

THE CORRELATION BETWEEN MENTAL STATE AND ORAL HEALTH SELF-EFFICACY OF PERIODONTITIS PATIENTS AND THE ESTABLISHMENT OF A LINE GRAPH PREDICTION MODEL

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ABSTRACT

Objective: To explore the correlation between mental state and oral health self-efficacy of patients with chronic periodontitis, and to establish a self-efficacy line graph prediction model.

Methods: The convenience sampling method was used to select 284 patients with chronic periodontitis who were treated from January 2021 to December 2024. All patients were divided into a modeling group (n=227) and a validation group (n=57), in an 8:2 ratio. General information about all subjects was collected. The Dental Anxiety Scale (DAS), Dental Fear Scale (DFS), and Self-Efficacy Scale for Self-Care (SESS) were used to score the subjects. A Pearson correlation analysis was conducted to investigate the correlation between the subjects' DAS and DFS scores

and their oral health self-efficacy. Multivariate logistic regression was utilized to analyze the influencing factors of oral health self-efficacy, and a prediction model was constructed based on the analysis.

Results: The average scores of DAS, DFS, and SESS in the modeling group were (15.80 ± 2.22), (49.39 ± 6.54), and (53.83 ± 3.53) points, respectively. The total scores and the scores in each dimension of DAS, DFS, and SESS were negatively correlated ($P < 0.05$). The modeling group was divided into a low oral health self-efficacy group ($n=149$) and a high oral health self-efficacy group ($n=78$) based on the total score of the SESS. Multivariate logistic regression analysis indicated that education level, monthly income, dental anxiety, and dental phobia were key factors influencing the oral health self-efficacy of patients with chronic periodontitis ($P < 0.05$). The AUC of the prediction model was 0.793 [95% CI (0.711, 0.821)], indicating good predictive performance.

Conclusions: The oral health self-efficacy of the patients with chronic periodontitis was associated with their education level, monthly income, dental anxiety, and dental phobia. Dental practitioners should pay attention to evaluating the individual characteristics and psychological changes of the patients to improve their oral health self-efficacy.

KEYWORDS

dental anxiety, periodontitis, oral health, self-efficacy, line graph prediction model

INTRODUCTION

Periodontitis is a disease caused by plaque buildup, smoking, eating habits, genetic factors, endocrine disorders, decreased immune function, diabetes, and other factors. The prevalence of periodontitis is 45% to 50% worldwide, with chronic periodontitis being the most common form^[1]. Chronic periodontitis occurs due to the destruction of periodontal tissues, which includes gums, alveolar bone, and the periodontal membrane, by microbial flora and pro-inflammatory factors^[2,3]. This destruction results in tooth loosening and loss. Dental anxiety and

dental fear represent negative emotional states, including worry, anxiety, and aversion, that patients may experience during dental treatment. Studies have shown that the prevalence of dental anxiety among patients treated in dental clinics was 41.44%, which not only affected patients' oral health behavior, but also led to their avoidance or resistance to dental treatment, further deteriorating oral health^[4-6]. Moreover, dental anxiety and fear can cause patients to neglect oral hygiene and decrease the frequency of oral treatments, thereby impacting the treatment outcomes for periodontitis^[7].

Patients' oral health self-efficacy is one of the important factors influencing oral health. Self-efficacy pertains to an individual's confidence and capability to perform a task or behavior, and oral health self-efficacy plays a crucial role in oral health behavior^[8]. Enhancing patients' oral health self-efficacy is beneficial for standardizing their oral health behaviors and fundamentally preventing periodontitis. The purpose of this study was to investigate the correlation between psychological state and oral health self-efficacy in patients with chronic periodontitis, construct a predictive model, and thereby provide a scientific basis for dental practitioners to develop targeted psychological intervention measures. The aim is to enhance patients' oral health self-efficacy and subsequently improve their oral health status.

MATERIAL AND METHODS

We declared that we were in accordance with the ethical standards of the responsible committee on human experimentation of Shanxi Bethune Hospital and with the Helsinki Declaration of 1975, as revised in 2000.

Clinical data and grouping

This study was a cross-sectional one, involving a total of 15 independent variables. The sample size should be 5 to 10 times that of the independent

variables. Considering potential interference from invalid questionnaires or other factors, the sample size should be increased by 10% to 20%^[9]. The calculated minimum sample size should not be less than $N=15 \times 10 \times (1+10\%) = 165$ cases. The final sample size for this study was 284 cases. A convenient sampling method was used to select 284 patients with chronic periodontitis as the research subjects, who visited Shanxi Bethune Hospital from January 2021 to December 2024. The subjects were divided into a modeling group ($n=227$) and a validation group ($n=57$), in an 8:2 ratio. Inclusion criteria: (1) Meeting the diagnostic criteria for chronic periodontitis as defined in the 4th edition of "Periodontology"^[10]; (2) Informed consent for participation in this study; (3) Age ≥ 18 years old. Exclusion criteria: (1) Any mental illness or cognitive impairment; (2) Recent periodontal treatment within the last 6 months; (3) Severe hypertension, diabetes, or other major malignant diseases.

General information questionnaire

A self-designed general information questionnaire^[4] was utilized to gather data on gender, age, education level, monthly income, tooth brushing frequency, tooth loss, and the severity of periodontitis among all subjects.

Modified Dental Anxiety Scale

The Modified Dental Anxiety Scale (MDAS) was an improved and optimized version of the Dental Anxiety Scale (DAS) developed by Humphris et al.^[11], designed to assess patients' anxiety during dental visits. The scale comprises four items, utilizing a Likert 5-point scoring system where 1 represents "not anxious at all", 2 "somewhat anxious", 3 "average", 4 "anxious", and 5 "very anxious". The total score ranges from 4 to 20. When the MDAS score is ≥ 13 , it is considered indicative of dental anxiety, with higher scores indicating more severe levels of anxiety.

Dental Fear Scale

The Dental Fear Scale (DFS) was developed by Kleinknecht et al.^[12] to assess patients' fear of dental visits. The scale comprises 20 items, encompassing three dimensions: treatment avoidance and anticipated anxiety, somatic anxiety, and treatment stimulation anxiety. It employs a Likert 5-point rating scale with a total score ranging from 20 to 100, where higher scores signify a greater severity of dental fear. The Cronbach's α coefficient for this scale is 0.94, and the retest reliability coefficient is 0.85, indicating good validity and reliability.

Self-efficacy Scale for Self-care

The Self-efficacy Scale for Self-care (SESS) was developed by Kakudate et al.^[13] to evaluate self-efficacy in oral health care for patients with chronic periodontal disease. SESS comprises 15 items within three dimensions: regular visits, proper brushing, and balanced diet, utilizing a Likert 5-point scoring system. The total score ranges from 15 to 75, with higher scores indicating better oral self-efficacy. The total score of SESS can be categorized into low and high levels; a total score ≤ 60 is classified as low oral self-efficacy, while a total score > 60 is classified as high oral self-efficacy. The Cronbach's α coefficient for this scale is 0.879, and the retest reliability coefficient is 0.922, indicating good validity and reliability.

Data collection method

This study primarily gathered data via questionnaires. Once the research objectives were clarified, all questionnaire survey personnel underwent unified training. Before administering the questionnaire, communication with subjects was conducted to explain the purpose of the survey, obtain informed consent, and then the survey was conducted. The questionnaire survey was conducted anonymously, without involving invasive procedures, ensuring ethical compliance and privacy protection. A total of 320 questionnaires were distributed in this survey. To ensure the authenticity and accuracy of the data, all questionnaires

were collected within the prescribed time frame. A total of 284 valid questionnaires were collected, and the recovery rate for valid questionnaires was 88.75%.

Statistical analysis

The SPSS 26.0 software package (SPSS Inc., Chicago, IL, USA) was used for the statistical analysis. For measurement data with a normal distribution, the mean $\pm$ standard deviation ($\bar{x} \pm s$) was selected to describe the distribution characteristics, and *t*-test or ANOVA was used for inter-group difference comparison. For measurement data that did not conform to a normal distribution, the median and quartiles [M (P25, P75)] were used to describe the differences between groups, and Wilcoxon rank sum test was employed to compare these differences. Enumeration data was represented using the number of cases (%), indicating the distribution, and the differences between groups were compared using χ^2 test. The relationship between DAS, DFS, and SESS in subjects was analyzed using Pearson correlation coefficient. Multivariate logistic regression analysis was employed to examine the factors influencing self-efficacy. The level of significance was set at 5%. The R4.0.4 software was utilized to construct a line graph prediction model for self-efficacy in patients with chronic periodontitis. To verify the efficacy of the model, the area under the Receiver Operating Characteristic (ROC) curve was used to evaluate the model's discrimination, and the calibration curve was utilized to assess the model's consistency.

RESULTS

General information of all subjects

There was no significant difference in the baseline data between the modeling group and the validation group ($P > 0.05$; *Table 1*).

Table 1 General information

Items		Modeling group (n=227)	Validation group (n=57)	χ^2 /t	P	
Gender	male	115	30	0.071	0.790	
	[n (%)] female	112	27			
Age	≤40	34	15	5.661	0.059	
	40~60	190	40			
	[n (%)] > 60	3	2			
Education level	Junior college and below	55	18	1.964	0.375	
	Undergraduate	71	19			
	[n (%)] Graduate and above	101	20			
Monthly income	≤CNY 3000	80	17	0.804	0.669	
	CNY 3000~6000	72	18			
	[n (%)] >CNY 6000	75	22			
Brushing frequency	≥1 per day	76	17	0.289	0.865	
	1 per day to	74	20			
	1 per 3 days					
	[n (%)] < 1 per 3 days	77	20			
Tooth loss	loss	117	30	0.022	0.883	
	[n (%)] no loss	110	27			
severity of periodontitis	mild	54	17	1.814	0.404	
	moderate	122	25			
	[n (%)] severe	51	15			
Dental anxiety($\bar{x} \pm s$, points)		15.80±2.22	15.37±2.17	0.313	0.190	
Dental phobia($\bar{x} \pm s$, points)		49.39±6.54	50.37±5.39	1.045	0.297	

DAS and DFS scores in modeling group

The total scores for DAS and DFS, treatment avoidance, expected anxiety, somatic anxiety, and treatment stimulation anxiety of 227 subjects in the modeling group were analyzed, with detailed scores presented in Table 2. The higher the score, the more severe the degree of dental anxiety and fear.

Table 2 DAS and DFS scores in modeling group ($\bar{x} \pm s$, points)

Items	Total	Average
DAS	3587	15.80±2.22
DFS	11211	49.39±6.54
Treatment avoidance and expected anxiety	4295	18.92±6.00
Somatic anxiety	2869	12.64±4.57
Treatment stimulation anxiety	4047	17.83±7.37

SESS scores in modeling group

The scoring of regular visits, correct brushing techniques, and balanced diets for the subjects in the modeling group was analyzed, with detailed scores presented in Table 3. The total score of SESS was less than 60, indicating that the subjects in the modeling group had a low level of oral self-efficacy.

Table 3 SESS scores in modeling group ($\bar{x} \pm s$, points)

Items	Total	Average
SESS	12219	53.83±3.53
Regular visits	3809	16.78±2.88
Correct brushing techniques	4370	19.25±3.96
Balanced diets	4040	17.80±3.47

Correlation analysis

The DAS and DFS scores exhibited a negative correlation with the total score and the scores of each dimension of SESS ($P<0.05$), suggesting that as dental anxiety and fear increase in the subjects, the level of self-efficacy in oral health care decreases, as reflected in Table 4.

Table 4 Correlation analysis in the modeling group (r)

Items	Total scores of SESS	Regular visits	Correct brushing	Balanced diets
Total scores of DAS	-0.245	-0.117	-0.139	-0.145
Total scores of DFS	-0.227	-0.121	-0.158	-0.136

Single factor analysis of oral health self-efficacy

The subjects in the modeling group were divided into two groups based on their SESS scores: a low oral health self-efficacy group ($n=149$) and a high oral health self-efficacy group ($n=78$). There was no significant difference in gender, age, or severity of periodontitis between the two groups ($P>0.05$). The differences between the two groups in terms of education level, monthly income, tooth brushing frequency, tooth loss, dental anxiety, and dental phobia were statistically significant ($P<0.05$), indicating that oral health self-efficacy was influenced by these factors, as illustrated in Table 5.

Multifactorial analysis of oral health self-efficacy

In the modeling group, oral health self-efficacy was considered the dependent variable, with education level, monthly income, brushing frequency, tooth loss, dental anxiety, and dental phobia serving as the independent variables. The evaluation was shown in Table 6. Multivariate logistic regression analysis indicated that education level, monthly income, dental anxiety, and dental phobia were key factors influencing oral health self-efficacy among the subjects ($P<0.05$), as presented in Table 7.

Table 5 Single factor analysis of oral health self-efficacy

Items		Low self-efficacy (n=149)	High self-efficacy (n=78)	χ^2 /t	P
Gender	male	78	37	0.317	0.573
	female	71	41		
Age	≤40	21	13	1.799	0.407
	40~60	125	65		
	>60	3	0		
Education level	Junior college and below	43	12	7.988	0.018
	Undergraduate	49	22		
	Graduate and above	57	44		
Monthly income	≤CNY 3000	65	15	27.576	<0.001
	CNY 3000~6000	52	20		
	>CNY 6000	32	43		
Brushing frequency	≥1 per day	37	39	21.871	<0.001
	1 per day to 1 per 3 days	47	27		
	<1 per 3 days	65	12		
Tooth loss	loss	86	31	6.623	0.010
	no loss	63	47		
severity of periodontitis	mild	31	23	5.480	0.065
	moderate	78	44		
	severe	40	11		
Dental anxiety($\bar{x} \pm s$, points)		17.72±2.15	13.93±2.34	12.233	<0.001
Dental phobia($\bar{x} \pm s$, points)		53.93±4.40	46.64±6.83	9.737	<0.001

Table 6 Variable assignments

Variables	Assignment methods
Education level	0=Junior college and below
	1=Undergraduate
	2=Graduate and above
Monthly income	0= $\leq$ CNY 3000
	1=CNY 3000~6000
	2= $>$ CNY 6000
Brushing frequency	0= $\geq$ 1per a day
	1=1per a day to 1 per 3 days
	2= $<$ 1 per 3 days
Tooth loss	1=loss; 2=no loss
Dental anxiety	original values
Dental phobia	original values

Table 7 Multivariate logistic regression analysis of oral health self-efficacy

Items	β	SE	Wald χ^2	<i>P</i>	OR	95%CI
Education level	0.620	0.418	8.204	<0.05	0.559	[0.120-0.913]
Monthly income	1.588	0.419	14.393	<0.05	0.495	[0.155-0.821]
Dental anxiety	-0.153	0.482	8.494	<0.05	2.858	[1.731-11.007]
Dental phobia	-1.737	0.544	10.188	<0.05	2.176	[1.061-9.511]
Constant term	2.912	1.276	5.206	0.023		

Line graph prediction model construction

A line graph prediction model for oral health self-efficacy was established, incorporating four factors: education level, monthly income, dental anxiety, and dental phobia, as depicted in Figure 1. The data of 57 subjects in the validation

group were substituted into the prediction model. The ROC curve showed that the AUC of the line graph prediction model was 0.793 [95%CI (0.711, 0.821)], TPR (sensitivity) was 0.871, and FPR (specificity) was 0.842, indicating that the risk prediction model had a good predictive effect (Figure 2).

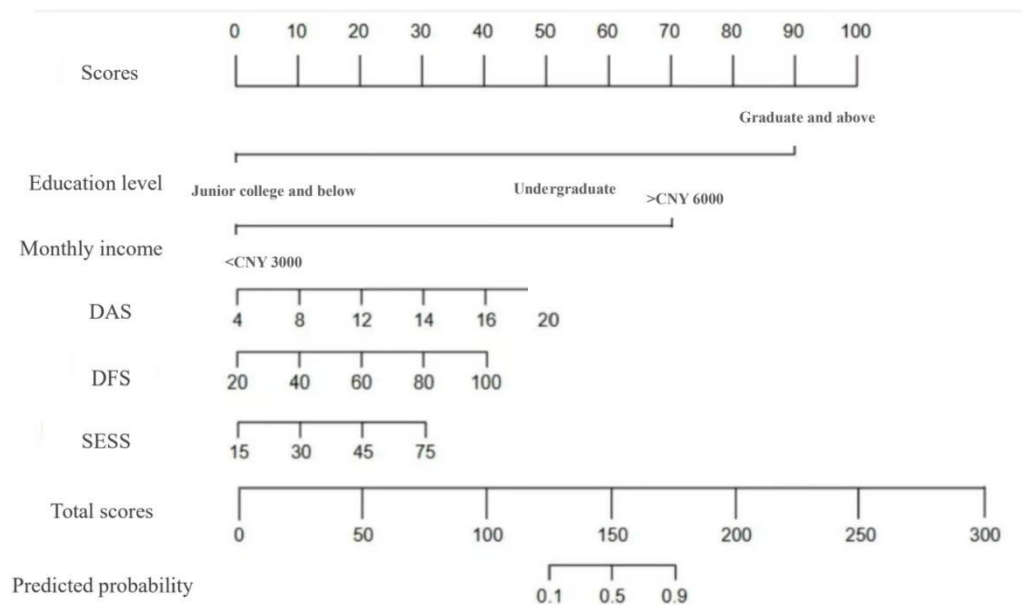


Figure1 Line graph prediction model

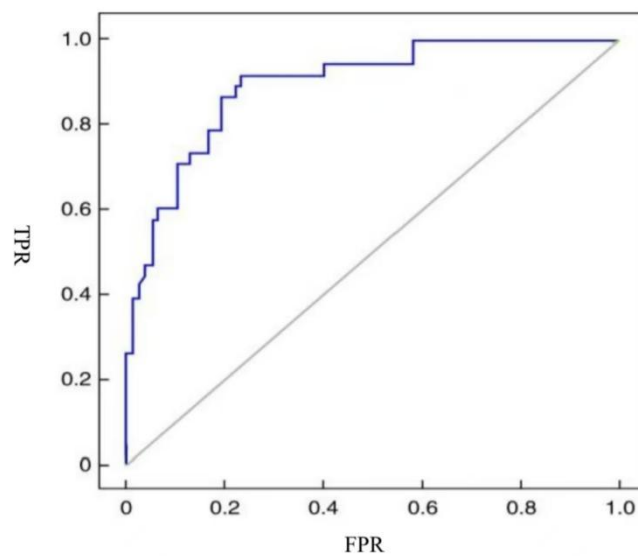


Figure2 ROC Curve

DISCUSSION

Anxiety is a mental disorder characterized by recurrent and persistent symptoms of anxiety, panic, and autonomic nervous system dysfunction. In the field of dentistry, anxiety and fear are particularly prevalent, which not only affects patients' medical experiences and treatment outcomes but may also have a long-term detrimental effect on oral health^[14,15]. Chronic periodontitis, a prevalent oral disease encountered in clinical practice, is characterized by chronic inflammation of the periodontal tissues. This condition can result in tooth loosening and loss, significantly impacting patients' daily eating habits and quality of life. Moreover, the advancement of chronic periodontitis is closely associated with patients' oral health behaviors. Oral health self-efficacy is the confidence and belief of an individual in his or her ability to engage in oral health behaviors^[16]. Studies indicated that patients' oral health self-efficacy significantly influenced their oral health behaviors and the effectiveness of disease treatment, and those with high oral health self-efficacy were more likely to take positive oral health measures, thus effectively controlling the progression of disease^[17,18]. In recent years, an increasing number of studies have begun to focus on the relationship between mental processes and oral health. However, there remains a scarcity of research on the correlation between dental anxiety and fear states and oral health self-efficacy in patients with chronic periodontitis.

This study aimed to investigate the correlation between dental anxiety and fear states and oral health self-efficacy among patients with chronic periodontitis, and construct a self-efficacy line graph prediction model. The goal was to provide a scientific basis for enhancing oral health by developing targeted intervention strategies for dental practitioners and improving oral health self-efficacy among patients. In this study, the total score of SESS for 227 patients with chronic periodontitis in the modeling group was 53.83 ± 3.53 points, indicating a moderate

level. Of these, 65.6% (149/227) were categorized into the low oral health self-efficacy group. The results indicated that a deficiency in oral health self-efficacy was prevalent among patients with chronic periodontitis. Consequently, enhancing patients' oral health self-efficacy and encouraging their proactive engagement in oral health behaviors are crucial for improving the oral health outcomes of those with chronic periodontitis.

Dental anxiety and fear are significant psychological factors that impact oral health self-efficacy. This study revealed that dental anxiety and dental fear were negatively correlated with oral health self-efficacy. That was, the higher the degree of dental anxiety and fear, the lower the oral health self-efficacy. Dental anxiety and fear cause patients to develop avoidance or resistance to oral treatment, diminishing their opportunities and motivation to engage in oral health care. Therefore, it is imperative to focus on individuals experiencing dental anxiety and dental fear. By employing psychological intervention and oral health education, dental practitioners can alleviate patients' anxiety and fear, thereby enhancing their oral health self-efficacy.

Multivariate logistic regression analysis indicated that education level, monthly income, dental anxiety, and dental phobia were key factors influencing oral health self-efficacy. Educational level is one of the important factors influencing oral health self-efficacy. The higher the educational level, the easier it is for patients to obtain and understand oral health knowledge, the clearer their comprehension of the importance of oral health behaviors, and the better they perform these behaviors. Monthly income is also an important factor influencing oral health self-efficacy. As monthly income increases, patients' oral health self-efficacy tends to improve. Patients with higher monthly incomes possess greater financial capacity to afford oral treatment and are more likely to access high-quality oral medical services, thereby having increased confidence in maintaining oral health.

Dental anxiety and fear can result in negative expectations and avoidance behaviors among patients concerning oral treatment, thereby limiting their access to oral health information and the opportunity to engage in oral health care. It is important to note that dental anxiety and fear can trigger a physiological stress response in patients, such as elevated blood pressure and increased heart rate, which in turn can exacerbate their anxiety and fear, creating a vicious cycle. Moreover, dental anxiety and fear can also impact patients' cognitive abilities, diminishing their capacity to comprehend and process oral health information, and lowering their oral health self-efficacy^[19]. In this study, a line graph prediction model for oral health self-efficacy was constructed using education level, monthly income, dental anxiety, and dental phobia as variables. The ROC curve AUC was 0.793 [95% CI (0.711, 0.821)], indicating that the risk prediction model had a good predictive effect.

CONCLUSIONS

The oral health self-efficacy among patients with chronic periodontitis is relatively low. The key factors influencing their self-efficacy include education level, monthly income, dental anxiety, and dental phobia. In dental practice, we should pay attention to the social attributes and psychological status of patients, and strengthen oral health education to improve their oral health self-efficacy.

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COMPETING INTERESTS

The authors state that there are no conflicts of interest to disclose.

DATA AVAILABILITY

The authors declare that all data supporting the findings of this study are available within the paper and any raw data can be obtained from the corresponding author upon request.

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