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Development of a Protection Motivation Theory–Based Health Education Program for Patients with Diabetes and Periodontitis

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Abstract: *Background*: Diabetes mellitus (DM) is a metabolic disorder characterized by persistent hyperglycemia, with a prevalence of approximately 11.2% in China that continues to rise. Periodontitis is a microorganism-initiated, multifactorial infectious disease and is regarded as the sixth complication of diabetes. Nearly 90% of individuals with diabetes are affected by periodontitis. The relationship between these two conditions is bidirectional: periodontitis worsens glycemic control, increases insulin resistance, and contributes to the development of diabetic complications, including higher mortality from ischemic heart disease and diabetic nephropathy. Conversely, sustained hyperglycemia, longer disease duration, and inadequate self-management increase the risk of periodontitis. In addition, severe periodontitis and tooth loss impose a substantial social and economic burden. However, oral-health knowledge among diabetic patients remains limited. This study aimed to develop a Protection Motivation Theory (PMT)-based health education program for patients with diabetes and periodontitis. *Objective*: To develop a PMT-based health education program for patients with diabetes and periodontitis and provide a replicable intervention for clinical practice. *Methods*: Guided by PMT, this study used evidence synthesis and Delphi expert consultation. Literature retrieval, screening, quality appraisal, evidence extraction, and grading were conducted to develop a draft program, which was then refined through expert consultation on content, delivery, intervention cycle, and expected outcomes. *Results*: Of 448 records identified, 22 studies were included, yielding 31 best-evidence items. Evidence confirmed the bidirectional relationship between diabetes and periodontitis and the importance of health education in improving glycemic and periodontal outcomes. After two Delphi rounds, the final program included 7 primary and 48 secondary items. Expert participation was 100% in both rounds; the authority coefficient was 0.87; coefficients of variation ranged from 0.10 to 0.25; Kendall's W values were 0.466 and 0.301 ($p < 0.01$), indicating good agreement. *Conclusion*: A structured PMT-based health education program with sound scientific basis and feasibility was developed for patients with diabetes and periodontitis.

Keywords: Diabetes; Periodontitis; Health education; Protection motivation theory; Program development

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1. Introduction

Diabetes mellitus (DM) is a complex metabolic disorder characterized by chronic hyperglycemia. In China, it has become a major public health concern, with a prevalence of approximately 11.2% that continues to rise steadily [1]. Emerging evidence has established a strong bidirectional relationship between diabetes and periodontitis, a multifactorial infectious disease initiated by microbial dysbiosis [2,3]. Periodontitis is now widely recognized as the "sixth complication" of diabetes and affects nearly 90% of individuals diagnosed with DM [4–6].

The interaction between these two conditions forms a vicious cycle. Periodontitis acts as a chronic systemic inflammatory burden that impairs glycemic control, exacerbates insulin resistance, and accelerates the development of diabetic complications [7–9]. It is also associated with increased mortality from ischemic heart disease and diabetic nephropathy [6]. Conversely, the diabetic environment marked by persistent hyperglycemia, prolonged disease duration, and frequently inadequate self-management, significantly increases susceptibility to periodontal tissue breakdown [6]. As a result, progression to severe periodontitis and subsequent tooth loss substantially diminishes patients' quality of life and imposes a considerable socioeconomic burden on both individuals and the healthcare system [10].

Diabetes is one of the major chronic diseases in China and is a metabolic–endocrine disease principally characterized by impaired glucose metabolism [11]. Periodontitis is also one of the most common oral diseases. Chronic periodontitis is an infectious disease initiated by microorganisms and affected by multiple factors [12]. Diabetes is a risk factor for periodontitis; conversely, periodontitis adversely affects glycemic control and promotes the occurrence and progression of diabetic complications [12]. Surveys indicate that the overall prevalence of oral diseases among patients with diabetes is 83.37%. In a screening of 1,613 eligible patients with type 2 diabetes, 80.8% were found to have periodontitis, of whom 21.8% had severe periodontitis [13]. Although periodontitis seriously endangers the health of people with diabetes and imposes substantial personal and social burdens, patients' awareness of the interplay between diabetes and periodontitis is low. Investigations report poor knowledge and application rates of oral-health-related information among diabetic patients, and limited understanding of the diabetes–periodontitis relationship [6]. Periodontitis in diabetic patients is easily overlooked by the public; therefore, targeted health education and guidance are warranted to help patients form correct understanding and improve self-management behaviors to prevent or mitigate periodontitis and improve glycemic control.

2. Theoretical basis

Protection Motivation Theory (PMT) was proposed by Rogers and explains how individuals respond to perceived threats and how attitudes and behaviors change accordingly [14]. PMT posits that when faced with a threat, individuals perform threat appraisal and coping appraisal, generating protection motivation that leads to specific actions [15]. The behavioral process in PMT comprises three parts: sources of information, threat appraisal, and coping appraisal. Sources of information are the internal and external triggers for health behaviors. Threat appraisal includes intrinsic rewards, extrinsic rewards, perceived severity, and perceived vulnerability (susceptibility). Coping appraisal subfactors include response efficacy, self-efficacy, and response costs. Under the PMT framework, interventions should augment positive factors, for example, perceived susceptibility and severity, response efficacy, and self-efficacy, while reducing internal and external rewards and response costs that discourage protective behaviors [16]. Specifically, perceived severity refers to an individual's perception of the

seriousness of a threat; perceived susceptibility denotes how likely the individual thinks they are to be affected; internal rewards are the subjective pleasures from engaging in unhealthy behaviors (for example, reducing blood-glucose monitoring to avoid repeated finger pricks); external rewards are social gains from unhealthy behaviors (such as accepting more food to fit in socially); self-efficacy denotes confidence in one's ability to undertake protective actions; response efficacy denotes perceived benefits of the protective behavior; response costs are the perceived social or economic costs associated with the protective behavior. PMT performs dual appraisals of environment and individual factors to stimulate self-protective motivation and serves as a useful tool for improving individual self-management capacity.

PMT has been widely applied in health promotion and behavior-change interventions and is an established theory for explaining, predicting, and intervening on behaviors. It has been used in HIV prevention, breast cancer screening, smoking cessation, and childhood myopia prevention among other fields. In recent years PMT has also been widely applied to chronic disease prevention and management.

Domestically, PMT has been used in various clinical interventions. For example, Yin Xue-mei applied a PMT-based health education intervention to 32 patients with duodenal ulcer and found that the intervention group showed higher overall adherence and improved daily-life and emotional-management abilities post-treatment [17]. Zhao Xiao-ling et al. applied PMT-guided nursing interventions to older adults with diabetes and demonstrated improved glycemic control and self-care ability [18]. Bai Ya-nan used PMT to guide pelvic-floor muscle training in patients with postpartum urinary incontinence and found significant improvement and neural recovery [19]. Zhao Qing-qing constructed a PMT-based family-support educational model for children with myopia, improving knowledge of proper eye habits and forming correct behavior [20]. However, PMT-based interventions specifically targeting patients with diabetes complicated by periodontitis remain scarce.

Internationally, PMT has been applied in public dental health education, and baseline health-education programs aimed at reducing childhood caries, resulting in decreased periodontal disease and increased oral-care engagement [21]. Sotoudeh et al. found PMT effective in analyzing sailors' skin-cancer preventive behaviors and proposed it as a framework for health-education planning [22]. Sherine Hassan and colleagues [23]. applied PMT to improve foot-care behaviors among diabetic patients, showing that PMT-based education strengthened foot-care adherence by enhancing self-efficacy and perceived severity while reducing perceived barriers. Although there are many international PMT application reports, application of PMT specifically for diabetes with periodontitis is limited [24].

In summary, PMT-based health education positively influences behavior motivation, facilitates behavior change, and strengthens individual beliefs through both personal and environmental mechanisms, offering promising clinical utility. Although PMT has been applied across multiple domains including diabetes and its complications, application to diabetes complicated by periodontitis is lacking. Given the bidirectional relationship and high prevalence of periodontitis among people with diabetes, and the generally suboptimal self-management observed in this population, a PMT-based, theory-driven, targeted intervention program is warranted to enhance motivation for behavior change and improve self-management.

3. Methods

3.1. Formulation of the evidence question

The evidence question for this study was formulated according to the PICO framework: Population (P): patients

with diabetes complicated by periodontitis; Intervention (I): health education; Outcome (O): glycemic and periodontal-related outcome measures.

3.2. Search strategy

Using the "6S" evidence model as guidance, Chinese search terms included "diabetes", "periodontitis", "health education", "health promotion", "blood glucose", "blood glucose management", "glycated hemoglobin", and "oral hygiene". English search terms included "Diabetes Mellitus", "periodontitis", "Health Education", "Community Health Education", "Health Promotion", "Blood Glucose", "blood glucose control", and "oral hygiene". The search targeted clinical guidelines, expert consensus statements, systematic reviews, randomized controlled trials (RCTs), and related studies on health education for patients with diabetes and periodontitis. Databases searched included UpToDate, National Guideline Clearinghouse (NGC), BMJ Best Practice, JBI Evidence-based Health Care database, SIGN, NICE, RNAO, PubMed, Ovid, Web of Science, Embase, Cochrane Library, VIP, Wanfang, and CNKI [25]. Both subject headings and free-text terms were used and adapted per database. The search window extended from database inception to January 1, 2025.

3.3. Inclusion and exclusion criteria

3.3.1. Inclusion criteria

(1) Study population
Patients with diabetes complicated by periodontitis, or patients with diabetes;
(2) Study content
Health-education interventions addressing oral health in patients with diabetes (not restricted to periodontal disease);
(3) Study types
Clinical guidelines, expert consensus statements, clinical decision documents, systematic reviews, and randomized controlled trials;
(4) Language
Chinese or English.

3.3.2. Exclusion criteria

(1) Duplicate publications or documents superseded by later updates;
(2) Studies with incomplete information or for which the full text was not obtainable;
(3) Documents rated Grade C in the methodological quality assessment.

3.4. Literature quality assessment

3.4.1. RCT appraisal tool

The methodological quality of included randomized controlled trials was independently assessed by two reviewers using the Joanna Briggs Institute (JBI) RCT appraisal instrument (2016 edition). The tool contains 10 items that evaluate aspects such as the randomization process, allocation concealment, blinding of participants and outcome assessors, and handling of follow-up data [25]. Trials with low risk of bias were rated Grade A; those with moderate risk were rated Grade B; trials with high risk of bias were rated Grade C. Grade-C studies were excluded.

3.4.2. Guideline appraisal tool

Clinical practice guidelines were assessed using the AGREE II instrument, which includes 23 items in six domains and two overall assessment items, each scored from 1 to 7 [26]. Domain scores were calculated independently, and standardized scores were computed as: (obtained score − minimum score) / (maximum score − minimum score) × 100%. Recommendations were then determined based on the six domain scores [26].

3.4.3. Systematic review appraisal tool

The methodological quality of included systematic reviews was independently assessed by two reviewers using the JBI systematic review appraisal checklist (2016 edition). Discrepancies were resolved through discussion with a third reviewer. The checklist comprises 11 items addressing clarity of the review question, comprehensiveness of the search strategy, rigor of data analysis, and related domains.

3.4.4. Expert-consensus appraisal tool

Included expert consensus statements were independently evaluated by two reviewers using the JBI expert consensus appraisal instrument (2016 edition). Any disagreements were resolved via discussion with a third reviewer. The appraisal tool contains eight items covering clarity of purpose, declaration of conflicts of interest, the evidentiary basis, the consensus-development process, and the clarity and feasibility of recommendations [27].

3.4.5. Clinical decision document appraisal

The quality assessment of clinical decision documents was conducted by tracing each recommendation back to its original source documents and appraising those original documents according to their respective study types.

3.5. Appraisal procedure

Two reviewers independently performed all quality assessments. Where disagreements arose, a third reviewer was consulted and consensus was reached by discussion. When conclusions from different evidence sources conflicted, inclusion and interpretation followed a hierarchy that prioritized higher-quality evidence, evidence-based documents, clinical guidelines, and, where applicable, the most recently published literature.

3.6. Evidence extraction and grading

A nursing postgraduate synthesized evidence on oral-health education for patients with diabetes [28]. Consistent and complementary evidence was integrated, independent evidence retained, and conflicting evidence resolved by prioritizing recent, high-quality sources. Evidence was graded using the JBI 2014 system, and recommendations were classified as Grade A or B [29].

3.7. Determination of expert-consultation questionnaire content

3.7.1. Literature retrieval

Following an evidence-based nursing workflow, formulating the evidence question, developing the search strategy, setting inclusion/exclusion criteria, conducting quality appraisal, and extracting and integrating evidence, the study team prepared a draft outline for a PMT-based health-education program for patients with diabetes and periodontitis.

3.7.2. Draft development

An initial PMT-based health-education program was developed with two primary dimensions, threat appraisal and coping appraisal and seven secondary indicators: perceived severity, perceived susceptibility, internal rewards, external rewards, self-efficacy, response efficacy, and response cost. The tertiary indicators addressed risk awareness, behavior correction, family support, self-management benefits, confidence building, and barrier reduction. The draft program was then discussed and revised by the research team to finalize the questionnaire content.

3.8. Implementation of expert consultation

3.8.1. Expert inclusion criteria

Experts were eligible if they met all of the following criteria:

(1) ≥ 10 years of clinical practice and/or nursing experience in diabetes and/or oral health;
(2) Familiarity with nursing and treatment relevant to diabetes complicated by periodontitis;
(3) Bachelor's degree or higher and associate senior professional title or above;
(4) High willingness to participate and voluntary engagement in this study.

3.8.2. Questionnaire development

The expert consultation (Delphi) questionnaire comprised three parts: a preface, an expert basic-information form, and the main questionnaire body [30].

(1) Preface

The questionnaire opened with a greeting, thanks, a brief introduction to the study purpose, and the return deadline. Contact information was provided for expert feedback.

(2) Expert information form

This section collected demographic data and assessed expert authority based on familiarity and judgment basis. Familiarity was rated on a 5-point Likert scale, and judgment basis included practice experience, theoretical basis, literature, and subjective judgment.

(3) Main questionnaire

Experts rated the importance of each item on a 5-point Likert scale and evaluated its relevance and wording, with space provided for suggestions on revision or deletion [16].

3.8.3. Consultation implementation

(1) Consultation timeframe

The consultation mode followed experts' preferred contact methods. A combination of e-mail and paper questionnaires was used, and questionnaires were collected within a predetermined period. To avoid memory effects, an interval of four weeks was maintained between successive rounds [31].

(2) Consultation method

A back-to-back (iterative Delphi) approach was adopted. After Round 1, experts' basic information plus item ratings and comments were collated and discussed. Criteria for retaining items were: coefficient of variation (CV) < 0.25, mean score (Mean) > 3.5, and full-score rate > 20%. Items meeting all three criteria were retained; items meeting at least one criterion were discussed by the research team to decide whether to retain; items satisfying none of the criteria were deleted. Based on these decisions, the Round-2

questionnaire was prepared. The first part of Round 2 presented a summary of Round-1 modifications for experts' reference; the second part listed the revised items and requested re-rating and further comments. This process was repeated for 2–4 rounds until expert opinion converged [32].

3.9. Result analysis

Data were analyzed using Excel and SPSS 24.0 with double entry and verification. Two researchers independently entered the data, and 20% of questionnaires were randomly checked for accuracy. Continuous variables were expressed as mean ± standard deviation, and categorical variables as frequency and percentage. Expert engagement was evaluated by response and suggestion rates; a response rate > 70% indicated good engagement. Expert authority was assessed by Cr = (Ca + Cs) / 2, with Cr > 0.8 indicating high authority.

4. Results

4.1. Literature analysis results

4.1.1. Literature screening results

The initial search retrieved 448 records. After removing 32 duplicates and screening titles and abstracts, 63 records were excluded; full-text review resulted in the exclusion of a further 256 records. Following methodological quality assessment, 19 low-quality documents were excluded. Ultimately, 22 studies were included, comprising 5 guidelines, 3 expert consensus statements, 2 systematic reviews, and 12 randomized controlled trials. The literature selection flow chart is shown in **Figure 1**. General characteristics of the included studies are presented in **Table 1**.

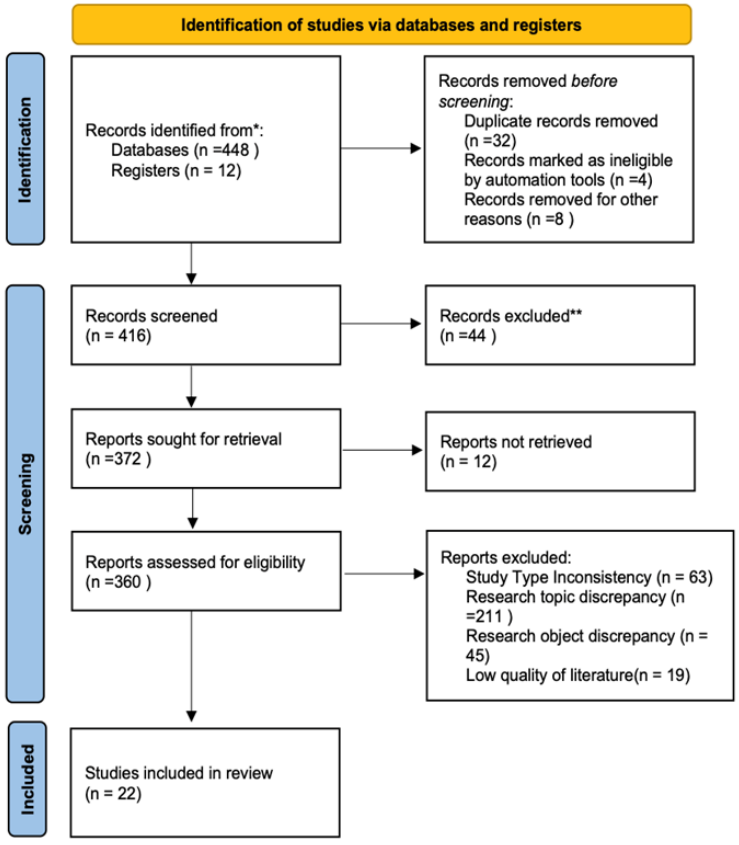

Figure 1. Flow diagram of literature screening and selection.

Table 1. Characteristics of included studies (n = 22)

Included literature	Time of publication (years)	Source of evidence	Type of evidence	Literature topics
German Society of Periodontology et al [33]	2024	National Guide Network	Guidelines	Management of Diabetes and Periodontitis
Sanz et al [34]	2018	National Guide Network	Guidelines	Scientific evidence on the links between periodontal diseases and diabetes
Scottish Dental Clinical Effectiveness Programme [35]	2024	PubMed	Guidelines	Prevention and treatment of periodontal diseases in primary care
Public Health England	2020	PubMed	Guidelines	Guidelines for oral health education
Department of Health and Social Care Welsh Government Department of Health Northern Ireland Public Health England NHS England [36]	2021	PubMed	Guidelines	In Delivering better oral health: An evidence-based toolkit for prevention
Dale et al [37]	2014	PubMed	Expert consensus	Oral management of diabetes
Ternois et al [38]	2017	PubMed	Expert consensus	Oral management of diabetes
Periodontology Committee of Chinese Stomatological Association [39]	2017	Wanfang database	Expert consensus	Nursing care of periodontitis
Gurav et al [40]	2016	PubMed	Systematic Review	Management of Diabetes and Periodontitis
Petropoulou et al [41]	2024	PubMed	Systematic Review	Health education of diabetic oral cavity
Saruta et al [42]	2014	PubMed	RCT	Effectiveness of lifestyle change plus dental care program on improving glycemic and periodontal status in the elderly with type 2 diabetes
Zhang et al [43]	2025	PubMed	RCT	Community interventions improve diabetes management and oral health in type 2 diabetes patients with chronic periodontitis
Sun Linlin et al [44]	2007	CNKI	RCT	Oral education for diabetic patients with periodontitis
Yang Xiaohui et al [45]	2017	CNKI	RCT	Health education for patients with diabetes mellitus and periodontitis
Tang Chao et al [46]	2018	Wanfang Data	RCT	Health education for patients with diabetes mellitus and periodontitis
Gong Deai et al [47]	2018	Wanfang Data	RCT	Health education for patients with diabetes mellitus and periodontitis
Qi Fengwei et al [48]	2018	Wanfang Data	RCT	Oral education in elderly patients with diabetes mellitus and periodontitis
Xu Ya et al [49]	2019	CNKI	RCT	Oral education for elderly patients with diabetes mellitus and periodontitis
Huang Qian et al [50]	2019	Wanfang Data	RCT	Oral education for elderly patients with diabetes mellitus and periodontitis
Niu Feng et al [51]	2020	CNKI	RCT	Health education for patients with diabetes mellitus and periodontitis
Lai Qizhi et al [52]	2023	Wanfang Data	RCT	Health education for diabetes mellitus with periodontitis
Liu Jingfang et al [53]	2024	Wanfang Data	RCT	Oral education in elderly patients with diabetes mellitus and periodontitis

4.2. Expert consultation

4.2.1. General characteristics of consulted experts

Fourteen experts took part in the two-round consultation; they were drawn from departments of endocrinology and stomatology. All 14 experts were female (100%). The largest group had 20–29 years of work experience (42.86%), followed by 10–19 years (28.57%) and ≥ 30 years (28.57%). All experts held a bachelor's degree or higher, with 42.86% holding a master's degree. Associate chief nurses accounted for 57.14% of the panel.

4.2.2. Expert positive coefficient (response rate)

Two rounds of expert consultations were conducted in this study. In the first round, 14 questionnaires were distributed and 14 were recovered, resulting in a response rate (positive coefficient) of 100.00%, with 71.43% of the experts providing additional suggestions. In the second round, 14 questionnaires were distributed and 14 were recovered, with a response rate of 100.00%. The effective recovery rates for both rounds were above 70%, indicating a high level of enthusiasm and engagement among the experts.

4.2.3. Expert authority coefficient (Cr)

The results of the consultation are considered reliable when the expert authority coefficient (Cr) is ≥ 0.7. In this study, the individual authority coefficients of the 14 experts ranged from 0.75 to 1.00, with an average authority coefficient of 0.87 for the expert panel. This indicates a high degree of authority among the participating experts.

4.2.4. Degree of coordination of expert opinions

The degree of coordination was measured using the Coefficient of Variation (CV) and Kendall's Coordination Coefficient (Kendall's WW). The CVCV values ranged from 0.1 to 0.3, and the Kendall's WW was 0.466 ($p < 0.01$). These results indicate a good degree of coordination among expert opinions and high consistency in the experts' evaluations of the indicators within the program.

4.3. The final version of health education program for patients with diabetes and periodontitis based on protection motivation theory

Following two rounds of expert consultation, the final version of the program was established. It consists of 7 first-level indicators and 48 second-level indicators. The detailed content is presented in **Table 2**.

Table 2. Final version of the health education program for diabetes with periodontitis based on the protection motivation theory

Intervention theme	Intervention content	Timing	Frequency	Setting
1. Perceived susceptibility	1.1 Explain the bidirectional exacerbation between uncontrolled diabetes and periodontitis. 1.2 Discuss genetic susceptibility to diabetes with periodontitis. 1.3 Use typical cases to illustrate susceptibility. 1.4 Guide patients to read the susceptibility section of the health manual. 1.5 Encourage patients to share daily unhealthy behaviors. 1.6 Analyze the link between unhealthy behaviors and susceptibility. 1.7 Conduct follow-up (phone/online) to reinforce susceptibility-related content.	1st week of admission	1 h Lecture, 30 min Peer Discussion, 30 min Q&A	Demonstration Room, Department of Endocrinology

Table 2 (Continued)

Intervention theme	Intervention content	Timing	Frequency	Setting
2. Perceived severity	2.1 Explain disease stages, progression, and complications. 2.2 Discuss adverse outcomes and impact on daily life. 2.3 Explain the economic burden and family stress caused by the disease. 2.4 Discuss the psychological burden on the patient and family. 2.5 Guide patients to read the severity section of the manual. 2.6 Provide health education videos on disease severity. 2.7 Lead discussions on the relationship between unhealthy behaviors and adverse outcomes. 2.8 Analyze the severity of unhealthy behaviors. 2.9 Conduct follow-up to reinforce severity-related content.	2nd week post-discharge	1 h Lecture, 30min Peer Discussion, 30min Q&A	Demonstration Room, Department of Endocrinology
3. Internal rewards	3.1 Discuss measures to address poor glycemic and periodontal control caused by unhealthy behaviors (e.g., poor oral hygiene, overeating). 3.2 Encourage patients to describe bad lifestyle habits (e.g., smoking, excessive drinking). 3.3 Provide guidance on how to quit unhealthy habits. 3.4 Guide patients to read the internal rewards section of the manual. 3.5 Explain the hazards of non-standard diabetes management. 3.6 Explain the hazards of improper periodontal care. 3.7 Conduct follow-up to reinforce internal rewards-related content.	3rd–4th week post-discharge	1 h Lecture, 30 min Peer Discussion, 30 min Q&A	Demonstration Room, Department of Endocrinology
4. External rewards	4.1 Explain the role and importance of family in disease management. 4.2 Guide patients on family caregiving content from the manual. 4.3 Instruct patients on how to educate family members about the disease. 4.4 Teach scientific dietary methods for the whole family. 4.5 Discuss the impact of medical expenses on the family. 4.6 Guide patients and families/friends to watch health education videos at home. 4.7 Conduct follow-up to reinforce external rewards-related content.	5th–6th week post-discharge	1 h Lecture, 30 min Peer Discussion, 30 min Q&A	Demonstration Room, Department of Endocrinology
5. Self-efficacy	5.1 Explain the positive impact of adopting healthy behaviors. 5.2 Provide guidance on standardized medication use. 5.3 Demonstrate proper periodontal care methods. 5.4 Teach daily blood glucose control methods. 5.5 Educate on scientific and healthy diet. 5.6 Instruct on scientific exercise methods. 5.7 Conduct follow-up to consolidate previous learning.	7th week post-discharge	1 h Lecture, 30 min Peer Discussion, 30 min Q&A	Demonstration Room, Department of Endocrinology
6. Response efficacy	6.1 Invite peers to share successful experiences in blood glucose control. 6.2 Present positive cases of successful glycemic control. 6.3 Present positive cases of effective periodontal care. 6.4 Explain the effectiveness of good habits in improving diabetes and periodontitis. 6.5 Conduct follow-up to consolidate previous learning.	8th week post-discharge	1 h Lecture, 30 min Peer Discussion, 30 min Q&A	Demonstration Room, Department of Endocrinology
7. Response costs	7.1 Encourage patients to share difficulties encountered during self-management. 7.2 Provide one-on-one guidance to identify barriers. 7.3 Assist patients in finding solutions to management obstacles. 7.4 Provide emotional and psychological support and affirm healthy behaviors. 7.5 Guide patients on how to utilize community resources effectively. 7.6 Conduct follow-up to consolidate the program content.	9th week post-discharge	1 h Lecture, 30 min Peer Discussion, 30 min Q&A	Demonstration Room, Department of Endocrinology

5. Discussion

5.1. Construction and innovation of an evidence-based integrated health education program

The quality of evidence included in this study exhibited stratified characteristics. Guidelines and certain systematic reviews demonstrated high quality, whereas some randomized controlled trials (RCTs) and lifestyle-related studies were of relatively lower quality. This discrepancy is closely related to the rigor of research design, the authority of evidence sources, and the degree of methodological standardization. High-quality evidence primarily originated from international authoritative guidelines and expert consensuses [34–36, 54]. These documents were typically developed using systematic evidence-based processes, strictly adhering to AGREE II or JBI evaluation criteria, and featured clear clinical question frameworks, comprehensive literature search strategies, standardized evidence grading systems, and transparent descriptions of recommendation strength. Furthermore, the development teams usually possessed multidisciplinary backgrounds with extensive clinical and research experience. The guideline development process often integrated results from multiple high-quality RCTs and systematic reviews, ensuring the scientific validity and stability of the evidence [55,56]. Additionally, guideline-related literature generally maintained high editorial independence and clear conflict-of-interest statements, enhancing the credibility and generalizability of the findings [57]. Consequently, core disease education, basic oral care measures, and multidisciplinary collaborative management were mostly categorized as Grade A (Strong Recommendation).

The innovations of this study are reflected in the following aspects: First, based on systematic retrieval and quality appraisal, fragmented research evidence was integrated and graded to form a structured health education evidence framework with clear hierarchical levels. This shifts clinical practice away from empirical education toward an evidence-based approach. Second, the content construction broke through previous single-intervention models by systematically integrating multiple dimensions, including disease cognition, oral care, lifestyle, follow-up management, social support, and psychological care, which better meets the comprehensive management needs of patients with the comorbidity of diabetes and periodontitis. Third, it emphasizes the integration of oral health education into the overall diabetes management system, highlighting the importance of synergistic management between oral health and endocrinology, thus providing a specific direction for multidisciplinary cooperation.

In contrast, the reasons for lower evidence quality mainly focused on: First, some RCTs had methodological limitations, such as small sample sizes, lack of blinding, inadequate allocation concealment, and insufficient reporting of baseline comparability. Although their results reached statistical significance, the risk of bias remained relatively high. Second, lifestyle intervention studies (e.g., diet, exercise, psychological support) often struggled to control for confounding factors, with significant variations in intervention formats and generally short follow-up periods (mostly 3–6 months), making it difficult to assess long-term effects. Third, some studies were confined to single centers or specific populations (e.g., elderly patients), limiting their representativeness and generalizability. Fourth, some literature was published in journals with lower impact factors, with variations in research design and reporting standards. Furthermore, while some expert consensuses held clinical value, they lacked transparency in conflict-of-interest statements and the level of detail in recommendations, which affected their evidence grade.

5.2. Construction and innovation of the evidence-based health education program

Systematic evidence integration reveals significant deficiencies in the current management of diabetes with periodontitis. Currently, these two conditions are often managed independently by different clinical departments, leading to a lack of integrated care pathways and making it difficult for patients to develop a systemic understanding of their health. Furthermore, health education content remains fragmented, with most studies

focusing on isolated intervention modalities, such as lectures, videos, or toothbrushing instructions, while lacking systematic frameworks and long-term follow-up mechanisms.

Previous research has generally overlooked behavioral change mechanisms; interventions have predominantly focused on knowledge transmission, paying insufficient attention to patients' self-efficacy, motivation formation, and sustained adherence. Additionally, limited sample sizes and short follow-up durations in existing studies hinder the assessment of long-term efficacy. Compared with existing literature, this study further identifies that the core issue lies not only in fragmented intervention methods but also in a profound "cognitive gap" regarding the bidirectional relationship between diabetes and periodontitis. Therefore, merely intensifying knowledge dissemination is insufficient. It is essential to construct a systematic, structured, and theoretically supported intervention program to facilitate the transition from knowledge acquisition to sustained self-management behavior.

5.3. Advantages of protection motivation theory (PMT) in the study program

Previous health education for diabetes with periodontitis has primarily relied on knowledge counseling or skill instruction. While these methods may improve short-term mastery of oral care or glycemic management, the lack of a systematic behavioral change theory often limits the impact to the cognitive level, failing to translate into stable, long-term self-management.

To address this, the present study adopted Protection Motivation Theory (PMT) as the theoretical framework, utilizing threat appraisal and coping appraisal as the core logic of the intervention. In the early stage, the intervention intensified patients' perceptions of susceptibility and severity, specifically how periodontitis affects glycemic control and increases complication risks. During the implementation phase, response efficacy and self-efficacy were enhanced through practical demonstrations, individualized guidance, interactive discussions, and weekly follow-ups. Furthermore, by addressing specific barriers identified through patient feedback, the study successfully reduced the response costs (behavioral execution costs), fostering a proactive management mindset.

In contrast to previous interventions lacking theoretical support, this study integrates evidence-based findings, behavioral theory, and multidisciplinary collaboration. This approach provides the intervention with a clear logical structure and action pathway, avoiding fragmented measures and insufficient mechanistic explanations while enhancing both sustainability and generalizability. This demonstrates that in the management of diabetes with periodontitis, knowledge transmission must be reinforced by behavioral change theories to truly achieve the transformation from cognitive improvement to behavioral maintenance.

6. Conclusion

A structured Protection Motivation Theory–based health education program for patients with diabetes and periodontitis was successfully developed. The program demonstrated a sound scientific basis and feasibility, and it provides a systematic, theory-driven, and clinically applicable framework for improving patients' knowledge, self-management behaviors, glycemic control, and periodontal health. This study offers a replicable reference for clinical health education and integrated management of diabetes with periodontitis.

Disclosure statement

The authors declare no conflict of interest.

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