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Effect of Continuous Quality Improvement Based on the Diabetes Plate on Dietary Management in Young and Middle-Aged Patients with Type 2 Diabetes

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Abstract

Objective: To investigate the effects of continuous quality improvement (CQI) on dietary adherence, glycemic control, lipid profiles, and glycated hemoglobin (HbA1c) levels in young and middle-aged patients with type 2 diabetes mellitus (T2DM). **Methods:** A time-based quasi-experimental before-after study was conducted using a Plan-Do-Check-Act (PDCA)-based continuous quality improvement program. Patients admitted between January and June 2023 were assigned to the pre-intervention phase, while those admitted between July and December 2023 were assigned to the post-intervention phase. Within each phase, 60 eligible patients were randomly sampled from hospitalized patients. Outcomes related to dietary adherence, glycemic control, lipid profiles, and HbA1c levels were compared before and after the intervention. **Results:** Following the implementation of CQI, the proportion of patients with qualified dietary adherence and overall glycemic control performance significantly improved. In addition, serum lipid levels and HbA1c levels showed significant improvement after the intervention (all $P < 0.05$). **Conclusion:** The implementation of continuous quality improvement effectively enhanced self-management abilities related to nutritional behaviors among young and middle-aged patients with T2DM.

Keywords

Continuous Quality Improvement, Type 2 Diabetes Mellitus, Young and Middle-Aged Adults, Dietary Management, Dietary Adherence Scale

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1. Introduction

Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder with a rapidly increasing global prevalence. According to the International Diabetes Federation, there are currently approximately 415 million individuals living with diabetes worldwide, and this number is projected to reach 642 million by 2040 [1] [2]. Moreover, the age of onset of T2DM has shown a progressive trend toward younger populations [3]. Young and middle-aged patients with T2DM often experience heavy work-related stress and fast-paced lifestyles, which contribute to poor dietary adherence and suboptimal glycemic control, thereby substantially increasing the risk of diabetes-related complications [4]. Dietary therapy is a cornerstone of diabetes management and plays a critical role in controlling blood glucose and lipid levels as well as improving quality of life [5]. However, previous studies have reported that 36% - 91.1% of patients with T2DM exhibit varying degrees of dietary nonadherence [6]-[7], highlighting the urgent need for effective and sustainable dietary management strategies.

Continuous quality improvement (CQI) is a systematic quality management approach that is patient-centered and process-oriented, emphasizing continuous enhancement of healthcare quality through data monitoring, teamwork, and iterative improvement cycles. Unlike traditional quality control models that focus primarily on outcome evaluation, CQI places greater emphasis on identifying critical process-related issues, analyzing root causes, and developing, implementing, and validating targeted improvement measures. The Plan-Do-Check-Act (PDCA) cycle represents the most commonly used and representative implementation framework of CQI, enabling continuous refinement and consolidation of improvement strategies through closed-loop management. In the context of chronic disease management, CQI is particularly suitable for addressing issues related to behavioral adherence, health education, and process standardization, thereby facilitating the translation of complex management objectives into practical, measurable, and sustainable clinical practices.

In this study, a CQI-based intervention was conducted using the PDCA cycle to achieve continuous improvement in dietary management [8]. Dietary behaviors were comprehensively evaluated using the *Dietary Adherence Scale for Patients with Type* 2 *Diabetes* developed by Qin *et al.* [9], which assesses multiple dimensions including dietary regularity and appropriateness of food selection. In combination with the diabetes plate method, dietary components were visually allocated into specific portions corresponding to carbohydrates, proteins, fats, and other essential nutrients, enabling patients to intuitively understand and implement balanced dietary patterns [10]. This study aimed to explore the effects of this CQI-driven dietary intervention on dietary adherence and glycemic control in young and middle-aged patients with T2DM, and the results are reported as follows.

2. Materials and Methods

2.1. General Information

PDCA (Plan-Do-Check-Act) continuous quality improvement management was

implemented in the Department of Endocrinology and Clinical Nutrition of Jingzhou First People's Hospital to improve dietary behaviors among middle-aged and young patients with type 2 diabetes mellitus starting in July 2023.

January-June 2023 was defined as the pre-implementation phase, and July-December 2023 as the post-implementation phase. Within each time period (January-June and July-December), eligible patients were randomly selected using a simple random sampling method from the hospitalization registry to reach the target sample size of 60 per group. Random sampling was conducted within each time block, not between blocks, to reduce selection bias while preserving the integrity of the PDCA-based institutional intervention.

2.2. Inclusion and Exclusion Criteria

Inclusion criteria:

1) Patients who met the diagnostic criteria for type 2 diabetes mellitus according to the Chinese Guidelines for the Prevention and Treatment of Type 2 Diabetes (2022 edition) [11];

2) Age between 18 and 59 years;

3) Clear mental status, ability to perform daily activities independently, absence of other severe underlying diseases, and no history of mental disorders;

4) A confirmed diagnosis of type 2 diabetes mellitus for ≥3 months;

5) Ability to cooperate with and complete the questionnaire survey;

6) Voluntary participation in this study with signed informed consent.

Exclusion criteria:

1) Patients with cognitive impairment or mental disorders;

2) Patients unable to perform daily activities independently;

3) Patients with severe underlying diseases or serious complications;

4) Middle-aged and young patients with type 2 diabetes mellitus who refused to participate in the survey;

5) Hospitalized patients with a length of stay of less than 7 days.

Termination criteria:

Patients who experienced disease deterioration or developed other severe complications during the study period were withdrawn immediately from the study.

This study protocol was reviewed and approved by the Ethics Committee of Jingzhou First People's Hospital, and all participants provided written informed consent prior to treatment.

2.3. Research Methods

During the pre-implementation phase, routine management was adopted. Medical staff provided patients with conventional health education and guidance.

During the post-implementation phase, PDCA continuous quality improvement management was applied.

Plan (P): The department conducted brainstorming sessions, reviewed relevant literature, and collected and analyzed existing data to identify key issues and deter-

mine the improvement theme. Team members discussed and finalized the details of the intervention strategies and assigned specific responsibilities accordingly.

Do (D): A PDCA quality improvement team was established, comprising a training and assessment subgroup, an evidence-based practice subgroup, a data collection subgroup, and a health education subgroup. The team analyzed existing problems in dietary behaviors among middle-aged and young patients with type 2 diabetes mellitus. A fishbone diagram was used to systematically identify primary and secondary causes, and major influencing factors were further identified using Pareto analysis, providing a basis for the development of targeted intervention measures.

Patient indicators were measured and recorded. Baseline data collected included age, sex, height, weight, total cholesterol (TC), triglycerides (TG), fasting blood glucose, 2-hour postprandial blood glucose, and glycated hemoglobin (HbA1c). Dietary adherence was assessed using a questionnaire survey. The Dietary Behavior Compliance Scale for Patients with Type 2 Diabetes, designed by Qin Ying *et al.* [9], was adopted. This scale evaluates dietary adherence across five dimensions: dietary self-management, carbohydrate- and lipid-related compliance behaviors, oil and salt intake compliance behaviors, fruit and vegetable intake compliance behaviors, and cooking and eating habits. The scale consists of 23 items, each scored on a 7-point Likert scale, yielding a total possible score of 189 points. A total score of ≥150 points was considered indicative of adequate dietary adherence. All reported dietary adherence rates in the Results section were generated exclusively from the Qin *et al.* scale. Dietary behaviors of hospitalized middle-aged and young patients with type 2 diabetes mellitus in the Department of Endocrinology and Clinical Nutrition were compared between two months before and two months after the implementation of continuous quality improvement management. All patients were observed for 7 consecutive days.

Patients were educated on food exchange portions, provided with educational pamphlets, and shown realistic food models representing six major food groups (legumes and dairy products, fruits, meat and eggs, cereals and tubers, vegetables, and oils and fats) [12]. Combined with hands-on demonstrations and the use of kitchen scales, patients were assisted in mastering food portion measurement techniques.

Body mass index (BMI) was calculated based on patient height and ideal body weight. Daily energy requirements were determined according to work intensity, and individualized dietary plans were formulated accordingly. Patients were instructed to perform food exchanges within the same food group using standardized "exchange portions" to ensure dietary diversity.

Patients were guided in using the "Diabetes Healthy Plate," which contains six compartments corresponding to the six major food groups, with food names and exchange portion numbers labeled to facilitate accurate portion control and promote scientifically balanced meals. During hospitalization, responsible nurses conducted group education sessions twice weekly, covering food exchange portions, caloric calculation, and appropriate eating order (consuming soup or water first, followed by vegetables and protein foods, and finally staple foods) to delay

postprandial blood glucose elevation [13].

For patients discharged from the hospital, a one-week meal plan was developed, and patients were enrolled in a dietary management group. They were encouraged to upload images of their meals and blood glucose records. Continuity of care was ensured through outpatient follow-up, promoting long-term adherence to healthy dietary behaviors.

Check (C): Members of the continuous quality improvement (CQI) team held weekly meetings to analyze patients' current nutritional status. Quality control was conducted using a self-developed Dietary Behavior Compliance Checklist for Middle-Aged and Young Patients with Type 2 Diabetes Mellitus, and changes in patient indicators were evaluated.

If improvements were observed, the intervention strategy was considered appropriate and effective and was continued. If no improvement was observed, underlying causes were analyzed, and the intervention design and implementation strategies were revised and optimized.

Statistical analysis was performed using SPSS software, and a P value of <0.05 was considered statistically significant.

Act (A): The optimized and effective management strategies were applied in subsequent work stages, continuously participating in the PDCA cycle. Quality improvement measures and management processes were regularly summarized, modified, and refined in routine clinical practice until optimal performance was achieved, after which they were implemented as long-term clinical practice standards.

2.4. Outcome Measures

In this study, a self-developed Dietary Behavior Adherence Checklist was employed exclusively for internal auditing of nursing practice during the PDCA "Check" phase and for quality control. This checklist assessed whether key intervention components (e.g., dietary plate education, portion guidance, follow-up supervision) were delivered as planned by nursing staff. As it was not used for patient outcome assessment, formal psychometric validation was not required, and all reported dietary adherence outcomes were derived from the validated scale by Qin *et al.*

Dietary behavior adherence before and after the implementation of the intervention was compared using questionnaire surveys. The dietary behavior adherence qualification rate during the observation period was calculated as follows:

(number of middle-aged and young patients with type 2 diabetes who met dietary adherence criteria during the observation period ÷ total number of middle-aged and young patients with type 2 diabetes during the same period) × 100%.

Glycemic control was also evaluated, and the blood glucose target achievement rate was calculated as:

(number of blood glucose measurements reaching target levels in middle-aged and young patients with type 2 diabetes during the observation period ÷ total number of blood glucose measurements during the same period) × 100%.

In addition, serum total cholesterol, TG, and HbA1c levels were monitored to comprehensively assess the intervention effects of diabetes plate-based Continuous Quality Improvement (CQI) on dietary behavior management in middle-aged and young patients with type 2 diabetes mellitus.

2.5. Statistical Analysis

Statistical analysis was performed using SPSS version 27.0 software. Continuous variables were expressed as mean ± standard deviation ($\overline{x} \pm s$) and compared using the t test. Categorical variables were expressed as percentages (%) and analyzed using the χ^2 test. A P value < 0.05 was considered statistically significant.

3. Results

The team conducted a brainstorming session to identify influencing factors, classified the causes using a fishbone diagram, and combined this with Pareto analysis to determine the key issues and prioritize areas for improvement.

Through cause analysis based on the fishbone diagram (**Figure 1**) and subsequent verification of the root causes, four main factors were identified: Excessive variety and inappropriate combination of foods, Inconsistent education competence of nurses to educate patients, poor self-management ability of patients, insufficient training of nurses.

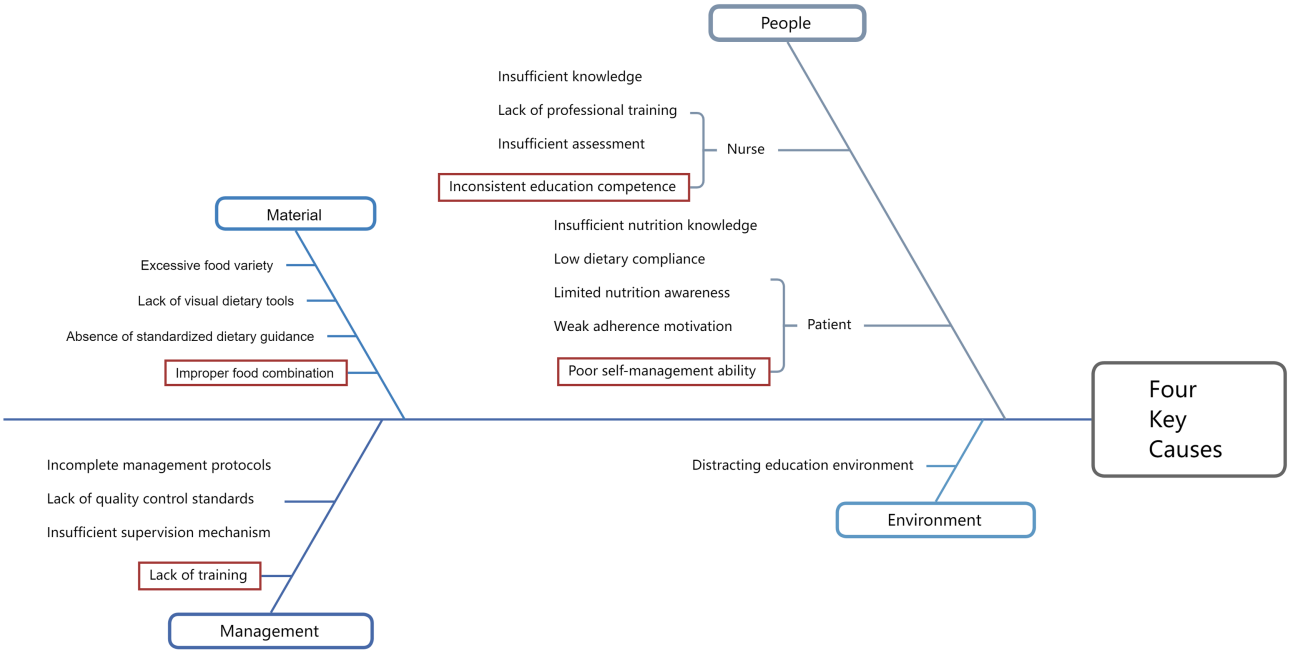

Figure 1. Fishbone diagram analysis.

This study selected the diabetes dietary plate as the intervention measure. After implementing the intervention, the dietary adherence rate increased from 51.6% to 80%. In addition, overall glycemic control performance improved, with the fasting blood glucose (FBG) target achievement proportion increasing from 64.1% to 76.9%

and the 2-hour postprandial blood glucose (2hPG) target achievement proportion increasing from 61.6% to 84.7%. Notably, glycemic control proportions were calculated based on the total number of blood glucose measurements obtained during the observation period, as each patient underwent multiple glucose assessments. The statistical results of other indicators are presented in the following Tables 1-4.

Table 1. Comparison of dietary adherence and glycemic control before and after the intervention.

Outcome	Indicator	Pre-intervention	Post-intervention
Dietary adherence	Number of patients with qualified dietary adherence during the observation period (n)	31	48
	Total number of patients during the observation period (n)	60	60
	Dietary adherence qualification rate (%)	51.6	80
Fasting blood glucose (FBG)	Number of measurements achieving target FBG levels during the observation period (times)	152	200
	Total number of FBG measurements during the observation period (times)	237	260
	FBG control rate (%)	64.1	76.9
2-h postprandial blood glucose (2hPG)	Number of measurements achieving target 2hPG levels during the observation period (times)	151	216
	Total number of 2hPG measurements during the observation period (times)	245	255
	2hPG control rate (%)	61.6	84.7

Table 2. Comparison of total cholesterol before and after intervention.

Time	Number of patients	Total cholesterol (mmol/L)
Before intervention	60	8.23 ± 1.05
After intervention	60	4.53 ± 0.74
t		22.26
P		<0.001

Table 3. Comparison of triglycerides before and after intervention.

Time	Number of patients	Triglycerides (mmol/L)
Before intervention	60	2.54 ± 0.75
After intervention	60	1.67 ± 0.59
t		7.06
P		<0.001

Table 4. Comparison of glycated hemoglobin before and after intervention.

Time	Number of patients	HbA1c (%)
Before intervention	60	8.59 ± 0.99
After intervention	60	6.93 ± 0.76
t		8.985
P		<0.001

4. Discussion and Conclusion

CQI, as a novel approach to quality management, has been increasingly applied in medicine in recent years [14]. Its theoretical framework emphasizes patient-centered care and process management, aiming to enhance service quality through continuous improvements. In endocrine nursing management, this approach should be integrated throughout the nursing process, with the goals of improving nursing quality and patient satisfaction while continuously identifying and addressing existing problems and deficiencies.

In this study, a CQI intervention model based on the diabetes dietary plate was implemented. By utilizing the plate method, complex dietary principles were translated into intuitive plate allocation proportions, significantly reducing patients' cognitive and execution burdens. This approach achieved remarkable outcomes in dietary management among young and middle-aged patients with type 2 diabetes.

The results indicate that, following the intervention, the dietary adherence rate increased from 51.6% to 80%, the fasting blood glucose control rate increased from 64.1% to 76.9%, and the 2-hour postprandial blood glucose control rate increased from 61.6% to 84.7%. Meanwhile, TC, TG, and HbA1c levels were all significantly improved (all $P < 0.05$). These findings suggest that CQI, through visualized dietary allocation, dynamic feedback adjustment, and psychological empowerment, effectively enhanced patients' adherence to dietary management and their metabolic control.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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