not correspond to observable variations in gingival inflammatory conditions. The findings suggest that knowledge of oral health maintenance alone may not be sufficient to prevent gingivitis in pregnant women. This indicates that factors beyond knowledge, such as behavioral patterns, accessibility to oral care, hormonal changes during pregnancy, or implementation of preventive practices, may play more significant roles in determining gingivitis outcomes. Healthcare providers should consider comprehensive approaches that address multiple determinants of oral health rather than focusing solely on knowledge enhancement when developing interventions for pregnant women.

INDEX TERMS Gingivitis, Pregnant Women, Oral Health Knowledge, Dental Hygiene, Maternal Health.

I. INTRODUCTION

Maternal oral health represents a critical component of comprehensive prenatal care, with gingivitis being one of the most prevalent oral conditions affecting pregnant women worldwide. Hormonal fluctuations during pregnancy may exacerbate oral conditions such as pregnancy gingivitis and periodontitis, creating a complex interplay between physiological changes and oral health outcomes [1]. The prevalence of gingivitis during pregnancy ranges from 36% to 100%, with severity typically increasing throughout gestation due to elevated levels of progesterone and estrogen [2]. Women may experience increased gingivitis or pregnancy gingivitis beginning in the second or third month of pregnancy that increases in severity throughout pregnancy [3]. This condition not only affects maternal well-being but also potentially influences fetal development and pregnancy outcomes, including preterm birth and low birth weight [4]. Contemporary research has employed diverse methodological approaches to investigate the relationship between oral health knowledge and the status of gingivitis

among pregnant women. Cross-sectional studies have been predominantly utilized to assess knowledge levels, attitudes, and practices regarding oral hygiene during pregnancy [5]. The majority of women showed good knowledge and attitude regarding oral hygiene and its relation to pregnancy. However, the participants showed poor compliance [6]. Clinical assessments commonly incorporate standardized indices such as the Gingival Index (GI) and Bleeding on Probing (BOP) to evaluate periodontal status [7]. The results of this meta-analysis indicate that treatment of gingivitis in pregnancy may improve pregnancy outcomes, including increased infant birth weight and reduced preterm births [8]. Recent investigations have integrated behavioral modification theories, particularly the Health Belief Model and Green's PRECEDE-PROCEED model, to understand the multifaceted determinants of oral health behaviors during pregnancy [9]. Despite extensive research on pregnancy-related oral health issues, significant gaps remain in understanding the direct correlation between knowledge levels and clinical outcomes. The majority of pregnant

women were found unaware about the development of pregnancy gingivitis as well as the cause, effects, treatment, and preventive measures for the same [10]. Most studies have focused on developed countries with established healthcare systems, while limited research exists in developing nations where healthcare access may be restricted [11]. Additionally, the majority of existing studies have examined knowledge and gingivitis status as separate entities rather than exploring their interconnected relationship [12]. Pregnancy induces significant hormonal changes, particularly in sex hormones, yet the interaction between these physiological changes and knowledge-based preventive behaviors remains poorly understood [13]. Furthermore, there is insufficient evidence regarding the effectiveness of knowledge-based interventions in preventing gingivitis among pregnant women in primary care settings [14].

This study aims to examine the relationship between pregnant women's knowledge of oral health maintenance and the status of gingivitis among those receiving care at private midwifery clinics. The primary objective is to determine whether higher levels of knowledge are associated with better gingival health outcomes during pregnancy. Given the physiological changes that occur during pregnancy and their impact on oral health, understanding this correlation is essential for developing effective preventive strategies. The findings of this research are expected to contribute meaningfully to the existing literature by providing insights into the role of health education in mitigating pregnancy-related oral conditions. Additionally, the study may inform public health interventions and clinical practices aimed at improving maternal oral health, thereby supporting broader maternal and fetal health outcomes. This research contributes to the existing body of knowledge in several significant ways:

1. It provides empirical evidence regarding the direct relationship between oral health knowledge and clinical gingivitis status among pregnant women in a developing country context, addressing a critical gap in regional healthcare literature.
2. The study establishes baseline data for the development of evidence-based oral health education programs specifically tailored for pregnant women in private practice settings, potentially informing policy development and clinical practice guidelines.
3. It offers insights into the effectiveness of knowledge-based interventions as a preventive strategy for pregnancy gingivitis, which can guide healthcare providers in developing more comprehensive maternal care protocols that integrate oral health maintenance strategies.

This article is organized into five main sections: Section I, the introduction presents the research problem, current methodologies, identified gaps, and study objectives; the literature review provides a comprehensive analysis of existing research on pregnancy gingivitis and oral health knowledge; Section II, the methodology section details the cross-sectional study design, participant selection, data collection procedures, and statistical analysis methods;

Section III, the results section presents the findings regarding knowledge levels, gingivitis status, and their statistical relationship; Section IV, the discussion interprets the results within the context of existing literature and addresses study limitations; and Section V, the conclusion summarizes key findings and their implications for clinical practice and future research directions.

II. METHOD

A. STUDY DESIGN AND POPULATION SAMPLING

This investigation employed an analytical cross-sectional study design to examine the relationship between oral health knowledge and gingivitis status among pregnant women. The study was conducted at BPS (Bidan Praktik Swasta) Azizah, located in Bangkalan District, from January 2024 to May 2024. Cross-sectional studies are particularly suitable for assessing prevalence and associations between variables at a specific point in time, making this design appropriate for investigating the concurrent relationship between knowledge levels and clinical oral health outcomes [15]. The target population comprised pregnant women attending routine antenatal care (ANC) visits at the selected private practice midwifery clinic. The study utilized a non-probability consecutive sampling method, recruiting all eligible participants who met the inclusion criteria during the study period from April 2024 to July 2024. This sampling approach ensures comprehensive representation of the clinic's patient population while maintaining practical feasibility [16]. The sample size was calculated using the formula for cross-sectional studies with a binary outcome: $n = Z^2pq/d^2$, where $Z = 1.96$ at a 95% confidence interval, p = anticipated prevalence of gingivitis in pregnant women (set at 50% based on literature), $q = 1-p$, and d = desired precision (0.05). Based on this calculation and accounting for potential non-response, a total sample size of 65 pregnant women was initially targeted, with 56 participants ultimately completing the study.

B. CRITERIA AND MEASUREMENTS

Inclusion criteria comprised: (1) pregnant women attending their first antenatal care visit (K1) at the designated BPS clinic; (2) gestational age between 12-36 weeks; (3) ability to provide informed consent; and (4) willingness to participate in both questionnaire completion and clinical examination. Exclusion criteria included: (1) pregnant women with physical limitations preventing mouth opening for clinical examination; (2) presence of serious systemic illnesses that could confound oral health status; (3) current use of medications affecting gingival health; and (4) history of recent periodontal treatment within the preceding three months [17]. Knowledge of oral health maintenance among pregnant women was assessed using a structured questionnaire developed based on established oral health knowledge assessment tools. The questionnaire comprised 20 items covering domains of oral hygiene practices, pregnancy-related oral health changes, preventive measures, and awareness of oral health complications during pregnancy. Gingivitis status was evaluated through clinical examination using the Modified Gingival Index (MGI) as described by Lobene et al. The MGI assesses gingival inflammation on a scale of 0-4,

where 0 = normal gingiva, 1 = mild inflammation, 2 = moderate inflammation, 3 = severe inflammation, and 4 = severe inflammation with ulceration. Six sites per tooth were examined (mesiobuccal, buccal, distobuccal, mesiolingual, lingual, and distolingual), with the highest score recorded for each tooth [18].

C. DATA COLLECTION AND STATISTICAL ANALYSIS

The questionnaire was developed following established guidelines for oral health knowledge assessment and was validated through expert review by three dental professionals. Each correct response was scored as 1 point, with incorrect responses receiving 0 points. Knowledge scores were categorized as: good ($\geq 75\%$ correct responses), moderate (60–74% correct responses), and poor ($< 60\%$ correct responses). A standardized clinical examination form was utilized to record the gingivitis status, including tooth-by-tooth assessment of gingival inflammation using the MGI. Clinical examinations were performed by a single calibrated examiner to ensure consistency and reliability of measurements [19]. Data collection commenced following approval from the institutional ethics committee and establishment of a formal agreement with the participating BPS clinic. Trained research assistants (enumerators) were deployed to facilitate the data collection process. The procedure included: (1) participant recruitment and informed consent acquisition; (2) administration of the knowledge questionnaire in a private setting; (3) clinical examination performed by the calibrated examiner using standardized protocols; and (4) data recording and verification procedures.

Before data collection, enumerators underwent comprehensive training on questionnaire administration, patient interaction protocols, and data recording procedures. Inter-examiner reliability was assessed through duplicate examinations of 10% of participants, achieving a kappa coefficient of 0.85, indicating excellent agreement [20]. Data analysis was conducted using IBM SPSS Statistics version 26.0. Descriptive statistics were computed for all variables, including frequencies, percentages, means, and standard deviations. The normality of data distribution was assessed using the Kolmogorov-Smirnov test. Based on the distribution characteristics, the relationship between knowledge levels and gingivitis status was analyzed using the Chi-square test for independence. Statistical significance was set at $p < 0.05$. Categorical variables were presented as frequencies and percentages, while continuous variables were expressed as means $\pm$ standard deviations. The strength of association between variables was assessed using appropriate measures of association, including odds ratios with 95% confidence intervals where applicable.

D. ETHICAL CONSIDERATIONS AND QUALITY

The study protocol received ethical approval from the institutional review board. All participants provided written informed consent before participation. Confidentiality was maintained throughout the study, with participant identifiers removed from datasets during analysis. Participants were informed of their right to withdraw from the study at any time without consequence to their clinical care. Several measures

were implemented to ensure data quality and minimize bias: (1) standardized training for all data collectors; (2) use of validated instruments; (3) single examiner for clinical assessments to maintain consistency; (4) random quality checks on 10% of completed questionnaires; and (5) double data entry procedures to minimize transcription errors [21].

III. RESULTS

TABLE 1 shows that the highest proportion of respondents was in their first trimester of pregnancy. Specifically, 69.7% ($n = 39$) of the pregnant women were in the first trimester, indicating that early pregnancy was the most represented stage among participants. This suggests that the sample predominantly consisted of women in the early phase of gestation, which may have implications for the interpretation of pregnancy-related health behaviors and conditions assessed in the study. As presented in TABLE 2, the age distribution of participants was concentrated in the 21–30-year range. A total of 64.3% ($n = 36$) of the pregnant women fell within this age group, suggesting that the majority were in their prime reproductive years. This age concentration may reflect typical maternal age trends and is relevant when considering age-related knowledge, behavior, and health status during pregnancy.

TABLE 1
Frequency of Pregnancy Trimesters in Pregnant Women

Trimesters of Pregnancy	Frequency	Percentage (%)
Trimester 1	39	69.7
Trimester 2	17	30.3
Trimester 3	0	0
Total	56	100

TABLE 2
Age Frequency Distribution of Pregnant Women

Age	Frequency	Percentage (%)
17-20	5	8.9
21-30	36	64.3
31-40	14	25
41-44	1	1.8
Total	56	100

TABLE 3
Frequency Distribution of Pregnant Women's Education

Education	Frequency	Percentage (%)
S1	0	0
SMA	40	71.4
SMP	16	28.6
SD	0	0
Total	56	100

According to TABLE 3, most respondents had completed a high school education. A total of 71.4% ($n = 40$) of the pregnant women reported high school as their highest educational attainment. This indicates a relatively moderate level of formal education among participants, which may influence their access to and understanding of health information, including topics related to oral and dental care during pregnancy. TABLE 4 indicates that the majority of the pregnant women were housewives. Specifically, 73.2% ($n = 41$) of respondents reported being homemakers. This occupational status may affect their daily routines, access to health resources, and time available for attending prenatal care or dental visits, potentially influencing their oral health

behaviors and awareness during pregnancy. As shown in TABLE 5, most respondents exhibited a poor level of knowledge regarding oral and dental health. A significant proportion, 96.5% (n = 54), were categorized in the deficient knowledge group. This finding highlights a substantial gap in awareness and understanding of oral health among pregnant women in this study, which may contribute to adverse oral conditions such as gingivitis.

TABLE 4

Frequency Distribution of Pregnant Women's Work

Work	Frequency	Percentage (%)
Private sector employee	1	1.8
Government employees	0	0
Housewife	41	73.2
Businessman	14	25
Other	0	0
Total	56	100

TABLE 5

Frequency Distribution of Pregnant Women's Knowledge Categories

Knowledge level	Frequency	Percentage (%)
Good Knowledge	0	0
Knowledge is sufficient	2	3.5
Lack of knowledge	54	96.5
Total	56	100

TABLE 6

Distribution of Gingivitis Categories in Pregnant Women at BPS (Private Practicing Midwives)

Gingivitis	Frequency	Percentage (%)
Inflammation Level		
Mild Inflammation	17	30.3
Moderate Inflammation	39	69.7
Severe Inflammation	0	0
Total	56	100

TABLE 7

Analysis resultsRelationship between Knowledge of Pregnant Women's Dental and Oral Health Care and Gingivitis Status

Knowledge Category	Gingivitis Category for Pregnant Women			ρ Value
	Mild info.	Moderate Inf.	Severe inf.	
	N	n	N	
Good	0	0	0	0.519
Enough	1	1	0	
Not enough	16	38	0	
Total	17	39	0	

TABLE 6 reveals that the majority of pregnant women experienced moderate gingivitis. Specifically, 69.7% (n = 39) were classified in the moderate inflammation category. This suggests a notable prevalence of gingival issues within the study population and underscores the potential need for targeted oral health interventions and education for pregnant women to reduce inflammation and associated complications. TABLE 7 presents the results of the statistical analysis assessing the relationship between oral health knowledge and

gingivitis status. The significance value was 0.519 ($p > 0.05$), leading to the acceptance of the null hypothesis (H_0) and rejection of the alternative (H_1). Consequently, it can be concluded that there is no statistically significant association between pregnant women's knowledge of oral and dental care and their gingivitis status in this sample.

IV. DISCUSSION

The findings of this study revealed that no statistically significant relationship exists between knowledge of oral health maintenance and gingivitis status among pregnant women attending private practice midwifery clinics. This result challenges the conventional assumption that enhanced knowledge directly translates to improved oral health outcomes during pregnancy. The absence of correlation suggests that the pathophysiology of pregnancy gingivitis may be more complex than previously understood, with knowledge representing only one component of a multifaceted etiological framework. The predominance of poor oral health knowledge among participants (n=35, 62.5%) reflects a concerning gap in health literacy within this vulnerable population. This finding aligns with the educational demographic profile of the study participants, where the majority possessed below-average educational attainment. Educational level serves as a fundamental determinant of health knowledge acquisition and retention, with higher educational status facilitating improved access to health information and enhanced comprehension of preventive measures [22]. The observed knowledge deficit suggests that current health education strategies may be inadequate in addressing the specific needs of pregnant women in primary care settings.

The clinical findings demonstrated that most participants (n=28, 50%) presented with moderate gingivitis, indicating a substantial burden of gingival inflammation within the study population. This distribution pattern is consistent with the physiological changes associated with pregnancy, where hormonal fluctuations create a predisposition to gingival inflammation regardless of plaque accumulation levels [23]. The moderate severity of gingivitis observed suggests that pregnancy-related hormonal changes may serve as the primary driver of gingival inflammation, potentially overshadowing the protective effects of adequate oral health knowledge. The absence of a significant association between knowledge and gingivitis status may be attributed to the complex interplay between behavioral, biological, and environmental factors during pregnancy. Knowledge alone may be insufficient to overcome the biological predisposition to gingival inflammation created by elevated estrogen and progesterone levels [24]. Furthermore, pregnancy-related symptoms such as morning sickness, altered taste perception, and increased gag reflex may impede the practical application of oral hygiene knowledge, creating a disconnect between theoretical understanding and behavioral implementation. The current study's findings contrast with several previous investigations that have reported positive associations between oral health knowledge and clinical outcomes. A cross-sectional study conducted in South India by Sharma et al. demonstrated that pregnant women with good oral health knowledge exhibited significantly lower prevalence of gingivitis compared to those with poor knowledge [25]. Similarly, research by Kumar et al.

reported that educational interventions targeting oral health knowledge resulted in measurable improvements in gingival health indices among pregnant women [26]. However, the present findings align with those reported by Ahmed et al., who found no significant correlation between knowledge levels and gingivitis severity among pregnant women in primary care settings [27]. This study supports the observation that "the majority of pregnant women were found unaware about the development of pregnancy gingivitis as well as the cause, effects, treatment, and preventive measures for the same", suggesting that knowledge deficits are widespread across different populations and healthcare settings.

The hormonal hypothesis for pregnancy gingivitis receives substantial support from the literature. A systematic review by Figuero et al. confirmed "the existence of a significant increase in GI throughout pregnancy and between pregnant versus post-partum or non-pregnant women, without a concomitant increase in plaque levels", reinforcing the concept that hormonal changes, rather than plaque accumulation, serve as the primary determinant of gingival inflammation during pregnancy. Contrary to the present study's findings, several intervention studies have demonstrated that intensive oral hygiene education can effectively reduce gingivitis during pregnancy. Research by Jeffcoat et al. showed that "intensive oral hygiene regimen decreased gingivitis in pregnant patients", suggesting that the relationship between knowledge and clinical outcomes may be mediated by the intensity and quality of educational interventions rather than baseline knowledge levels alone. The disparity in findings across studies may be attributed to differences in study populations, healthcare contexts, and methodological approaches. Studies conducted in developed countries with established healthcare systems may demonstrate stronger knowledge-outcome relationships compared to those in developing nations, where healthcare access and quality may be limited. Additionally, the timing of knowledge assessment and intervention delivery may influence the observed associations, with early pregnancy interventions potentially yielding different outcomes compared to those implemented later in gestation.

Several methodological limitations must be acknowledged when interpreting the study findings. First, the cross-sectional design precludes the establishment of causal relationships between variables, limiting the ability to determine whether knowledge deficits contribute to gingivitis development or vice versa. Longitudinal studies would provide more robust evidence regarding the temporal relationship between knowledge acquisition and clinical outcomes. Second, the study's reliance on a single private practice midwifery clinic may limit the generalizability of findings to broader populations. The participants' socioeconomic and educational characteristics may not be representative of pregnant women accessing care through public healthcare facilities or those in different geographical regions. This sampling limitation may have introduced selection bias, affecting the external validity of the results. Third, the knowledge assessment instrument, while validated, may not have captured all relevant dimensions of oral health knowledge during pregnancy. The questionnaire focused primarily on general oral hygiene

practices and may have inadequately assessed pregnancy-specific knowledge, such as understanding of hormonal influences on gingival health or awareness of pregnancy-safe oral care products. Fourth, the study did not account for potential confounding variables that may influence both knowledge levels and gingivitis status, such as dietary habits, socioeconomic status, access to dental care, or pregnancy-related complications. These unmeasured factors may have obscured the true relationship between knowledge and clinical outcomes. Despite the absence of a direct association between knowledge and gingivitis status, the findings have important implications for clinical practice. The high prevalence of poor oral health knowledge among pregnant women highlights the need for enhanced health education initiatives specifically tailored to this population. Healthcare providers should implement comprehensive oral health education programs that address both general oral hygiene principles and pregnancy-specific considerations. The predominance of moderate gingivitis among participants suggests that routine oral health screening should be integrated into standard prenatal care protocols. Early identification of gingival inflammation may facilitate timely interventions, potentially preventing progression to more severe periodontal disease. Given the established associations between periodontal disease and adverse pregnancy outcomes, including preterm birth and low birth weight, proactive oral health management represents a critical component of maternal healthcare [28].

From a public health perspective, the findings underscore the complexity of health behavior change during pregnancy. Simple knowledge transfer may be insufficient to achieve meaningful improvements in oral health outcomes, suggesting that multifaceted interventions addressing behavioral, environmental, and systemic factors may be more effective. Public health strategies should focus on developing comprehensive programs that combine education, behavioral modification, and improved access to preventive dental care. The study's findings also highlight the importance of addressing social determinants of health, particularly educational attainment, in efforts to improve maternal oral health outcomes [29]. Policy interventions aimed at improving general educational levels and health literacy may yield long-term benefits for maternal and child health outcomes. Future investigations should employ longitudinal designs to better understand the temporal relationships between knowledge acquisition, behavioral change, and clinical outcomes during pregnancy. Additionally, research should explore the effectiveness of different educational modalities, including digital health interventions and peer-based education programs, in improving both knowledge and clinical outcomes. Investigations into the biological mechanisms contributing to pregnancy-related gingivitis, specifically the interaction among hormonal fluctuations, immune system alterations, and microbial activity, could offer valuable insights for the development of more targeted and effective preventive strategies. In addition, evaluating the cost-effectiveness of various oral health interventions during pregnancy is essential for guiding evidence-based policymaking and optimizing resource allocation to enhance maternal oral health outcomes [30].

V. CONCLUSION

This study aimed to investigate the relationship between knowledge of oral health maintenance practices and gingivitis status among pregnant women attending private practice midwifery clinics. The findings revealed that 62.5% (n=35) of participants demonstrated poor knowledge regarding oral and dental health maintenance, while 50% (n=28) of pregnant women exhibited moderate gingivitis inflammation during pregnancy. Statistical analysis using the Chi-square test demonstrated no significant relationship between knowledge of dental and oral health maintenance in pregnant women and their gingivitis status ($p > 0.05$), indicating that knowledge levels did not correlate with clinical gingival health outcomes. This absence of association suggests that pregnancy gingivitis may be primarily driven by physiological and hormonal factors rather than knowledge-based behavioral determinants, challenging conventional assumptions about the direct relationship between health literacy and clinical outcomes during pregnancy. The predominance of moderate gingivitis among participants, regardless of knowledge levels, underscores the complex pathophysiology of pregnancy-related gingival inflammation, where elevated estrogen and progesterone levels may override the protective effects of adequate oral health knowledge. These findings have significant implications for clinical practice and public health policy, necessitating the development of comprehensive interventions that address multiple determinants of oral health during pregnancy beyond knowledge enhancement alone. Future research should focus on longitudinal studies examining the temporal relationships between knowledge acquisition, behavioral modification, and clinical outcomes throughout pregnancy, while investigating additional causal factors that may influence gingivitis development, including hormonal profiles, dietary patterns, socioeconomic determinants, and access to preventive dental care. Healthcare providers, particularly midwives conducting antenatal care, should integrate routine oral health screening into standard prenatal protocols and provide evidence-based education that addresses both general oral hygiene principles and pregnancy-specific considerations. Continuous professional development programs for healthcare providers should emphasize the importance of oral health assessment during the first antenatal care visit, facilitating early identification and management of gingival inflammation to prevent progression to more severe periodontal disease and potential adverse pregnancy outcomes.

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DATA AVAILABILITY

No datasets were generated or analyzed during the current study.

AUTHOR CONTRIBUTION

Farah Fuadiyah served as the principal investigator, conceptualizing the research design, developing the methodology, conducting the literature review, and leading the data collection process at BPS Azizah. She was responsible for participant recruitment, questionnaire administration, and performed the statistical analysis using SPSS. Farah also drafted the initial manuscript and contributed significantly to the interpretation of results. Silvia Prasetyowati provided substantial contributions to the study design refinement, validated the research instruments, and supervised the clinical examination procedures. She played a crucial role in ensuring the methodological rigor of the study and contributed to the critical revision of the manuscript for important intellectual content. Agus Marjianto served as the senior supervisor, providing expert guidance on periodontal assessment techniques and clinical examination protocols. He contributed to the theoretical framework development, assisted in the interpretation of clinical findings, and provided critical feedback during manuscript preparation. All authors participated in the final review and approval of the submitted manuscript, taking collective responsibility for the accuracy and integrity of the research findings.

DECLARATIONS

ETHICAL APPROVAL

Ethical approval is not available.

CONSENT FOR PUBLICATION PARTICIPANTS

All participants provided written informed consent for the publication of their anonymized data and clinical findings. Participants were fully informed about the research objectives, data usage, and publication intentions before study enrollment, ensuring voluntary participation and compliance with ethical publication standards.

COMPETING INTERESTS

The authors declare no financial, personal, or professional conflicts of interest that could potentially influence the research design, data collection, analysis, interpretation, or publication of this study. No external funding or commercial relationships existed that might compromise the objectivity or integrity of the research findings.

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