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Overcoming dietary complexity in type 2 diabetes: influencing factors and coping strategies

Yingying Tang¹ and Dongmei Yang^{2*}

Abstract

Background Adherence to dietary guidelines is a fundamental aspect of diabetes management; however, it poses a significant challenge for patients with diabetes. Our research aims to assess the level of dietary compliance among individuals with type 2 diabetes (T2DM) and to identify the factors that influence their adherence to dietary advice.

Methods This study was a cross-sectional survey. The patients with T2DM undergoing treatment at our hospital from March, 2023, to June, 2024 were included. Compliance with dietary recommendations was assessed using the validated dietary compliance scale for type 2 diabetes mellitus patients (DCS-T2DM). Spearman correlation and logistic regression analyses were conducted to evaluate the factors influencing dietary compliance in patients with T2DM.

Results A total of 308 T2DM patients were included in our study. The results revealed that 46.10% of the participants had suboptimal dietary compliance. There were significant correlations between dietary compliance and several demographic and clinical factors, including age ($r=0.501$), gender ($r=0.447$), education level ($r=0.610$), average monthly household per capita income ($r=0.627$), and the duration, since T2DM diagnosis ($r=0.552$), all of which were statistically significant ($p < 0.05$). Logistic regression identified age ($OR=1.705$, 95%CI 1.262 ~ 1.987), gender ($OR=2.401$, 95%CI 1.909 ~ 3.134), education level ($OR=3.083$, 95%CI 2.434 ~ 3.957), average monthly household per capita income ($OR=3.721$, 95%CI 2.553 ~ 4.405), and the time since T2DM diagnosis ($OR=2.470$, 95%CI 1.755 ~ 3.262) as significant predictors of dietary compliance.

Conclusions 46.10% of patients with T2DM exhibited suboptimal dietary adherence, with age, gender, education, income, and diabetes duration significantly predicting compliance. It is imperative for healthcare providers to devise individualized intervention strategies that incorporate these pivotal factors to enhance dietary adherence in patients with T2DM.

Keywords Dietary, Compliance, Diabetes, Clinical, Care, Nursing

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Background

According to data released by the International Diabetes Federation, the number of adult persons with diabetes in China has reached 114 million cases, making it the country with the highest number of persons with diabetes globally [1, 2]. Diabetes is a metabolic disorder characterized by hyperglycemia, with a complex pathogenesis influenced by multiple factors, such as genetics, specific



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unhealthy choices and behaviors [3]. Among the classifications of diabetes, type 2 diabetes mellitus (T2DM) is the most prevalent, accounting for 90% of all diabetes cases [4]. In the treatment of T2DM, dietary management is one of the core principles [5]. A well-planned diet not only helps control body weight, improve hyperglycemia, dyslipidemia, and hypertension but also reduces the burden on pancreatic islet cells, with an importance comparable to that of drug therapy [6]. However, persons with diabetes often do not pay enough attention to dietary treatment, leading to poor compliance [7]. Therefore, assessing the dietary behavior compliance of patients with T2DM is crucial for providing targeted dietary guidance, which is not only beneficial in delaying the onset of diabetes complications but also key to improving the quality of life for patients [8, 9].

Further research indicates that dietary management has significant effects on controlling blood sugar and preventing complications, markedly slowing down the progression of the disease [10, 11]. However, patients face many challenges in implementing dietary management, such as a lack of relevant knowledge and difficulties in adaptation, which collectively contribute to low compliance [12]. With the continuous rise in the incidence of diabetes, dietary management has become an important component of health education, attracting widespread attention from both patients and healthcare professionals [13]. Healthcare professionals need to understand the current situation of patients in the dietary management process, identify and address the factors that promote and hinder patients' dietary management. At present, the literature suffers from a paucity of detailed insights into the dietary adherence rates among individuals with T2DM, as well as the precise determinants that modulate these rates. This ambiguity underscores the need for a more nuanced understanding of the factors that could potentially impact dietary compliance in this patient demographic. Therefore, the purpose of this study is to analyze the current status of dietary compliance and its influencing factors among T2DM patients, aiming to provide insights for informing and enhancing the management and care strategies for patients with T2DM.

Methods

Ethics

This study was a cross-sectional investigation, and the research protocol was formally approved by the ethics committee of the fourth affiliated hospital of Soochow university (approval number: 241054). During the course of the study, all participants provided written informed consent forms. We assured that all collected data would be used solely for the purpose of this scientific research.

Sample size consideration

In accordance with prior research [14], the sample size for a survey should be 5 to 10 times the number of items on the scale. The scale utilized in this study comprised 23 items, and taking into account a potential sample attrition rate of 10%, the minimum sample size for this study was calculated using the formula: $(23 \times 5 \times (1 + 0.10)) = 126.5$. Consequently, to ensure the reliability of the study's findings, the study should enroll at least 127 patients with T2DM.

Study population

This study included patients with T2DM who were hospitalized for diabetes and treated at a tertiary hospital in Suzhou, China from March 1, 2023, to June 30, 2024. The inclusion criteria were as follows: the diagnosis of T2DM had to conform to the internationally recognized diagnostic criteria for diabetes [4, 15, 16]. The patients were hospitalized for diabetes in our hospital. Patients were required to be over 18 years of age. They had to possess clear consciousness and the ability to read and communicate effectively. They were expected to participate voluntarily in the research and to cooperate in signing the informed consent form. The exclusion criteria were as follows: patients with other serious organic diseases, such as heart, liver, and kidney failure, were excluded. Patients with gestational diabetes or those with diabetes complicated by pregnancy were not included, because gestational diabetes and pregnancy-complicated diabetes presented unique physiological and metabolic challenges that could confound the analysis of dietary compliance factors specific to T2DM. Patients with eating disorders were also excluded.

Survey scale

We collected the following information of T2DM patients, including age, gender, body mass index (BMI), occupation, marital status, place of residence, educational level, average monthly household per capita income, and years since T2DM diagnosis. In this study, we utilized the dietary compliance scale for type 2 diabetes mellitus patients (DCS-T2DM) to assess the dietary compliance of patients. This scale was developed and validated by scholars Zhao et al. [17], with the purpose of quantitatively evaluating the dietary compliance of patients with type 2 diabetes. The scale comprised 23 items, categorized into five dimensions: dietary self-regulation, compliance to medical advice regarding sugar and fat intake, compliance to medical advice regarding oil and salt intake, compliance to medical advice regarding fruit and vegetable intake, and cooking and eating habits. Items were scored using a Likert 5-point scale, with

ratings from “never” to “always” assigned scores of 1–5, respectively. The total score of the scale ranged from 23 to 115, with higher scores indicating better dietary behavior compliance. The content validity of the scale was 0.928, and the Cronbach's α coefficient was 0.886, demonstrating good reliability and validity [18]. A DCS-T2DM score of 70 or less indicated that the patient had poor dietary compliance [19].

Survey process

Following ethical approval from the pertinent hospital committees, our research team meticulously selected participants based on predefined inclusion and exclusion criteria. Utilizing a standardized protocol, we provided comprehensive explanations to potential subjects regarding the rationale, significance, and procedure for completing the survey. Informed consent was obtained from each participant prior to their participation. Subsequently, the research team distributed the questionnaires, ensuring that patients completed them autonomously. Upon completion, the questionnaires were collected immediately, and their validity was meticulously assessed post-collection to ensure the integrity of the data.

Data analysis

Data were analyzed using the SPSS 25.0 software package for statistical analysis. Initially, descriptive statistical analysis was conducted on general sociodemographic characteristics using frequency, mean, standard deviation, and percentage; subsequently, the scores of each dimension were described using mean and standard deviation. For metric data, normality testing was first performed; if the data were normally distributed, t tests and F tests were used; if not normally distributed, rank sum tests were applied. Categorical data were analyzed using the chi-square test. Spearman correlation analysis was employed to assess the correlation between dietary compliance and the characteristics of T2DM patients, while logistic regression analysis was utilized to evaluate the factors influencing dietary compliance in T2DM patients. A P value of less than 0.05 was considered to indicate statistical significance.

Results

A total of 308 T2DM patients were included in this survey, the DCS-T2DM score of 142 patients (46.1%) was ≤ 70 .

As indicated in Table 1, statistical differences in the age, gender, educational level, average monthly household per capita income, and years, since T2DM diagnosis was found between the poor dietary compliance and control group (all $p < 0.05$). No statistical differences in the gender, BMI, occupation, marital status, place of residence

were found between the poor dietary compliance and control group (all $p > 0.05$).

As presented in Table 2, the average total DCS-T2DM score was 86.05 ± 10.21 , and the highest score was the dimension of compliance to medical advice regarding fruit and vegetable intake, the lowest score was the dimension of cooking and eating habits.

As shown in Table 3, Spearman correlation analysis indicated that age ($r = 0.501$), gender ($r = 0.447$), educational level ($r = 0.610$), average monthly household per capita income ($r = 0.627$), and years, since T2DM diagnosis ($r = 0.552$) was correlated with the dietary compliance of T2DM patients (all $p < 0.05$).

As presented in Table 4, logistic regression analysis indicated that age (OR = 1.705, 95%CI 1.262 ~ 1.987), gender (OR = 2.401, 95%CI 1.909 ~ 3.134), educational level (OR = 3.083, 95%CI 2.434 ~ 3.957), average monthly household per capita income (OR = 3.721, 95%CI 2.553 ~ 4.405), years, since T2DM diagnosis (OR = 2.470, 95%CI 1.755 ~ 3.262) was the influencing factors of dietary compliance of T2DM patients (all $p < 0.05$). In the context of diabetes management, specific demographic subsets, notably those who were younger, male, had lower educational attainment, were economically disadvantaged, and had T2DM for an extended period, exhibited reduced dietary compliance. This observation suggests that these particular groups may require tailored interventions to address the unique challenges they face in adhering to recommended dietary guidelines.

Discussions

Dietary therapy is pivotal to the effective self-care of individuals living with diabetes, this approach is essential for optimizing glycemic control and mitigating the complications associated with the disease [20, 21]. The results of this study indicate that 46.10% of patients with T2DM have poor dietary compliance. Furthermore, the dietary compliance of T2DM patients is influenced by factors, such as age, gender, education level, household income, and the duration of diabetes. Therefore, healthcare professionals in clinical settings should take appropriate intervention measures based on these influencing factors to enhance patients' dietary compliance and thereby improve their prognosis.

In previous studies [12, 22, 23], the compliance rate among persons with diabetes was generally low, averaging only 40%. This low compliance is primarily attributed to the patients' lack of knowledge about the disease and poor dietary control capabilities. Further investigative research has revealed that although approximately 75% of persons with diabetes receive formal medical guidance, less than half of them are able to follow dietary treatment plans. In addition, studies [24, 25] have indicated that

Table 1 Characteristics of included T2DM patients ($n = 308$)

Characteristic	Poor dietary compliance group ($n = 142$)	Control group ($n = 166$)	t/χ^2	p
Age (years)	56.10 ± 6.24	63.88 ± 5.91	12.005	0.016
Male/female	90/52	81/85	1.942	0.003
BMI (kg/m^2)	22.57 ± 2.10	22.60 ± 2.57	4.895	0.104
Occupation			1.446	0.097
Manufacturing operatives	53(37.32%)	66(39.76%)		
Farmer	31 (21.83%)	37 (22.29%)		
Self-employed	20 (14.08%)	20 (12.05%)		
Civil servant	18 (12.68%)	21 (12.65%)		
Retired	16 (11.27%)	19 (11.45%)		
Other	4 (2.41%)	3 (1.81%)		
Marital status			2.187	0.115
Married	104 (73.24%)	124 (74.70%)		
Unmarried	15 (10.56%)	20 (12.05%)		
Divorced	19 (13.38%)	16 (9.64%)		
Widowed	4 (2.82%)	6 (3.61%)		
Place of residence			1.368	0.204
Rural	57 (40.14%)	62 (37.35%)		
Urban	85 (59.86%)	104 (62.65%)		
Educational level			1.144	0.009
Primary school	53 (37.32%)	38 (22.89%)		
Junior High school	35 (24.65%)	22 (13.25%)		
Senior high school	14 (9.86%)	46 (27.71%)		
Associate degree	27 (19.01%)	40 (24.10%)		
Bachelor's degree	10 (7.04%)	15 (9.04%)		
Master's degree	3 (2.11%)	5 (3.01%)		
Average monthly household per capita income (Yuan)	4468.12 ± 648.10	5420.77 ± 752.16	25.003	0.036
Years since T2DM diagnosis	2.78 ± 1.58	7.02 ± 2.65	1.734	0.022

Type 2 diabetes mellitus, T2DM; body mass index, BMI

Table 2 DCS-T2DM score of T2DM patients

Dimension	Number of items	Average score
Dietary self-regulation	5	18.14 ± 5.09
Compliance to medical advice regarding sugar and fat intake	5	18.07 ± 6.22
Compliance to medical advice regarding oil and salt intake	4	15.79 ± 5.65
Compliance to medical advice regarding fruit and vegetable intake	5	19.03 ± 4.12
Cooking and eating habits	4	12.35 ± 5.80
Total DCS-T2DM	23	86.05 ± 10.21

Dietary compliance scale for type 2 diabetes mellitus patients, DCS-T2DM

among patients with T2DM, only 25% are able to fully comply with medical advice, and about 37% can meet the dietary requirements set by their doctors. More concerning is that 20% of patients exhibit an indifferent attitude towards the treatment arrangements made by their doctors [26]. These figures highlight the deficiencies in dietary compliance among T2DM patients. The results

of this survey further confirm that the current state of dietary compliance among T2DM patients is not ideal. In light of this, improving patients' dietary compliance is particularly urgent and necessary. This requires not only an increase in patients' understanding of the disease and their self-management abilities but also the provision of more personalized and easily implementable dietary

Table 3 Spearman correlation analysis on the correlation of dietary compliance and characteristics of T2DM patients

Characteristic	<i>r</i>	<i>p</i>
Age	0.501	0.016
Gender	0.447	0.034
BMI	0.133	0.146
Occupation	0.201	0.077
Marital status	0.152	0.104
Place of residence	0.179	0.090
Educational level	0.610	0.029
Average monthly household per capita income (Yuan)	0.627	0.001
Years since T2DM diagnosis	0.552	0.035

Type 2 diabetes mellitus, T2DM; body mass index, BMI

Table 4 Logistic regression analysis on the influencing factors of dietary compliance of T2DM patients

Variables	β	<i>Sx</i>	OR	95%CI	<i>p</i>
Age	0.144	0.102	1.705	1.262~1.987	0.040
Gender	0.123	0.113	2.401	1.909~3.134	0.015
Educational level	0.103	0.158	3.083	2.434~3.957	0.025
Average monthly household per capita income	0.218	0.102	3.721	2.553~4.405	0.011
Years since T2DM diagnosis	0.117	0.104	2.470	1.755~3.262	0.028

Type 2 diabetes mellitus, T2DM

guidance by healthcare professionals [27, 28]. Such guidance will assist patients in better adhering to treatment plans, thereby improving their health status and quality of life.

This study reveals an upward trend in compliance to medical advice among patients with T2DM as age increases. Prior research [29] has indicated that the elderly, post-retirement, have more personal time, which allows them to engage more actively in health education, thereby exhibiting higher levels of compliance. A survey conducted among T2DM patients showed significant differences in dietary compliance across various age groups, with older patients demonstrating better compliance [30]. However, contrasting findings suggest that younger patients may have better dietary treatment compliance than older patients, possibly due to a lack of understanding of the dietary treatment regimen among the elderly, which in turn affects the efficacy of their dietary therapy [31]. Therefore, the impact of age on patients' compliance to dietary treatment warrants further in-depth investigation in future studies. The findings of this study reveal that female patients exhibit a higher level of compliance to dietary treatment compared to their male counterparts. This may be attributed to the fact that female

patients are more communicative and receptive to dietary guidance provided by physicians, demonstrating a strong desire to acquire health-related knowledge [32]. Previous surveys [33, 34] have also indicated that women have better compliance to dietary treatment than men, possibly due to their relatively fewer social activities, which makes them more inclined to learn about diabetes through communication and place greater emphasis on daily health care.

Diabetes, as a chronic condition requiring long-term systematic treatment, involves a complex therapeutic process accompanied by high costs, making it challenging for patients to maintain consistent treatment compliance. Studies [25, 35] have indicated that there is a close relationship between economic income level and patient compliance with treatment; patients with lower incomes tend to exhibit poorer compliance. It has been reported that higher-income groups, due to their higher utilization of medical resources, are more inclined to participate in preventive health activities, which helps them develop good health behaviors and dietary habits [36, 37].

Furthermore, an increase in educational level is directly proportional to the attention paid to health care knowledge, with patients of different educational backgrounds demonstrating varying levels of compliance to medical advice [38]. Patients with lower levels of education may have insufficient understanding of diabetes, leading to relatively poor dietary compliance [39, 40]. In contrast, patients with higher levels of education are more receptive to knowledge about diabetes. They not only focus on continuous learning about the condition but also have a more accurate understanding and acceptance of dietary treatment plans, thereby showing higher compliance during the treatment process [41]. Therefore, improving patients' economic status and educational level is an important pathway to enhancing their dietary compliance. Recent studies have underscored the significance of these factors in diabetes management. For instance, a study [42] has revealed that diabetes prevalence increases with increasing wealth, indicating a substantial relationship between socioeconomic status and diabetes risk, which is independent of body mass index. In addition, educational differences in diabetes self-management behaviors have been observed across WHO SAGE countries, suggesting that higher educational attainment may influence diabetes diagnosis and self-management [43]. Furthermore, a scoping review [44] of nutrition education interventions highlighted the positive impact of such programs on improving the competencies, lifestyle, and dietary habits of medical students and residents, which could be extrapolated to patient populations. These findings collectively suggest that addressing economic and educational disparities is not only crucial for enhancing

dietary compliance but also for improving overall diabetes management and outcomes.

There is a certain correlation between patients' dietary compliance and the duration of the disease course. Research [45] indicates that persons with diabetes with a shorter disease course often place greater emphasis on disease management due to their fresh understanding of the condition and their desire for health, which translates into a higher rate of compliance to medical advice. They are typically able to actively cooperate with the treatment plans of physicians and strictly adhere to the requirements of diet and medication [46]. However, for persons with diabetes with a longer disease course, the long-term torment of the disease may lead to emotional fluctuations, such as irritability, pessimism, and even stubbornness in character [47]. These changes in emotional and psychological state often pose greater challenges for them in adhering to dietary control, thereby affecting compliance. Coexisting with the disease over a long period may lead to a certain degree of adaptation or numbness to the condition, which to some extent weakens their compliance to treatment [48]. Interestingly, it has been reported that when the disease course exceeds 10 years, patients' compliance actually improves [49]. This may be because as time goes on, patients gain a deeper understanding and acceptance of the disease, coupled with the possibility of having undergone more health education and self-management training, thus forming a more stable habit of self-management in the long-term treatment process [50]. However, for patients with a shorter disease course, since the symptoms of T2DM are not obvious, they may lack sufficient understanding and attention to the condition, and this neglectful attitude may lead to poorer dietary compliance [51]. Clinical physicians and nursing staff should adopt differentiated management strategies when facing persons with diabetes with different disease courses. For patients with a shorter disease course, health education should be strengthened to enhance their understanding and attention to the disease. For patients with a longer disease course, more attention should be paid to their psychological state and emotional management, helping them to establish and maintain good self-management habits to improve their dietary compliance.

While this survey has provided valuable preliminary data, there are indeed limitations in its design and execution that warrant careful consideration and further exploration. First, the utilization of a hospitalized cohort in our study could indeed impart a selection bias, which may lead to a representation that is disproportionately composed of individuals with more severe health conditions compared to the general T2DM population. Consequently, this potential bias is a critical factor to consider when extrapolating our results to the entire spectrum of

T2DM patients, suggesting that our findings should be approached with a degree of caution in broader applicability. Second, the survey is a single-center study, and although the sample size meets the predetermined statistical requirements, the relatively small scale of the sample may limit the generalizability of the study results and increase the risk of insufficient statistical power. This could result in the failure to adequately capture certain subtle but important influencing factors, thereby affecting the accuracy and reliability of the research conclusions. Third, while the survey included some known key variables in its analysis of influencing factors, there may be additional unidentified factors affecting the dietary compliance of patients with T2DM. These potential factors could include the patients' personal beliefs, psychological health status, and more, all of which could influence the dietary choices and behaviors of patients to varying degrees. Considering the acknowledged limitations, subsequent studies are encouraged to employ larger sample sizes and robust, multi-centric research designs to facilitate a more exhaustive examination of dietary adherence and its determinants among individuals with T2DM. By doing so, these investigations would yield data that are more precise and dependable, thereby enhancing the validity of conclusions drawn. In addition, such an approach would elucidate regional and demographic variations, which are pivotal for crafting tailored and efficacious therapeutic and nursing protocols grounded in scientific evidence.

Conclusions

The results of this study indicate that 46.10% of patients with T2DM have poor dietary compliance. Furthermore, the dietary compliance of T2DM patients is influenced by factors, such as age, gender, education level, household income, and the duration of T2DM. In the context of individuals with diabetes, particularly those who are male and younger, have lower levels of education, are in poorer economic conditions, and have had the disease for a longer duration, targeted strategies are imperative to enhance dietary adherence. It is essential to initially emphasize the critical role of dietary therapy in diabetes management to this demographic, underlining its indispensable nature. Educational interventions should be designed to empower these patients, enabling them to understand the long-term benefits of a balanced diet for blood glucose control, the prevention of complications, and the enhancement of overall quality of life. Subsequently, healthcare providers should engage in a collaborative process with patients to develop personalized dietary plans that take into account individual preferences, cultural backgrounds, economic realities, and daily routines. Furthermore, considering the potential barriers

faced by patients with limited economic resources in accessing nutritious foods, it is crucial to provide cost-effective dietary options that are nutritionally balanced. This support aids in facilitating healthful dietary choices within the constraints of their budgets. For patients who have been managing the disease over an extended period, additional psychological support and encouragement are essential to help them navigate the fatigue and negative emotions associated with chronic illness. Regular follow-ups and assessments are vital to adjust dietary plans in response to the evolving health conditions and lifestyle needs of the patients. This approach may not only tailor care to the individual but also promotes a more effective and sustainable management of diabetes.

Abbreviations

T2DM	Type 2 diabetes mellitus
BMI	Body mass index
DCS-T2DM	Dietary compliance scale for type 2 diabetes mellitus patients

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Author contributions

YT, DY designed research; YT, DY conducted research; YT, DY analyzed data; YT wrote the first draft of manuscript; DY had primary responsibility for final content. All authors read and approved the final manuscript. All authors contributed to the conception or design of the study or to the acquisition, analysis, or interpretation of the data. All authors drafted the manuscript, or critically revised the manuscript, and gave final approval of the version that was submitted for publication. All authors agree to be accountable for all aspects of the work, ensuring integrity and accuracy.

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Availability of data and materials

The data associated with the paper are not publicly available but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

In this study, all methods were performed in accordance with the relevant guidelines and regulations. The study has been reviewed and approved by the ethics committee of the fourth affiliated hospital of Soochow university (approval number: 241054). In addition, written informed consents had been obtained from all the included patients.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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