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# The Mediating Role of Nutritional Status in the Association between Oral Frailty Risk and HbA1c Levels among Elderly Patients with Type 2 Diabetes

**Weixiao Ren [1], Haoyun Feng [1], Jie Cheng [2,*], Zonghai Guo [2], Qiqun Tang [1]**

[1] North China University of Science and Technology, Tangshan Hebei, 063210, China
[2] Affiliated Hospital of North China University of Technology, Tangshan Hebei, 063000, China

[*] **Corresponding author**: Jie Cheng

**Abstract:** Objective To investigate the interactions among nutritional status, oral frailty risk, and glycated hemoglobin (HbA1c) in elderly patients with type 2 diabetes mellitus (T2DM). Methods Elderly T2DM patients who were treated at the Affiliated Hospital of North China University of Science and Technology from August to December 2024 were recruited as the research subjects. A general information questionnaire, the Mini-Nutritional Assessment - Short Form (MNA-SF), and the Oral Frailty Index-8 (OFI-8) were employed for data collection. The HbA1c levels of the patients were collected after admission. The mediating effect of nutritional status on the relationship between oral frailty risk and HbA1c was analyzed. Results In this study, the incidence of high oral frailty risk among elderly T2DM patients was 75.23%. The mean HbA1c level was 7.6 (6.8, 9.5) %, and the total nutritional score was 10 (8, 12) points. Oral frailty risk was positively correlated withHbA1c ($r=0.421$, $p<0.01$) and nutritional status ($r=0.421$, $p<0.01$). Nutritional status was also positively correlated with HbA1c ($r=0.438$, $p<0.01$). Nutritional status served as a mediating variable between oral frailty risk and HbA1c, and the mediating effect accounted for 21.97% of the total effect. Conclusion Nutritional status acts as a mediating variable between oral frailty risk and HbA1c in elderly T2DM patients. This finding implies that medical staff should closely monitor the nutritional and oral health of patients to optimize HbA1c control and minimize the incidence of complications.

**Keywords:** Elderly Type 2 Diabetes Mellitus; Nutritional Status; Oral Weakness Risk; HbA1c; Mediating Effect.

## 1. Introduction

Diabetes, as a common chronic disease, has an incidence rate of 30% among the elderly population, with over 95% of them suffering from type 2 diabetes mellitus (T2DM) [1]. It poses a significant threat to the property and life safety of the elderly. Glycated hemoglobin (HbA1c), as a clinical indicator reflecting blood sugar control, is of great significance throughout the treatment process of diabetes. Affected by the disease, diabetic patients often have imbalances in periodontal tissues and pathogenic factors, leading to a series of oral problems such as periodontitis[2]. Studies have shown that the incidence of oral frailty among diabetic patients is 53.2%[3], significantly higher than that of the normal population. Oral frailty can affect the HbA1c of patients, aggravate insulin resistance, and lead to the occurrence of complications. Therefore, the oral frailty of diabetic patients, especially elderly patients, cannot be ignored[4]. It has been found that more than 50% of elderly diabetic patients have varying degrees of nutritional problems[5], indicating that abnormal nutritional status is relatively common among elderly diabetic patients. The occurrence of oral frailty can lead to impaired eating function in patients and is a major risk factor affecting their nutritional status[6]. Currently, there is a lack of research on the relationship between the risk of oral frailty, nutritional status, and HbA1c in elderly T2DM patients. Therefore, this study aims to analyze the mediating effect of nutritional status between the risk of oral frailty and HbA1c through the establishment of a mediating model, in order to guide clinical practice in controlling the HbA1c of elderly T2DM patients within the optimal range, reducing the occurrence of complications, and improving the prognosis of patients.

## 2. Objectives and Methods

### 2.1. Participants

A convenience sampling method was employed to select elderly patients with type 2 diabetes mellitus (T2DM) who visited the Affiliated Hospital of North China University of Science and Technology from August to December 2024 as the research subjects. Inclusion criteria: (1) Age≥60 years; (2) Meeting the T2DM diagnostic criteria of WHO in 1999; (3) No reading, writing or communication disorders, and able to complete the questionnaire independently or with assistance; (4) Signing informed consent and voluntarily participating in this study. Exclusion criteria: (1) Diabetes combined with severe heart, brain, kidney, etc. complications; (2) Diabetes combined with malignant tumors; (3) Receiving systematic periodontal treatment in the past year; (4) Having mental symptoms or a history of mental illness. This study included 16 variables. Based on the sample size estimation method, the sample size was 10 times the number of independent variables [7], and considering a 30% dropout rate, the calculated sample size was n= (16×10) × (1+30%) = 208 cases. Finally, 327 cases were included. This study has been approved by the Ethics Committee of North China University of Science and Technology (2024257), and all subjects gave informed consent.

### 2.2. Methods

#### 2.2.1. Investigation Tools

(1)General Information Questionnaire. It was self-developed based on the references, including gender, age,

marital status, educational level, disease duration, etc. (2)Oral Frailty Index-8 (Oral Frailty Index-8). It was formulated by the Japanese Dental Association[8], and was adapted into Chinese by Chen Zongmei[9], including 5 dimensions: chewing function (2 items), swallowing function (2items), whether using dentures (1 item), social participation (1 item), and oral health behavior (2 items). The total score is 11 points, with 0-2 points indicating low risk, 3 points indicating moderate risk, and ≥4 points indicating high risk. The Cronbach's α coefficient is 0.949, the retest reliability is 0.786, and the content validity is 0.934. (3)Simple Nutritional Assessment Method Scale (MNA-SF). It was simplified from the Mini Nutritional Assessment (MNA) by Rubenstein et al [10], including evaluations of the eating situation in the past three months, weight change, psychological trauma or acute disease situation, activity ability, psychological condition, and body mass index. The total score is 14 points, with a score of≥12indicating normal, 8-11 indicating a risk of malnutrition,and≤7indicating malnutrition. The Cronbach's α coefficient is 0.711[11].(4)HbA1c was detected within 24 hours after the patient's admission and recorded(instrument model: Bio-Rad VARIANT II Glycated Hemoglobin (HbA1c) Analyzer).

### 2.2.2. Survey Method

A questionnaire was used for on-site investigation. Uniform instructions were provided during the investigation, and the purpose and significance of this study were introduced to the patients and their families. After obtaining informed consent, the patients filled out the questionnaire by themselves. For those who could not fill it out by themselves, the researchers filled it out on their behalf. The questionnaires were collected on the spot, and those with logical errors or incomplete or incorrect filling were excluded. At the same time, HbA1c within 24 hours after admission of the patients was collected. A total of 340 questionnaires were distributed, and 327 valid questionnaires were retrieved, with an effective recovery rate of 96.18%.

### 2.2.3. Statistical Methods

Data analysis was conducted using SPSS 27.0 software. Quantitative data with non-normal distribution were expressed as M ($P_{25}$, $P_{75}$), and comparisons between two groups were performed using the Mann-Whitney U test, while comparisons among multiple groups were conducted using the Kruskal-Wallis H test. Count data were described by frequency and percentage. The Harman single-factor method was used for common method bias test, and Spearman was used for correlation analysis. Model 4 in the PROCESS program was used to explore the mediating effect of nutritional status between oral frailty risk and HbA1c in elderly patients with T2DM. The mediating effect was tested using the Bootstrap method, and differences with $P<0.05$ were considered statistically significant.

# 3. Results

## 3.1. Patient General Information

**Table 1.** Comparison of HbA1c Levels in Elderly Patients with Type 2 Diabetes Mellitus of Different Characteristics M ($P_{25}$, $P_{75}$)

| Project | | n(%) | HbA1c(%) | Z/H | P |
|---|---|---|---|---|---|
| Age | 60~ | 219(66.97) | 7.5(6.7,9.2) | 2.934[b] | 0.231 |
| | 71~ | 98(29.97) | 8.0(7.075,9.625) | | |
| | ≥81 | 10(3.06) | 7.25(6.95,9.575) | | |
| Gender | Male | 179(54.7) | 7.7(6.9,9.5) | -0.841[a] | 0.400 |
| | Female | 148(45.3) | 7.55(6.7,9.475) | | |
| Marital status | Married | 270(82.6) | 7.40(6.7,9.000) | -3.479[a] | <0.001 |
| | Divorced\widowed | 57(17.43) | 8.4(7.45,10.115) | | |
| Address | City | 165(50.46) | 8.6(7.5,10.0) | -8.148[a] | <0.001 |
| | Countryside | 162(49.54) | 7.0(6.4,7.85) | | |
| Educational | Primary | 97(29.66) | 8.6(7.5,10.0) | 82.519[b] | <0.001 |
| | Middle | 93(28.44) | 8.3(7.3,10.3) | | |
| | High | 137(41.896) | 6.9(6.4,7.415) | | |
| Medical insurance | No | 7(2.1) | 9.6(7.4,10) | 11.144[b] | 0.011 |
| | Resident | 107(32.7) | 8.0(7.2,9.7) | | |
| | Employee | 212(64.8) | 7.3(6.7,8.9) | | |
| | Business | 1(0.3) | 8.2(8.2,8.2) | | |
| Course of the disease | 1~ | 101(30.9) | 6.7(6.4,7.4) | 59.038[b] | <0.001 |
| | 6~ | 90(27.5) | 7.6(6.885,9.625) | | |
| | ≥11 | 136(41.6) | 8.3(7.5,9.875) | | |
| Family history | Yes | 126(38.5) | 8.15(7.3,10.0) | -4.725[a] | <0.001 |
| | No | 201(61.5) | 7.3(6.5,8.8) | | |
| Treatment | Antidiabetic drugs | 130(39.8) | 7.3(6.6,8.4) | 12.210[b] | 0.002 |
| | insulin | 120(36.7) | 8.0(7.0,10.0) | | |
| | Drugs+insulin | 77(23.5) | 7.8(7.0,9.5) | | |
| Smoking | Yes | 119(36.4) | 8.6(7.5,10.0) | -6.983[a] | <0.001 |
| | No | 208(63.6) | 7.2(6.5,8.3) | | |
| Drinking | Yes | 79(24.2) | 8.1(7.1,9.6) | -2.203[a] | 0.028 |
| | No | 248(75.8) | 7.5(6.7,9.3) | | |

Note: a represents the Mann-Whitney U test, b represents the Kruskal-Wallis H test.

A total of 327 elderly patients with type 2 diabetes mellitus (T2DM) were included. The average age was 67 (62,72) years. The HbA1c levels of elderly T2DM patients with different marital statuses, living areas, educational levels, and types of medical insurance were compared, and the differences were statistically significant ($P$<0.05). See Table 1.

## 3.2. Common Method Bias Test

A common method bias test was conducted for all scale items. The results showed that after rotation, four factors with eigenvalues greater than 1 were obtained. The loading of the first common factor was 29.153%, which was far less than the critical value of 40%, indicating that there was no serious common method bias problem in this study.

## 3.3. Current Status of Nutritional Status and Oral Weakness Risk in Elderly T2DM Patients

Among the 327 elderly T2DM patients in this survey, the average HbA1c was7.6 (6.8, 9.5) %. The total nutritional score was 10 (8, 12) points. There were 118 patients (32.09%) with normal nutritional status, 128 patients (39.14%) with a risk of malnutrition, and 81 patients (24.77%) with malnutrition. There were 54 patients (16.51%) with low risk of oral weakness, 27 patients (8.26%) with moderate risk, and 246 patients (75.23%) with high risk.

## 3.4. Correlation

Correlation analysis was conducted between the HbA1c of elderly T2DM patients, the risk of oral weakness, and nutritional status. The results showed that the risk of oral weakness was positively correlated with HbA1c($r$=0.421, $p$<0.01); the risk of oral weakness was positively correlated with nutritional status ($r$=0.421, $p$<0.01); and nutritional status was positively correlated with HbA1c ($r$=0.438, $p$<0.01). See Table 2.

**Table 2.** Correlation Analysis of HbA1c, Oral Frailty Risk Index and Nutritional Status

| | HbA1c | Oral Frailty Index-8 | MNA-SF |
|---|---|---|---|
| HbA1c | 1.000 | | |
| Oral Frailty Index-8 | 0.421** | 1.000 | |
| MNA-SF | 0.438** | 0.421** | 1.000 |

Note: * indicates $p < 0.05$, ** indicates $p < 0.01$.

## 3.5. The Mediating Effect of Nutritional Status between Oral Weakness Risk and HbA1c in Elderly Patients with Type 2 Diabetes Mellitus

This study analyzed using Model 4 of the PROCESS program to test the mediating effect of nutritional status between the oral weakness risk and HbA1c in elderly patients with type 2 diabetes mellitus. Variables with significance in the univariate analysis (marital status, place of residence, education level, type of medical insurance, disease duration, family history, treatment method, smoking, drinking) were taken as control variables. The results are shown in Table 3.

**Table 3.** The Mediating Effect of Nutritional Status on the Relationship between Oral Frailty Risk and HbA1c in Elderly Patients with Type 2 Diabetes Mellitus

| Variable | Model 1 | | Model 2 | | Model 3 | |
|---|---|---|---|---|---|---|
| | MNA-SF | | HbA1c | | HbA1c | |
| | β | t | β | t | β | t |
| Marital status | 0.0978 | 3.7702*** | 0.2408 | 1.0265 | 0.2437 | 0.4489 |
| Address | 0.0940 | -2.6760** | 0.2313 | -2.2713* | 0.2315 | -1.8630 |
| Educational | 0.0599 | -1.3190 | 0.1475 | -1.6099 | 0.1465 | -1.4201 |
| medical insurance | 0.0727 | -0.6332 | 0.1791 | -0.5320 | 0.1774 | -0.4400 |
| Course of the disease | 0.0524 | 0.3330 | 0.1291 | 0.5243 | 0.1278 | 0.4785 |
| Family history | 0.0785 | 1.5791 | 0.1933 | 1.2227 | 0.1921 | 0.9891 |
| Treatment | 0.0464 | -0.8475 | 0.1141 | 1.1499 | 0.1131 | 1.2900 |
| Smoking | 0.0869 | 3.0693** | 0.2140 | 2.4081* | 0.2150 | 1.9333 |
| Drinking | 0.0889 | 0.1606 | 0.2187 | 0.9178 | 0.2166 | 0.9024 |
| Oral Frailty Index-8 | 0.0549 | 4.5109*** | 0.1352 | 3.1169** | 0.1381 | 2.3814* |
| MNA-SF | | | | | 0.1371 | 2.7253** |
| $R^2$ | 0.3478 | | 0.2584 | | 0.2755 | |
| $R$ | 0.5897 | | 0.2584 | | 0.5249 | |
| $F$ | 0.5897*** | | 11.0097*** | | 10.8876*** | |

Note: * indicates $p$<0.05, ** indicates $p$<0.01, and *** indicates $p$<0.001.

Model 1 indicated that among all control variables, marital status, place of residence, and smoking had significant effects on the nutritional status of elderly patients with type 2 diabetes mellitus ($P$<0.05), and the oral weakness risk had apositive predictive effect on the nutritional status ($\beta$=0.0549, $P$<0.001); Model 2 indicated that the place of residence and smoking had significant effects onHbA1c ($P$<0.05), and the oral weakness risk had apositive predictive effect on HbA1c ($\beta$=0.1352,$P$<0.01); Model 3 indicated that when the nutritional status was the mediating variable and could significantly affect HbA1c ($\beta$=0.1371, $P$<0.01), the oral weakness risk also significantly affected HbA1c ($\beta$=0.1381,

*P*<0.05), indicating that there was a partial mediating effect of nutritional status between the oral weakness risk and HbA1c in elderly patients with type 2 diabetes mellitus. The mediating effect model is shown in Figure 1.

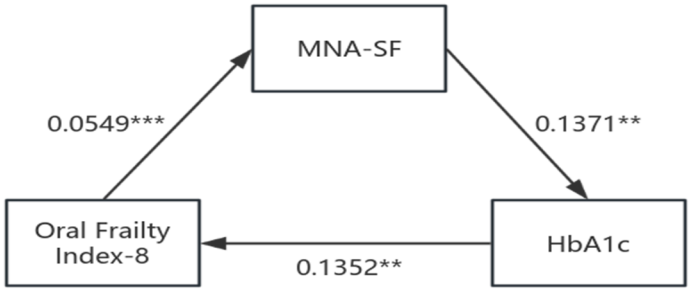


**Figure 1.** Mediating effect of nutritional status on oral frailty risk and HbA1c in elderly patients with type 2 diabetes mellitus

To ensure the accuracy of the test, the Bootstrap method was used to verify the mediating effect, and 5000 replications were repeated. The results are shown in Table 4. The total effect value was 0.4215, and the 95% *CI* was (0.1554 -0.6875), indicating a significant total effect; the direct effect value was 0.3289,and the 95% CI was (0.0572 - 0.6006), indicating a significant direct effect, and the effect value accounted for 78.03%; the indirect effect value was 0.0926, and the 95% CI was (0.013 - 0.193), indicating a significant indirect effect, and the effect value accounted for 21.97%.

**Table 4.** Test results of Bootstrap mediation effect

| | *Effect* | *SE* | *T* | 95%*CI* | | Effect value proportion |
|---|---|---|---|---|---|---|
| | | | | *BootLLCI* | *BootULCI* | |
| Overall | 0.4215 | 0.1352 | 3.1169 | 0.1554 | 0.6875 | 100% |
| Directly | 0.3289 | 0.1381 | 2.3814 | 0.0572 | 0.6006 | 78.03% |
| Indirectly | 0.0926 | 0.0465 | \ | 0.013 | 0.193 | 21.97% |

# 4. Discussion

The results of this study indicate that elderly patients with type 2 diabetes mellitus (T2DM) have a higher risk of oral frailty, which is consistent with the findings of Zhong Lei[12]. Analyzing the reasons, it may be related to the patients' age and the disease itself. As age increases, the body's resistance decreases, and most patients have abnormal white blood cell functions, resulting in significantly enhanced bacterial susceptibility[13]. Elderly patients are more prone to oral diseases such as periodontitis, which in turn leads to oral frailty. Oral frailty causes inflammatory mediators to enter the bloodstream, promoting an increase in serum C-reactive protein, interleukin-6, etc., exacerbating insulin resistance [14], forming a vicious cycle of "oral frailty - aggravated insulin resistance - deterioration of oral frailty". In addition, limited medical insurance coverage for oral diagnosis and treatment is also a key factor for the high incidence of oral frailty in elderly T2DM patients[15]. It is recommended to conduct regular screening for oral frailty in elderly T2DM patients and conduct relevant knowledge education in conjunction with specialized departments to improve their oral health literacy.

In this study, the total nutrition score of elderly T2DM patients was 10 (8, 12)points, and 39.14% of the patients had a risk of malnutrition, and 24.77% of the patients had malnutrition. This is consistent with the research results of Zhao Hengxia[5] and others. The reduction of digestive function and taste sensitivity in elderly patients seriously affects their food perception and appetite. At the same time, dietary management runs through the diabetes treatment process, but elderly patients often have biased understanding and improper operation of the requirements[16], ultimately leading to the occurrence of malnutrition. It is suggested that medical staff should pay attention to the nutritional status of elderly T2DM patients, enrich the content of dietary education, and regularly assess the nutritional status of patients.

In this study, the average HbA1c of elderly T2DM patients was 7.6 (6.8, 9.5)%, showing an overall situation of poor blood sugar control, similar to the research results of Hu Jie[17]. Marital status, place of residence, education level, type of medical insurance, disease duration, family history, treatment method, and smoking and drinking all have a significant impact on HbA1c ($p$<0.05). Analyzing the reasons, it may be because rural patients have less exposure to outside food compared to urban patients, and their blood sugar rises more slowly; patients with higher education levels have a better understanding of the disease and stronger compliance, resulting in better HbA1c control. The reimbursement ratio of employee medical insurance is higher than that of resident medical insurance[17], which can reduce the economic burden of patients and facilitate their timely medical treatment, which is beneficial to the control of HbA1c. Patients with shorter disease duration, no family history, appropriate treatment methods, and no smoking or drinking have better HbA1c control than those with longer disease duration, family history, poor treatment methods, and smoking or drinking.

The results of this study show that the risk of oral frailty in elderly T2DM patients is positively correlated with HbA1c (r= 0.421, p<0.01). The higher the risk of oral frailty, the higher the HbA1c. This is consistent with the research results of foreign scholars Poyil [18]. The reason is that inflammatory aging is an important driving force for the occurrence and development of diabetes, causing the patient's body to remain in a pro-inflammatory state, and the secretion of inflammatory factors increases. Excessive inflammatory

reaction combined with weakened oral defense ability [19] increases the risk of oral frailty in elderly patients, with higher HbA1c and aggravated difficulty in controlling blood sugar. Nutritional status is positively correlated with HbA1c ($r=0.438$, $p<0.01$). The worse the nutritional status, the worse the control of HbA1c. Diabetes is a metabolic disease that can cause digestive dysfunction and affect the absorption of various nutrients. At the same time, elderly patients are limited by their living abilities and dietary habits, resulting in deficiencies in various nutrients and an increased risk of malnutrition, which further enhances the invasion of pathogenic factors on pancreatic β cells and increases the difficulty of controlling HbA1c [20]. The risk of oral frailty is positively correlated with the nutritional status ($r=0.421$, $p<0.01$). The higher the risk of oral frailty, the worse the nutritional status of the patients. Oral frailty can increase the discomfort in the mouth of patients, such as dry mouth, decreased chewing ability, etc., which leads to food intake obstruction and reduced intake of various nutrients, posing a threat to the nutritional status of the patients.

The results of this study indicate that nutritional status has a partial mediating effect between the risk of oral frailty and HbA1c in elderly T2DM patients, with the effect value accounting for 21.97%. This suggests that the risk of oral frailty not only directly affects HbA1c, but can also indirectly affect HbA1c through the mediating effect of nutritional status. The reasons are as follows: Insulin resistance, as an important cause of poor blood sugar control in elderly T2DM patients, is closely related to inflammation. Oral frailty is prone to cause local infections, inflammation and systemic inflammatory responses in the mouth, aggravating insulin resistance, and subsequently leading to an increase in the difficulty of blood sugar control and a persistently high HbA1c level[14]. Good oral health status is crucial for ensuring adequate nutritional intake in elderly patients and reducing the risk of malnutrition[21]. However, elderly patients often tend to prefer single soft foods in their diet, which are mostly processed products with low nutrient content. Insufficient nutrient intake can easily cause abnormal nutritional status in patients. Moreover, elderly T2DM patients often have chronic comorbidities, and long-term control of diet and medication may lead to anorexia in patients, further increasing the risk of malnutrition[22]. Abnormal nutritional status will exacerbate the impaired secretion function of pancreatic β cells, which is less conducive to the control of HbA1c [20]. Therefore medical staff should attach importance to the oral health of elderly T2DM patients, conduct regular oral assessments, strengthen oral-related health education activities, and enhance patients' awareness of oral health care. At the same time dietary education for elderly T2DM patients should be strengthened, and diabetes diet management clinics should be established for patients to consult, and the nutritional status of patients should be evaluated regularly to ensure the rationality of nutritional intake, helping patients control HbA1c within the ideal range and reducing the risk of adverse outcomes.

# References


[1] Chinese Clinical Guidelines for the Prevention and Treatment of Type 2 diabetes in the Elderly (2022edition) [J]. Chinese Journal of Diabetes, 2019,30 (01) :2-51.

[2] Wang Hui, Li Yunkai, Sun Shuzhen. Effects of blood glucose on the colonization and growth of oral periodontal pathogens in the elderly [J]. Chinese Journal of Gerontology, 2014,34 (19) :5437-5439.

[3] Ishii M, Yamaguchi Y, Hamaya H, et al. Influence of oral health on frailtyin patients with type 2 diabetes aged 75 years or older[J]. BMC geriatrics,2022, 22 (1) : 145.

[4] Kocher T, Holtfreter B, Petersmann A, et al. Effect of periodontal treatmenton HbA1c among patients with prediabetes [J]. Journal of dental research, 2019, 98 (2) : 171-179.

[5] Zhao Hengxia, Zhang Xiaowan, Jiang Ximeng, et al. Effects of food intakeon nutritional status in elderly patients with diabetes [J]. Modern Preventive Medicine, 2019,51 (01) :50-54.

[6] de Sire A, Ferrillo M, Lippi L, et al. Sarcopenic dysphagia, malnutrition, and oral frailty in elderly: a comprehensive review[J]. Nutrients, 2022, 14 (5) :982.

[7] Zhao Wanyue, Zou Hao, Lv Yumei, et al. The effect of executive function on frailty in the elderly: moderated mediation model [J]. Military Nursing,2022, 39 (11) : 21-24.

[8] Tanaka T, Hirano H, Ohara Y, et al. Oral Frailty Index-8 in the risk assessment of new-onset oral frailty and functional disability among community-dwelling older adults[J]. Archives of gerontology andgeriatrics, 2021, 94: 104340.

[9] Chen Zong-Mei, Tan Ying, LIANG Yuan-Jun, et al. Sinicization and validity test of oral frailty risk screening scale for elderly people [J]. Chinese Nursing Research, 2023, 37 (21).

[10] Rubenstein L Z, Harker J O, Salvà A, et al. Screening for undernutrition in geriatric practice: develo the short-form mini-nutritional assessment (MNA-SF) [J]. The Journals of Gerontology Series A: Biological Sciences and Medical Sciences, 2001, 56 (6) : M366-M372.

[11] Zhang Yan, Wang Lixian, Lv Xiaohua, et al. Application of Mini-nutritionAssessment Table in nutritional screening of elderly hospitalized patients with chronic diseases [J]. Chinese Journal of geriatric multi-organ Diseases, 2019, 18 (2) : 107-111.

[12] Zhong Lei, Zhang Hui, Xu Jing, et al. Construction of a nomogram prediction model for oral frailty in elderly patients with type 2 diabetes [J]. Journal of Practical Clinical Medicine, 2024, 28 (16) : 98-103.

[13] Yang Zhengxiang, Li Hang, Deng Lin. Analysis of the prognosis and riskfactors of dental implantation in diabetic patients with chronic periodontitis [J]. Journal of Oral and Maxillofacial Prosthodontics,2019,23 (04) :252-256.

[14] Li Lili, Xie Xiaoting, Wu Yun, et al. Research Progress on the Association Mechanism between Periodontitis and Diabetes Mellitus [J]. Journal of Sichuan University (Medical Science Edition), 2023, 54(01): 71-76.

[15] Wang Lin, Pu Xiaolan, Wang Ting, et al. The mediating effect of oral health related self-efficacy on oral frailty risk and nutrition in elderly people[J]. Chinese Journal of geriatric multi-organ Diseases, 2019,23 (09) :680-684.

[16] Chu Yumei, Wei Guangyu, Jiang Bo, et al. Analysis of the occurrence and influencing factors of malnutrition in elderly patients with type 2 diabetes mellitus [J]. Chinese Journal of Clinical Diagnosis and Misdiagnosis, 2020, 33(01): 57-61.

[17] Hu Jie, Zhang Ling, Zhang Feng, et al. Glycemic control and its influencing factors in patients with type 2 diabetes in Yulin area [J]. Journal of Xi'an Jiaotong University (Medical Science Edition), 2022, 43(06): 901-904.

[18] Poyil N J T, Vadakkekuttical R J, Radhakrishnan C. Correlation of periodontal inflamed surface area with glycated hemoglobin, interleukin-6 and lipoprotein (a) in type 2 diabetes with retinopathy[J]. World Journal of Diabetes, 2024, 15 (4) : 686.

[19] Ding Ysen, Shao ZW, Lin ZJ, et al. Periodontal health of 916 patients with type 2 diabetes mellitus and its influencing factors [J]. Shanghai Journal of Stomatology, 2019,31 (02) :173-177.

[20] Lin Bing, Wang Yafei, Shi Mai. Investigation of nutritional risk in elderlypatients with type 2 diabetes mellitus and its relationship with dietary intake and glycated hemoglobin [J]. Journal of Medical Research, 2016, 45 (4): 97-100.

[21] Chan A K Y, Tsang Y C, Jiang C M, et al. Diet, Nutrition, and oral health in older adults: a review of the literature[J]. Dentistry Journal, 2023, 11 (9) : 222.

[22] Kemmler W, Kohl M, Jakob F, et al. Effects of high intensity dynamic resistance exercise and whey protein supplements on osteosarcopenia in oldermen with low bone and muscle mass. Final results of the randomized controlled FrOST study[J]. Nutrients, 2020, 12 (8) : 2341.