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Original Research article

Evaluation of periodontal screening score for prediction of severe periodontitis in Côte d'Ivoire: A cross-sectional pilot study

Gnaba Samson Mobio[1], Zocko Ange Désiré Pockpa[1]*, Naomi Delima Koffi[1], Nadin Thérèse Koffi-Coulibaly[1], Assem Soueidan[2], Yoann Maitre[3], Camille Bechina[2], Xavier Struillou[2]

[1]Dept. of Periodontology, Dental College, Felix Houphouet Boigny University, Côte d'Ivoire
[2]Dept. of Periodontology, Dental College, University of Nantes, Nantes, France
[3]Dept of Public Health, Dental College, University of Nantes, Nantes, France

Abstract

Aim: The objective of this study was to evaluate the effectiveness of a self-reported questionnaire as an alternative to conventional clinical examination for the screening of severe periodontitis.

Materials and Methods: Eligible patients completed a structured questionnaire and underwent a comprehensive periodontal examination. Based on questionnaire scores, participants were classified into two groups: non-severe periodontitis (score <5) and severe periodontitis (score ≥5). Clinical classification, according to the Chicago Classification (2017), also divided participants into two groups: those without severe periodontitis (gingivitis, mild, and moderate stages) and those with severe periodontitis. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and Cohen's kappa coefficient (κ) were calculated to assess the concordance between questionnaire-based screening and clinical diagnosis.

Results: A total of 397 patients aged 15 to 79 years were included. The prevalence of severe periodontitis was 25.7% using the questionnaire and 11.1% based on clinical diagnosis. The questionnaire showed high sensitivity (95.45%) and good specificity (83.06%). The PPV was 18%, and the NPV was 99.32%. A moderate agreement was observed between the questionnaire and clinical examination (κ = 0.498).

Conclusion: This study suggests that the questionnaire may serve as a promising alternative to conventional clinical examination for the screening of severe periodontitis in Côte d'Ivoire. Further data collection will be necessary to confirm these findings and refine the optimal cutoff score for use in clinical practice.

Keywords: Periodontal diseases, Periodontitis, Questionnaires, Screening, Diagnosis.

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1. Introduction

Severe periodontal diseases (stage III/IV) is chronic, multifactorial inflammatory conditions associated with dysbiotic plaque biofilms and characterized by advanced attachment loss.[1,2] According to the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions (Chicago classification), stage III periodontitis is defined by interdental clinical attachment loss ≥5 mm, deep periodontal pockets (≥6 mm), and potential tooth loss (≤4 teeth). In contrast, stage IV periodontitis involves extensive tooth loss (≥5 teeth), significant masticatory dysfunction, and complex rehabilitation needs.[1,2] Without treatment, these conditions often lead to tooth loss, severely compromising quality of life.[3,4]

Beyond oral health implications, severe periodontal disease (SPD) is linked to increased risks of systemic diseases,[5] such as cardiovascular conditions, diabetes, and pregnancy complications.[6] Globally, SPD affects approximately 11.2% of the population.[1,2,7] However, in Côte d'Ivoire, the burden of SPD is significantly higher, with prevalence among young adults estimated at 43.4% in 2021.[8] This disparity suggests that socioeconomic factors, limited access to dental care, and differences in oral health awareness may contribute to a much greater impact on the

*Corresponding author: Zocko Ange Désiré Pockpa
Email: angepockpa2013@gmail.com

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population.Given its high prevalence and severe health consequences, early detection and treatment of SPD are strongly recommended.

Traditionally, periodontal assessment requires examining all teeth in the oral cavity, probing six sites per tooth to collect data on plaque indices, bleeding on probing, pocket depths, and clinical attachment loss. This evaluation is complemented by radiographic examinations and, when necessary, biological tests.[1,2]

However, this comprehensive approach is time-consuming, requiring a skilled practitioner and specialized equipment. As a result, periodontal examinations are not routinely performed by certain healthcare professionals (dentists, gynecologists, cardiologists, and diabetologists) who frequently encounter patients at high risk for SPD.[9,11]

To address these challenges and encourage broader participation in early SPD detection, it is imperative to develop a rapid, affordable, and non-invasive diagnostic method that eliminates the need for a direct oral cavity examination. Innovative screening techniques are being developed to meet this need.[9-11]

Since 2003, several research initiatives, in collaboration with the Centers for Disease Control and Prevention (CDC) and the American Academy of Periodontology (AAP), have proposed self-assessment questionnaires for periodontal disease screening.[9-15] In France, Carra et al.[16] developed a simplified model known as the Periodontal Screening Score (PESS), designed to detect SPD efficiently. This tool has been validated, proving its effectiveness and could be especially useful in routine clinical settings with limited access to conventional periodontal examinations.[16]

However, the PESS's applicability and validity in diverse cultural and socioeconomic environments, such as Côte d'Ivoire, remain untested. Given the higher prevalence of SPD in Côte d'Ivoire, factors such as oral health knowledge, attitudes, and practices may significantly impact the performance of such questionnaires.

Thus, this study aims to evaluate the predictive ability of the PESS in detecting SPD in Côte d'Ivoire, considering the unique epidemiological and socioeconomic factors of the region.

2. Materials and Methods

2.1. Study setting and population

This study was conducted at the Periodontology Department of the Odontostomatological Consultation and Treatment Center (CCTOS) at the University Hospital of Cocody-Abidjan, from January to March 2024. It focused on patients attending in the department and meeting specific eligibility criteria. Only volunteer patients consulting for the first time, were included. Patients were excluded if they had previously received treatment or were currently under follow-up for periodontal disease, had undergone periodontal treatment within the three months preceding the study, or were not proficient in French.

Initially, all participants were provided with clear and comprehensive information regarding the study's objectives and procedures. Informed consent was then obtained, confirming their voluntary participation. Subsequently, participants independently completed a structured questionnaire while waiting in the designated area. Once the questionnaire was completed, a conventional clinical examination was performed by examiners (KN, PZ) who were blinded to the questionnaire responses.

The sample size was determined using the single proportion formula for cross-sectional studies17: $n = (Z^2 \times p \times (1 - p)) / d^2$ where n is the required sample size, Z is the Z-score for the desired confidence level (1.96 for 95%), p is the estimated prevalence (43.4%), and d is the margin of error (5%). Based on this, a minimum of 377 participants was required. To account for a 10% anticipated non-response rate, the sample size was increased to 419 participants.

Only respondents with complete data were considered for the final analysis.

2.2. Self-reported questionnaire and presumptive diagnostic (Test)

The study employed the Periodontal Evaluation Screening Score (PESS) developed by Carra et al.[16] which consists of seven self-reported items (Table 1):

1. How old are you? (15–39; 40–54; ≥55);
2. Do you smoke? (Yes; No);
3. In general, how would you rate the health of your teeth and gums? (Excellent; Very good; Good; Fair; Poor; Don't know; Prefer not to answer);
4. Have you ever received treatment for gum disease, such as scaling and root planing, sometimes called a "deep cleaning"? (Yes; No; Don't know; Prefer not to answer);
5. Have you ever had a tooth that became loose without any trauma? (Yes; No; Don't know; Prefer not to answer);
6. Have you ever been informed by a dentist that you are losing bone around your teeth? (Yes; No; Don't know; Prefer not to answer);
7. In the past 3 months, have you noticed anything unusual with one of your teeth (pain, swollen gums, bad taste, etc.)? (Yes; No; don't know; Prefer not to answer).

Each response was assigned a score according to the PESS scoring criteria, yielding an individual periodontal screening score ranging from 0 to 13. Based on the total score, participants were classified into two categories:

1. No severe periodontitis (PESS score <5)
2. Severe periodontitis (PESS score ≥5)

3.3. Clinical examination (Gold standard)

A comprehensive periodontal examination was performed by two periodontists (KN, PZ), blinded to the questionnaire. All permanent fully erupted teeth, except third molars, were assessed using William's periodontal probe (Michigan O probe, Hu-Friedy Mfg. Co., Chicago, IL, USA). Plaque index (PI), bleeding on probing (BOP), probing depth (PD), gingival recession (REC), and clinical attachment loss (CAL). PI and BOP were recorded at six sites per tooth (mesiobuccal, mid-buccal, distobuccal, mesiolingual, mid-lingual, and distolingual). PD was the distance from the free gingival margin to the pocket's base, and REC was the distance from the cementoenamel junction to the free gingival margin. CAL was the sum of PD and REC. For this study, based on the clinical criteria of Chicago classification,[2,18] subjects were categorized into two groups: severe periodontitis group (periodontitis stage 3 or 4) and no severe periodontitis group (gingivitis or periodontitis stage 1 or 2).

3.4. Statistical analysis

Statistical analyses were performed using SPSS software (version 22), with a significance threshold set at $\alpha = 0.05$. The characteristics of the study population were described based on periodontal status. The Chi-square test was applied to compare percentages between groups. To assess the concordance between the diagnostic presumption scores (test) and the clinical diagnosis (gold standard), the Chi-square test was also employed. Diagnostic performance metrics such as sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and Cohen's Kappa coefficient were calculated. Judgment criteria for diagnostic performance were as follows:

1. Sensitivity and Specificity: Excellent (≥90%), Good (80–89%), Moderate (70–79%), and Poor (<70%).[19,20]
2. Positive and Negative Predictive Values (PPV, NPV): High (≥90%), Acceptable (80–89%), Low (<80%).[19,20]
3. Cohen's Kappa Coefficient: Almost perfect agreement (0.81–1.00), Substantial agreement (0.61–0.80), Moderate agreement (0.41–0.60), Fair agreement (0.21–0.40), and Poor agreement (≤0.20).[21]

3.5. Ethical considerations

All participants were provided with detailed information about the study's objectives and procedures. Participation was entirely voluntary, and consent was obtained prior to inclusion. The study adhered to ethical principles to ensure the participants' rights, privacy, and confidentiality were respected throughout. The study's protocol received approval from the Scientific and Ethical Committee of the Odontostomatology Training and Research Unit at the University Felix Houphouët Boigny in Abidjan (authorization number 531/24).

3. Results

Among the volunteers who met the inclusion criteria, 26 were excluded due to missing data. Consequently, the study population consisted of 397 subjects, with an average age of 37.88 years (SD = 13.17; range: 15–79 years). Of these, 220 (55.4%) were male and 177 (44.6%) were female. The majority (97%) of the participants were non-smokers. In terms of oral hygiene, 69% considered it acceptable, while 26.4% reported poor hygiene. A total of 69.5% did not notice any periodontal abnormalities in the months preceding the study. Among those who observed abnormalities, 40% reported dental mobility, 26% gum inflammation, and 22% gingival bleeding. Additionally, 14% of participants reported having mobile teeth, 61% reported never undergoing periodontal treatment, and 5.5% were informed by a dentist about bone loss around one or more teeth (**Table 1**).

Based on the PESS score, 102 participants (25.69%) were classified in severe periodontitis group (score ≥5), while 295 (74.31%) were classified in no severe periodontitis group (score <5). (**Figure 1**)

Clinical examination, following the Chicago classification criteria2,18, revealed that 279 participants (70.3%) had gingivitis and 118 (29.7%) had periodontitis. The breakdown of periodontitis stages was as follows: Stage 1 (50 participants, 12.6%), Stage 2 (24 participants, 6.1%), Stage 3 (27 participants, 6.8%), and Stage 4 (17 participants, 4.3%). Severe periodontitis (Stages 3 and 4) was identified in 11.1% of participants, while 89.1% were classified as having gingivitis or mild periodontitis (Stages 1 and 2). (**Figure 1**)

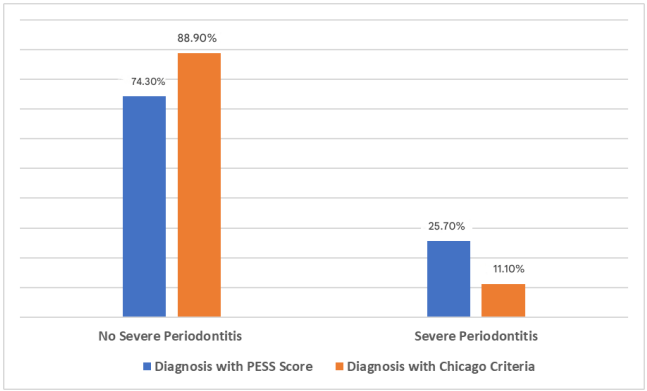

Figure 1: Prevalence of severe periodontitis assessed through questionnaire and clinical evaluation.

Table 1: Responses to questions stratified by periodontitis status (N = 397).

Item	Question	NSP	SP	Total	p-value
1	**How old are you?**				< 0.001
	15–39	22 (63.2%)	13 (29.5%)	236 (59.4%)	
	40–54	95 (26.9%)	18 (40.9%)	113 (28.5%)	
	≥ 55	35 (9.9%)	13 (29.5%)	48 (12.1%)	
2	**Do you smoke?**				0.631
	No	343 (97.2%)	42 (95.5%)	385 (97.0%)	
	Yes	10 (2.8%)	2 (4.5%)	12 (3.0%)	
3	**In general, how would you rate the health of your teeth and gums?**				0.006
	Excellent/ Very good/ Good.	250 (70.8%)	24 (54.5%)	274 (69.0%)	
	Fair.	18 (5.1%)	0 (0.0%)	18 (4.5%)	
	Poor	85 (24.1%)	20 (45.5%)	105 (26.4%)	
4	**Have you ever received treatment for gum disease, such as scaling and root planing, sometimes called a "deep cleaning"?**				< 0.001
	No	231 (65.4%)	11 (25.0%)	242 (61.0%)	
	Yes	122 (34.6%)	33 (75.0%)	155 (39.0%)	
5	**Have you ever had a tooth that became loose without any trauma?**				< 0.001
	No	330 (93.5%)	10 (22.7%)	340 (85.6%)	
	Yes	23 (6.5%)	34 (77.3%)	57 (14.4%)	
6	**Have you ever been informed by a dentist that you are losing bone around your teeth?**				< 0.001
	No	342 (96.9%)	33 (75.0%)	375 (94.5%)	
	Yes	11 (3.1%)	11 (25.0%)	22 (5.5%)	
7	**In the past 3 months, have you noticed anything unusual with one of your teeth (pain, swollen gums, bad taste, etc.)?**				< 0.001
	No	269 (76.2%)	7 (15.9%)	276 (69.5%)	
	Yes	84 (23.8%)	37 (84.1%)	121 (30.5%)	

SP: severe periodontitis. NSP: no severe periodontitis: PESS: Periodontal Screening Score

Table 2: Responses to questions stratified by periodontitis status (N = 397).

Clinical Diagnosis \ PESS	SP (PESS)	NSP (PESS)	Total
SP (Clinic)	42 (10.6%)	2 (0.5%)	44 (11.1%)
NSP (clinic)	60 (15.1%)	293 (73.8%)	353 (88.9%)
Total	102 (25.7%)	295 (74.3%)	397 (100%)

SP: severe periodontitis. NSP: no severe periodontitis: PESS: Periodontal Screening Score

Sensitivity: 95.45%; Specificity: 83.06%, Positive Predictive Value (PPV): 41.18%, Negative Predictive Value (NPV): 99.32%, Cohen's Kappa coefficient: 0.498

The proportion of patients diagnosed with severe periodontitis using the PESS was higher than those identified through clinical examination (25.7% versus 11.1%). Furthermore, a statistically significant association was observed between these two approaches ($p < 0.05$). The diagnostic validity of the PESS (score ≥5) was evaluated in this population, yielding the following performance metrics: Sensitivity: 95.45%; Specificity: 83.06%, Positive Predictive Value (PPV): 41.18%, indicating that 41.18% of individuals with a positive test result were truly diseased. Negative Predictive Value (NPV): 99.32%, indicating that 99.32% of individuals with a negative test result were truly disease-free (**Table 2**). The Cohen's Kappa coefficient of 0.498 indicates moderate agreement between the screening test and the gold standard.

4. Discussion

The present study evaluated the diagnostic performance of the PESS in identifying individuals at high risk of severe periodontitis and explored the correlation between presumptive results based on this score and clinical diagnosis.

The proportion of patients diagnosed with severe periodontitis using the PESS was higher than those identified through clinical examination (25.7% versus 11.1%). We therefore assessed the validity of this test on our study population by calculating the performance parameters of the diagnostic test. For a PESS score ≥5, we obtained a sensitivity of 95.45% and a specificity of 83.06%. These results are superior to those of Carra et al[16] who gave a sensitivity of 78.9% and a specificity of 74.8%, as well as those of Hassine et al.[22] who obtained a sensitivity of 83.8% and a specificity of 40%.

The test used on this study population obtained a high sensitivity (95.45%), which means that it is able to correctly identify 95.45% of sick people (true positives). In other words, the test is good at detecting those who are actually sick, which is crucial to minimize undetected cases of disease. The test also achieved a high specificity (83.06%), indicating that it can correctly identify 83.06% of non-diseased individuals (true negatives). This means that the test is effective in avoiding false positives (individuals wrongly identified as diseased).

In general, previous studies on this topic have generally reported an acceptable specificity rate;[23] but the sensitivity varied considerably from one study to another, ranging from low to fair. Our results demonstrated high sensitivity and high specificity, which were consistent with those of several studies.[24,25] However, they contrast with some studies, which found high specificity but low sensitivity.[26-29] The difference with our study could be in the definition of periodontitis cases.

These studies adopted the definition of periodontitis cases according to the CDC-AAP 31. While our study used the definition from the new Chicago classification of periodontal diseases.[31]

Ideally, screening tools should have high sensitivity and specificity.[32] However, sensitivity and specificity sometimes have an inverse relationship. To select appropriate screening tools based on sensitivity and specificity, the severity of the disease and treatments should be taken into account. A test with high sensitivity results in a low false-negative rate, while a high specificity results in a low false-positive rate.[33] In periodontitis, a disease with high prevalence and low morbidity, many people have the disease without knowing it. predictable treatment outcomes can be expected, especially in the early stages, and there are few treatment-related adverse events.[32]

Therefore, periodontitis surveillance should identify and recruit as many high-risk participants as possible and then persuade them to undergo a standard periodontal examination and follow appropriate treatment. Thus, according to Lertpimonchai et al,[32] a high-sensitivity self-assessment screening tool is preferable.

The calculation of predictive values gave a PPV of 41.18% indicating that among the people who tested positive, 41.18% are really sick and a NPV of 99.32% meaning that, among the people who tested negative, 99.32% are not sick. The relatively low percentage of the PPV could be explained by the age of the majority of patients in our sample. More than half (59.4%) were under 40 years old. However, age has a huge impact on the calculation of the PESS score. Indeed, in the PESS, age is divided into 3 groups (those under 40, those between 40 and 54 years inclusive and those over 55). These age groups have respectively a score of 0, 2, 4. Therefore, a patient already in the last age group has 4 points from the outset. It is therefore sufficient that there is a single aggravating factor such as tobacco or the presence of an anomaly for the score to be equal to 5, thus giving severe periodontitis.

This was also observed in the studies by Carra et al.16 and Hassine et al.,[22] which involved an older population. The age factor may have contributed to a higher number of severe periodontitis cases detected in their studies using a PESS (score ≥5).

The statistically significant association between PESS (scores ≥5) and clinical diagnosis underscores the utility of this tool as a preliminary screening method. Our findings are consistent with studies conducted in the United States and Europe, such as those by Eke et al.,[10] Saka Herrán et al.,[29] and Carra et al.[16] However, discrepancies with studies conducted in Asia, including Lertpimonchai et al.,[32] warrant further investigation. These variations may stem from differences in population characteristics (age and gender) and the instruments used for self-assessment of periodontal status.

The findings of this study underscore the potential of the PESS score as a cost-effective and easily implementable tool for early risk identification in resource-limited settings. Incorporating such tools into community-based awareness and screening programs could significantly improve the early detection of severe periodontitis. However, the low PPV highlights the importance of follow-up clinical examinations to confirm presumptive diagnoses.

It is important to note that the PESS, as originally developed by Carra et al., does not include a question specifically related to self-reported gingival bleeding. Although gingival bleeding is a common early symptom of periodontal disease and often used in epidemiological surveys, the developers of the PESS prioritized items with a stronger association with severe periodontitis in the general population. The absence of a bleeding-related item may reduce the sensitivity of the tool for detecting early or moderate periodontal conditions. This limitation should be considered when interpreting the screening performance of the PESS, particularly in populations with high prevalence of gingivitis or early-stage periodontitis.

Future efforts should focus on improving public awareness of periodontal health and training healthcare providers to better communicate the significance of symptoms like gingival bleeding. Additionally, further research is needed to refine the PESS score for enhanced accuracy in diverses populations.

5. Conclusion

The study demonstrated that the questionnaire based on the Periodontal Screening and Evaluation System is an effective tool for detecting severe periodontitis in Côte d'Ivoire. Its high sensitivity, specificity, and predictive values validate its reliability, aligning with findings from similar studies conducted in the United States and France. However, the moderate agreement with clinical diagnoses highlights areas for improvement, particularly in refining its positive predictive value. Future research should focus on optimizing the scoring system by incorporating adjustments for age and other demographic factors.

6. Conflict of Interest

No potential conflict of interest relevant to this article was reported.

7. Source of Funding

None.

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