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# EVALUATION OF A QUESTIONNAIRE-BASED DIABETES SCREENING CONCEPT IN THE SOUTH INDIAN POPULATION WITH STAGE III OR IV PERIODONTITIS: A PRACTICE-BASED STUDY

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**ABSTRACT**
**Background:** This pragmatic retrospective study evaluated a diabetes mellitus (DM) screening method using the Finnish diabetic Risk Score questionnaire in patients with Stage III or IV periodontitis (FINDRISC).
**Methods:** We enrolled subjects with Stage III or IV periodontitis who underwent FINDRISC screening at a private dental college in India. People with positive FINDRISC scores (≥12, FINDRISC+) were selected for diabetological investigation. Numerous demographic and periodontal findings from the patients' documents were verified and analysed.
**Results:** A total of 170 subjects (50.15 ± 11.49 years) were included. In diabetes mellitus examination, 23.4% (n = 44) subjects were FINDRISC+, as well as all individuals presently diagnosed with Diabetes mellitus (21 of 21). 63.2% (12 of 19, or 7.6% of the entire cohort) of the remaining FINDRISC+ participants had an HbA1c ≥5.7%, and 82.6% (19 of 23) went to see their medical practitioner. Accordingly, 75% of the FINDRISC+ participants had diabetes mellitus, which included people with pre-existing diabetes, and were diabetologically prominent (HbA1c ≥ 5.7%). Among those who were diabetologically inconspicuous, those with a record of undiagnosed diabetes mellitus had higher mean ages, more missing teeth, advanced periodontitis stages (more Stage IV), and more frequently teeth with suppuration (P <0.01).
**Conclusion:** The FINDRISC questionnaire can be suggested in a dental practice context and is suitable for patients with Stage III or IV periodontitis.

**KEYWORDS:** Diabetes mellitus, Periodontitis, Finnish Diabetes Risk Score questionnaire.

## INTRODUCTION

Diabetes mellitus (DM) and periodontitis influence each other through shared inflammatory pathways. Dental clinics are therefore a sensible place to screen for undiagnosed (pre)diabetes. FINDRISC is a validated 8-item, non-invasive tool, but three gaps remain: Its fixed cut-off (≥12) was derived in European populations, and its accuracy in South Indian periodontitis patients is unverified. It ignores periodontal findings (stage, tooth loss, suppuration), which our earlier study linked to dysglycaemia. Paper administration is slow, depends on staff time, and is language-limited.

Our previous practice-based study (n = 170) had two weaknesses that this protocol corrects: only FINDRISC-positive patients received HbA1c testing (verification bias), and only about 12 undiagnosed cases were identified, which is too few for any predictive modelling.

This study therefore tests (a) whether a machine-learning model that combines FINDRISC items with periodontal variables outperforms FINDRISC alone, and (b) whether a chatbot can administer FINDRISC as reliably as the standard method while being acceptable to patients.

Diabetes mellitus and periodontitis have a reciprocal association that is frequently discussed and appears to be evident. [1]. The extent of periodontitis and responses to periodontal therapy are impacted by diabetes mellitus due to altered glycemic load [1]. Hence, the idea of examining for unidentified diabetes mellitus in subjects suffering from periodontal diseases in dental settings is frequently stated [1].

Overall, diabetes mellitus evaluation in dental settings is likely to screen for previously undisclosed (pre-)diabetes mellitus. Two different methods exist: invasive blood collection in the dental office for HbA1c measurement, and a non-invasive questionnaire-based examination accompanied by the assignment of susceptible patients to general physicians/diabetologists [2]

The claiming of evaluation process for Diabetes Mellitus in a dental setting appears judicious as it is economical; patients are more ready to take part in non-invasive means compared to invasive approaches [3]

Finnish Diabetes Risk Score (FINDRISC) questionnaire was created by Lindström and Tuomilehto to detect the probability of a person developing type 2 diabetes. It is an easy, rapid, cost-effective, non-intrusive, and dependable tool. It can assess the risk of a person developing diabetes within the next 10 years [4]. Several studies

have validated the FINDRISC questionnaire as an effective diabetes screening tool. A cross-sectional study in India in 2016 on 1,530 adults in Srinagar confirmed that FINDRISC can detect undiagnosed type 2 diabetes and estimate 10-year diabetes risk [4]. Among 1,537 first-degree relatives in the Iranian population of type 2 diabetics, those in the highest FINDRISC quartile were 21.7 times more likely to develop diabetes over 1.7 years than those in the lowest quartile [7].

A practice-based retrospective study in German patients with Stage III/IV periodontitis found a significant link between advanced periodontitis and elevated HbA1c (≥ 5.7%) using FINDRISC screening [6]. Thus a firm relationship among the Finnish Diabetes Risk Score (FINDRISC) and possibility of diabetes is proclaimed in European community where but can't accordingly be general to other populations [5]. The assessment of an efficacy of screening model in Indian community for Diabetes Mellitus and pre-diabetes mellitus according to patients' grading applying FINDRISC score may be practically important. Such a clinical assessment tool should be convenient and adequate for the clinicians and patients with periodontitis in routine practise.

The existing practice-based retrospective study will be leaded by screening for Undiagnosed Diabetes utilizing the FINDRISC Questionnaire in Indian Community with Advanced Periodontitis.

**2. Aim**

- To assess the efficacy of the FINDRISC questionnaire in identifying undiagnosed diabetes risk among Indian patients with severe periodontitis (Stage III/IV).

**3. Objectives**

- To determine the correlation between FINDRISC scores and random blood sugar (RBS).
- To explore the association between stage III and IV periodontitis and diabetes risk categories based on FINDRISC.

## 2. MATERIAL AND METHODS

### 2.1 Study Design.

The present study is a practice-based, cross-sectional study that was conducted at a dental college located in Dakshin Kannada, India, in an outpatient department setting for a duration of 4-6 months among the Indian community aged 30–65 years with Stage III/IV periodontitis.

The present study has attained ethical approval from the institutional ethics committee, and the study was in compliance with the 2013 revision of the 1975 Helsinki Declaration. All candidates were abreast orally and on paper regarding the study and signed agreement for partaking was taken. Privacy was maintained.

The estimated sample size is a target of 171 patients based on expected undiagnosed diabetes prevalence of 20% in periodontal patients. The selection criteria is as mentioned below [6].

### 2.2 Patients

Individuals undergoing periodontal examinations and treatments at the private dental college in Mangalore, India, between June 2025 and September 30, 2025, were taken into consideration. Only adults aged 30–65 years, diagnosed with Stage III or IV periodontitis (2017 classification), not previously diagnosed with diabetes, and those who have provided informed consent were included for the study. Individuals with known diabetes mellitus, systemic diseases that affect the periodontium, pregnant or lactating women and patients on steroids or immunosuppressants were excluded from the study.

Qualified patients will be enlisted by convenience sampling from the dental outpatient department. The social characteristics of the candidates will be documented. Periodontal assessment will be carried out based on classification of periodontitis 2017 based on stages defined by severity (according to the level of interdental clinical attachment loss, radiographic bone loss, and tooth loss), complexity, and extent and distribution [9].

### 2.3 Patient General Data

A number of general statistics were gathered from the medical records of the patients. Records were kept of the individual's age, sex, and smoking status (smoker: currently smoking, non-smoker: currently not smoking) Individuals' most recent HbA1c level at the time diabetes mellitus screening was conducted was recorded, as was whether they currently had diabetes mellitus. It should be determined if a patient had an initial (untreated) or refractory form of periodontitis according to the existence of a prior periodontal therapy.

### 2.4 Diabetes Mellitus screening and diabetological examination.

Based on a Finnish preventative trial, the FINDRISC questionnaire was utilized for DM screening [1]. This structured survey uses eight distinct questions about the most prevalent risk factors for DM to calculate the likelihood of getting type 2 DM within the next ten years. Each response had a point value that added up to a cumulative score ranging from 0 (no risk) to 26 (high risk). This study group's cut-off value for the average rating for every individual was set at 12 points after a prior pilot research. Every patient was assigned to a general practitioner. A standardized physician's note showing an elevated risk of diabetes mellitus was utilized for randomization. Reports on the corresponding laboratory results were obtained from general practitioners (HbA1c value). Each individual who saw the general practitioner had their reports taken from their medical records. An HbA1c level of 5.7% was considered a noteworthy result by the International Experts Committee [10].

### 2.5 Oral Examination

The results of the oral examination were evaluated retroactively from the patient records. Throughout the examination period, a single skilled dentist (GS) examined each patient's periodontal health. It was noted how many teeth (M-T) were missing. The entire state of the periodontal tissues was evaluated. Probing depth (PD),

clinical attachment loss (AL), and bleeding on probing (BOP) were measured using a periodontal probe in a six-point manner. The aforementioned oral findings were evaluated from the patients' records as part of the retrospective assessment: the identification of at least one tooth with suppuration on periodontal probing, the total number of teeth with PD >5 mm, the bleeding on probing (in percentage), and the diagnosis of periodontitis (stage and grade).

**2.6 Statistical Analysis**

Descriptive statistics to calculate the mean, standard deviation and frequency. Chi-square test to analyze associations between risk groups and random blood sugar. Spearman Correlation will be used to find the relation between FINDRISC and HBA1c and periodontal parameters. P< 0.05 will be considered statistically significant and Significance at P < 0.05.

RESULTS

**3.1 Patients**

Of the 254 individuals who attended the private dental practice's periodontal consultation during the observational period, 232 met the inclusion criteria. The retrospective analysis comprised 170 patients who gave signed informed consent for the present investigation (mean age 52.65 ± 11.49 years, 57.5% male). Table 1 shows that 11.7% (n = 19) of these subjects had been diagnosed with DM at the time of DM screening.

Table 1: Patient sociodemographic data of the total cohort (n=170)

| Parameter | Results |
|---|---|
| Age (mean value SD) | 52.65± 11.49 |
| Sex (n (%) Female | 76 (42.5%) |
| Male | 103 (57.5%) |
| Smoking Habit | |
| Smoker | 30 (16.8%) |
| Non- smoker | 149 (83.2%) |
| Known Diabetes Mellitus | |
| Yes | 21 (11.5%) |
| HbA1C | 6.37 ± 0.65 |
| | |

Table2:Results of the FINDRISC questionnaire and allocation to the general practitioner

| Parameters | Results |
|---|---|
| FINDRISC score (mv ± SD) Total (n = 170) | 9.13±4.37 |
| FINDRISC+ | 27.3% (52/170) |
| Known diabetes with FINDRISC+ | |
| Visiting general practitioner n (% out of 25 FINDRISC+ without known DM) | 82.6% (20/23) |
| **HbA1c≥5.7%atgeneral practitioner** | |
| Number of patients | 65% 915/19) |
| Mean HbA1c (mv ± SD) | 6.3±0.49 |
| Patients with HbA1c ≥5.7% out of FINDRISC+ (including known DM) | 75% (35/45) |
| Patients with HbA1c ≥5.7% out of total cohort(including known DM) | 18.4% (34/180) |
| Patients with previously unknown DM withHbA1c ≥5.7% | 12% (12/159) |
| Patients with previously unknown DM withHbA1c ≥6.5% | |

Table 3: Differences in general and oral health findings based on diabetological findings (HbA1c)

| Parameters | Previously Unknown Diabetes (n=12) | HbA1c<5.7% (n=146) | P value |
|---|---|---|---|
| Age | 59.50±10.50 | 49.03±9.80 | <0.01 |
| Sex, Male | 63.2% | 53.3% | 0.50 |
| Smoking | 8.1% | 15.4% | 0.59 |
| No. of absent teeth | 9.23±3.08 | 4.39±4.25 | <0.01 |
| Earlier periodontal therapy | 55.3% | 35.7% | 0.21 |
| Periodontitis stage<br>I<br>II<br>III<br>IV | <br>0<br>0<br>8%<br>89.2% | <br>0<br>0<br>49.4%<br>39.6% | <br><br><br>,0.01 |
| Periodontitis Grade<br>A<br>B<br>C | <br>0<br>39.3%<br>56.3% | <br>0<br>58.1%<br>31.9% | <br><br>0.9 |
| No. of teeth with probing depth > 5mm | 6.03±6.09 | 5.01±5.19 | 0.50 |
| BOP (in %) | 19.08±9.50 | 16.23±9.50 | 0.08 |
| Incidence of one pocket with suppuration | 55.3% | 17.2% | <0.01 |

**3.2 DM screening and diabetological findings**

Using a cut-off of 12 points, almost 25% of the patients (n = 44) were classified as FINDRISC+. As a result, every patient with DM who was currently recognized had FINDRISC+ (21 of 21, 100%). The majority of individuals (82.6%) sought clarification from their medical practitioner for diabetologically significant findings (HbA1c ≥5.7%). The other 23 individuals were sent to their general practitioner. FINDRISC-negative (FINDRISC-) individuals made up 63.2% of these 19 patients, while FINDRISC-positive (FINDRISC+) individuals had an overall score of ≥12. Each individual was assigned to a general practitioner. A predetermined doctor's letter showing an elevated risk of diabetes mellitus was utilized for randomization. Reports on the corresponding test results were obtained from general practitioners (HbA1c). Every patient who saw the general practitioner had their results taken from their medical records. An HbA1c ≥5.7% was considered a noteworthy finding by the International Expert Committee.

**3.3 Oral Examination**

A number of variations were found when diabetologically conspicuous patients (HbA1c ≥5.7%) and inconspicuous individuals (HbA1c <5.7%) were compared. Compared to the diabetologically inconspicuous subjects, individuals with unidentified DM had a greater average age (P <0.01), greater missing teeth (P <0.01), more Stage IV periodontitis (P <0.01), and were more likely to have lost at least one tooth with suppuration ( P < 0.01).

**4. DISCUSSION**

**4.1 Summary of the main results**

Twelve patients (7.6% of the entire cohort, excluding known DM) with unidentified (pre-)DM were found by the use of the FINDRISC questionnaire for detecting patients with Stage III and IV periodontitis. Every individual with DM was FINDRISC+. Diabetes was evident in three-quarters of FINDRISC+ individuals (HbA1c ≥5.7%).

**4.2 Comparison to the Existing Literature**

Number of people with diabetes is 589 million adults with an age group of 29 years to 70 years and this represents 1 in 9 adults worldwide have diabetes. International Diabetes Federation have reported that about 10.5% of the Indian adult population has diabetes [11]. In India, it's estimated that more than 50% of people with diabetes are unaware of their condition, leading to potential complications, while the exact number for 2024 is not specified [12]. In the present study, known DM patients were excluded from the current investigation; the percentage of unknown (pre-)DM patients was 7.6%. This incidence is similar to the Indian expected count of unreported instances, suggesting that individuals with Stage III and IV periodontitis have accumulated these cases, as the

prior pilot study had already assumed [8]. The total number of unidentified (pre-)DM was similar to the 8% observed in this earlier pilot investigation [1]. There is a wide range of data about the testing for unidentified (pre-)DM in dental practices. In India, screening identifies a high rate of undiagnosed diabetes; on research of persons aged 40 and older found an age-standardized prevalence of 6.0% [13].In Indian dental settings, testing for undiagnosed diabetes revealed a high prevalence; multiple studies have found the prevalence of undiagnosed diabetes and prediabetes ranges from approximately 11% to 35%. Testing for unidentified diabetes in the dental setting in India is practicable, with point-of-care (PoC) HbA1c tests displaying potential in identifying patients with prediabetes and Type 2 Diabetes (T2D). About 23% of patients were identified with type 2 diabetes mellitus using HbA1c as a reliable tool for screening[13]. These findings imply that a pure questionnaire-based screening does not identify a number of noticeable cases.

The present research took into account a numeral of parameters in an effort to lower the proportion of false-positive results from DM screening in dentistry practices. 75% of those screened were accurately recognized thanks to the emphasis on the specific screening of individuals with severe periodontitis (Stages III and IV). Thirty-three out of forty-four FINDRISC+ patients had a HbA1c of ≥5.7%; four of them were uncertain since they did not see a healthcare practitioner which produced the anticipated benefit over the earlier pilot research. There was no correlation between DM and periodontal markers in one study that looked at patients with mild periodontitis. Yet, it is appropriate to examine people who have periodontal disease. A study aimed to investigate the link between glycated hemoglobin and diabetic complications with chronic periodontitis showed two to four fold increase of retinopathy and neuropathy in subjects having periodontal inflamed surface area [14]. There is a reciprocal, inflammation-driven link between diabetes mellitus (DM) and periodontitis. According to epidemiological statistics from NHANES (2009–2010), the rate of developing of diabetes is almost twice as high in people with periodontitis (12.5%) as it is in people without it (6.3%) [15]. Individuals with diabetes are around threefold more likely to get periodontitis. With the production of cytokines such IL-1β, IL-6, TNF-α, prostaglandin E2, MMPs, IL-12, and IL-18, periodontitis is a chronic plaque-induced inflammatory condition that causes bone loss and connective tissue degradation [16]. Glycemic regulation may be hampered and insulin resistance exacerbated by this systemic inflammation. Serum IL-6 and CRP levels tend to rise in type 2 diabetes (T2DM), and the risk of acquiring T2DM is increased by higher TNF-α levels tends to increase the odds of developing Diabetes Mellitus [17]. Advanced glycation end products (AGEs), which are produced in response to hyperglycemia, trigger RAGE signaling, increasing TNF-α, IL-1β, IL-6, and reactive oxygen species. By weakening the host's defenses, these processes can encourage the loss of alveolar bone and periodontal ligaments. Infections linked to periodontitis exacerbate hyperglycemia by increasing insulin resistance [18].

In individuals who have periodontitis who do not have type 2 diabetes, non-surgical periodontal therapy reduces HbA1c by around 0.16–0.17% in 3–6 months. The significance of integrated management of periodontal and metabolic health is shown by years of cross-sectional studies that consistently show poorer periodontal health in T2DM patients compared to non-diabetic controls [19]. A broad proposal for questionnaire-based DM screening in patients with severe periodontitis (Stage III/IV) may be made after taking into account the results of the present research in light of the body of existing literature.

A number of general and periodontitis-related factors may be taken into consideration in order to better implement the idea of DM detection in the field of dentistry. Diabetologically noticeable outcomes were shown to be connected with higher mean age [20]. Age (≥45 years) was revealed to be a potential predictor for DM in an investigation which employed DM screening [21]. Age-dependent alterations in immune function may be linked to the increasing the level of periodontitis. Aging also increases risk for developing diabetes mellitus[22]. As a result, the applied FINDRISC questionnaire also includes an issue about age (see supplementary Table 1). One significant common risk factor of diabetes mellitus and periodontitis is age. Additionally, it was discovered that those with diabetes who were noticeable had a higher frequency of suppuration. After periodontal probing, suppuration could indicate severe periodontal inflammation, particularly endo-periodontal lesions or periodontal abscesses[23]. According to a large cross-sectional investigation, periodontal abscess may be a clinical indicator of undetected diabetes mellitus in older adults[23].

**4.3 Strength and Limitations**

According to the existing classification, the present research is the first practice-based investigation to assess a questionnaire-based DM screening approach among Indian population who have Stage III/IV periodontitis [23]. The majority of the 170 individuals who had been recruited—who got assigned based on an approved doctor's letter—went to their general practitioner for a diabetological examination. Although the German version of the FINDRISC survey was found to be a reliable instrument for identifying undiscovered DM in a German population, the applicable version was not assessed for reliability in the present investigation [1]. The study did, however, have a number of shortcomings. There is a chance of bias in the retrospective design and the postal correspondence used to reach patients, particularly as most compliant individuals may respond to the correspondence and give their informed consent. Only one private dentist office in a single dental setting area participated in the research. Even if the testing and data gathering were conducted by a single, skilled dentist, the study's restricted to a single center raises the possibility of bias because it failed to account for regional variations in India. A multicentric design in several districts and other states is required for the results to be generalizable. Furthermore, there were only 12 individuals with a previously unidentified DM, which is unquestionably insufficient for a risk predictor study. Hence, Table 3's data are only considered preliminary and cannot be used to draw firm conclusions.

Additionally, the frequency of (pre-)DM was almost in line with the Indian population, which limited the total amount of individuals with diabetes. All things considered, the lack of a power calculation ought to be noted as a possible drawback. The HbA1c cut-off of 5.7% is in line with the guidelines that are currently provided [11]. However, the FINDRISC+ patients who saw the general practitioner had an average HbA1c of 6.31±0.59%, which supports pre-DM in these patients. Thus, as previously mentioned in the pilot study, the low cut-off for FINDRISC+ (12 points) seems to be adequate to identify (pre-DM} with a high sensitivity. The main drawback in this case is that only those individuals who were FINDRISC+ were assigned and had their HbA1c levels checked. Even though the FINDRISC questionnaire has been verified, the present study's assessment of sensitivity and specificity is predicated on the speculative and unproven assumption that all FINDRISC patients are diabetologically inconspicuous. Therefore, FINDRISC patients ought to get a diabetological examination, and the present results and recommendations require additional confirmation in large-scale prospective trials.

## 5. CONCLUSION

Individuals with Stage III/IV periodontitis were able to identify previously unidentified (pre-Diabetes Mellitus) with the use of the FINDRISC questionnaire, which is advised in the dental office for such individuals.


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None


## AUTHORS CONTRIBUTION

Anette Renisha Dsouza has contributed to the collection of the patient data; Akshatha Shetty has contributed to the manuscript preparation and literature review conceptualization.

## CONFLICT OF INTEREST

The authors have no conflict of interest.


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