

A Study on Nursing Strategies for Low-Carbohydrate Dietary Intervention and Exercise Guidance in Elderly Diabetes Patients

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Abstract: This study aims to investigate the effectiveness of a synergistic care strategy combining a low-carbohydrate dietary intervention with individualized exercise guidance in elderly patients with type 2 diabetes. It analyzes the impact of this intervention on patients' glucose metabolism, quality of life, and the incidence of nocturnal hypoglycemia, thereby providing clinical evidence to optimize care plans for elderly patients with type 2 diabetes and enhance the safety and efficacy of disease management. Using stratified random sampling, 120 elderly patients with type 2 diabetes were selected and randomly assigned to either the control group (standard care) or the intervention group (standard care + low-carbohydrate dietary intervention + exercise guidance). The 12-week intervention period evaluated fasting blood glucose, 2-hour postprandial blood glucose, quality of life, and nocturnal hypoglycemia incidence. After 12 weeks of intervention, the observation group exhibited significantly lower fasting blood glucose and 2-hour postprandial blood glucose levels compared to the control group ($P < 0.05$). The observation group also demonstrated markedly superior quality of life in aspects such as mental health and social adaptability ($P < 0.05$), along with a lower incidence of nocturnal hypoglycemia ($P < 0.05$). Conclusion A synergistic care model combining low-carbohydrate dietary intervention with exercise guidance can effectively improve glucose metabolism levels, enhance quality of life, and reduce the incidence of nocturnal hypoglycemia, demonstrating significant clinical application value.

Keywords: Diabetes in the elderly; Low-carbon diet; Exercise Guidance; Collaborative Care

1. Introduction

Type 2 diabetes is a common chronic metabolic disease among the elderly. Due to physical inactivity, sleep disturbances, and poor nutrition, it severely impacts patients' quality of life and health status [1]. In particular, with the aging of the population, the number of elderly patients with type 2 diabetes is increasing; these patients often face difficulties in blood glucose control and have a high incidence of complications, leading to growing demands for nursing interventions. Dietary management and exercise intervention are integral components of comprehensive diabetes treatment; however, traditional nursing models primarily consist of general guidance and lack a systematic, individualized approach, failing to meet the long-term management needs of elderly patients. A low-carbohydrate diet stabilizes blood glucose levels through the scientific and reasonable control of carbohydrate intake, while scientifically grounded, gradual exercise guidance can improve insulin sensitivity. Combining these two approaches can further enhance nursing outcomes. Therefore, this study established a synergistic nursing model combining low-carbohydrate dietary intervention and exercise guidance to observe its impact on glucose metabolism, quality of life, and the incidence of nocturnal hypoglycemia among community-dwelling elderly patients with type 2 diabetes, with the aim of providing a practical basis for the care of elderly patients with diabetes in the community.

2. Materials and Methods

2.1 Inclusion and Exclusion Criteria

Inclusion Criteria:

- ① Meets the diagnostic criteria for type 2 diabetes;
- ② Age ≥ 60 years;
- ③ Disease duration ≥ 1 year;
- ④ Alert and able to cooperate with nursing interventions;
- ⑤ Willing to participate and have signed an informed consent form.

Exclusion Criteria:

- ① Patients with severe cardiac, cerebrovascular, hepatic, or renal insufficiency;
- ② Patients with acute complications or malignant tumors;
- ③ Patients with severe cognitive impairment or psychiatric disorders;
- ④ Patients who have recently participated in other intervention studies.

2.2 General Information

This study recruited 150 elderly patients with diabetes from three communities in Zhangqiu District between June and September 2025. After applying exclusion and inclusion criteria, 120 elderly patients with type 2 diabetes were ultimately selected as study subjects. Participants were assigned with equal probability to the control group and the observation group using a randomization method, with 60 participants in each group. The control group consisted of 34 male and 26 female participants, aged between 60 and 82 years, with a mean age of (71.2 ± 5.4) years. Their duration of diabetes ranged from 2 to 18 years, with a mean duration of (8.9 ± 3.1) years; The observation group consisted of 32 men and 28 women, ranging in age from 61 to 84 years, with a mean age of (71.6 ± 5.2) years and a disease duration ranging from 2 to 17 years, with a mean duration of (9.1 ± 3.3) years. A comparative analysis of baseline characteristics—including gender, age distribution, and disease duration—between the two groups revealed no significant differences ($P > 0.05$).

2.3 Intervention Methods

2.3.1 Control Group

Patients in the control group received standard care. Community nurses provided patients with basic education on diabetes, covering topics such as disease-related knowledge, medication precautions, and blood glucose monitoring methods; general dietary guidance, advising patients to reasonably control their total calorie intake and reduce consumption of high-sugar and high-fat foods; and encouragement for patients to engage in moderate exercise appropriate to their individual circumstances, such as walking or brisk walking. However, no systematic, individualized diet or exercise plans were developed, nor was follow-up management provided. The nursing intervention lasted 12 weeks.

2.3.2 Observation Group

In addition to routine care, the observation group received a combined “low-carbohydrate diet and exercise guidance” nursing intervention, with the specific details as follows:

(1) Low-Carbohydrate Diet Intervention

Low-carbohydrate diet plans were developed based on evidence-based nutritional principles and tailored to each patient’s individual circumstances.

- ① The dietary structure was designed based on the “Chinese Dietary Guidelines (2022)”, limiting the proportion of energy derived from carbohydrates and selecting local, seasonal ingredients with a low glycemic index, minimal processing, and a low carbon footprint. A basic meal plan consisting of 1 staple food + 2 vegetables + 1 high-quality protein source was implemented [2].

② Dietary guidance focuses on reducing the intake of refined rice and wheat products as well as sugary foods, while increasing the intake of whole grains, mixed grains, fresh vegetables, and high-quality protein.

③ Carbon Emissions Control: Guide patients to make appropriate food choices using a simplified low-carbon food selection chart, ensuring that daily dietary carbon emissions remain within the target range.

④ Integrated Adjustments: For patients with concomitant hypertension, limit sodium intake to ≤ 5 g/day; for those with concomitant sarcopenia, appropriately increase protein intake to 1.2–1.5 g/kg·day to ensure nutritional balance [3].

(2) Exercise Guidance Intervention

Based on the American College of Sports Medicine (ACSM) Exercise Guidelines for Older Adults [4], a progressive exercise program was developed for patients:

① Adaptation Phase (Weeks 1–2): Primarily low-intensity exercises at home, such as seated leg raises and slow walking, 20 minutes per session, 3 times per week.

② Intensive Phase (Weeks 3–8): Gradually increase exercise volume by participating in community group activities, such as tai chi and square dancing, for 30 minutes per session, 4 times per week.

③ Maintenance Phase (Weeks 9–12): Make personalized adjustments based on the patient's physical condition and, using data from a smart wristband, maintain the exercise heart rate between 50% and 60% of the maximum heart rate.

④ Safety Management: Instruct patients to monitor their blood glucose levels before and after exercise; if they experience any discomfort, they should stop exercising immediately and report it to the nursing staff.

(3) Collaborative Management and Follow-up

① Conduct one group counseling session per week, during which nursing staff provide guidance on dietary planning and demonstrate exercise routines;

② Nurses use smart wristbands to record patients' daily fasting blood glucose levels, step counts, heart rates, and other data, and provide timely feedback and recommendations for adjustments based on this data.

③ Conduct one home visit per month to assess patients' implementation of the intervention plan and their adherence, and promptly address any issues that arise.

2.4 Outcome Measures

① Glucose Metabolism Measures: The following parameters were measured in patients before the intervention and 12 weeks after the intervention: fasting plasma glucose (FPG); 2-hour postprandial glucose (2hPG); and glycated hemoglobin (HbA1c), to assess overall glycemic control.

② Quality of Life Scores: The Diabetes-Specific Quality of Life Scale (DSQL), a diabetes-specific quality of life assessment tool, was used to quantitatively evaluate patients' quality of life [5]. The scale comprises four dimensions—psychological, physiological, social relationships, and treatment—each scored on a 5-point scale, with lower scores indicating better quality of life.

③ Incidence of Nocturnal Hypoglycemia: The incidence of nocturnal hypoglycemia in patients during the intervention period was recorded. Nocturnal hypoglycemia was defined as a blood glucose level below 3.9 mmol/L during the night (22:00–6:00) or the presence of typical symptoms of hypoglycemia.

2.5 Statistical Methods

Data analysis was performed using SPSS 26.0 statistical software. Continuous variables are expressed as numerical values ($\bar{x} \pm s$), and differences between groups were compared using an independent samples t-test; categorical variables are presented as the number of cases, and differences

in distribution between groups were analyzed using the chi-square test. A difference was considered statistically significant when the p-value was less than 0.05.

3. Results

3.1 Comparison of Glucose Metabolism Indicators Between the Two Groups

Glucose metabolism control is crucial for patients with diabetes, and stable blood glucose levels are an important indicator for evaluating treatment efficacy. By improving dietary habits, strengthening exercise guidance, and implementing comprehensive nursing care, blood glucose levels in patients can be effectively reduced.

Prior to the intervention, a comparison of fasting blood glucose and 2-hour postprandial blood glucose levels between the two groups revealed no significant differences ($P > 0.05$). After 12 weeks of intervention, both groups' fasting blood glucose and 2-hour postprandial blood glucose levels were significantly lower than pre-intervention levels, with the observation group showing a more pronounced decrease compared to the control group. Following the intervention, the observation group's fasting blood glucose and 2-hour postprandial blood glucose levels were significantly lower than those of the control group ($P < 0.001$). See Table 1.

Table 1 Comparison of Glucose Metabolic Parameters Between the Two Groups ($n=60$, mmol/L)

Category	Time	Fasting Blood Glucose	Blood glucose 2 hours after a meal
Control group	Before Care	9.62±0.81	13.15±1.20
	After Care	7.34±0.48	9.68±0.55
Observation Group	Before Care	9.58±0.79	13.09±1.18
	After Care	6.81±0.42	8.52±0.47
t-value		6.12	10.47
P-value		<0.001	<0.001

3.2 Comparison of Quality of Life Scores Between the Two Groups

Quality of life is one of the key indicators for evaluating the effectiveness of diabetes treatment. Particularly among elderly patients with diabetes, improving quality of life can enhance treatment adherence and alleviate the burden of the disease. The quality of life of patients with diabetes is closely related to disease control; therefore, it is crucial to monitor improvements in patients' psychological well-being, social adaptation, and treatment adherence during therapy.

After a 12-week intervention, scores across all dimensions of the DSQL improved in both groups compared to pre-intervention levels. The observation group performed better than the control group in terms of psychological support, physical function, social adaptation, and treatment adherence. A comparison of the data between the two groups revealed statistically significant differences ($P < 0.001$), indicating that the observation group achieved greater improvements in quality of life than the control group, as shown in Table 2.

Table 2 Comparison of DSQL Scores Between the Two Groups of Patients ($n=60$, scores)

Dimension	Control group	Observation Group	t-value	P-value
Psychological Assessment Score	12.06±1.02	9.78±0.85	13.54	<0.001
Physiological Score	21.14±1.63	15.92±1.21	18.37	<0.001
Social Relationships	8.12±1.01	6.34±0.82	10.21	<0.001
Treatment Score	5.68±0.34	4.52±0.28	21.46	<0.001

3.3 Comparison of Nocturnal Hypoglycemia Incidence Between the Two Groups

Nocturnal hypoglycemia is a common complication in the treatment of patients with diabetes. For older adults, nocturnal hypoglycemia not only increases health risks but also severely impacts their quality of life. Therefore, reducing the incidence of nocturnal hypoglycemia is a key priority in diabetes management.

During the intervention period, 3 cases of nocturnal hypoglycemia occurred in the observation group, accounting for 5.00% of the total cases, while 11 cases occurred in the control group, accounting for 18.33% of the total cases. A comparison of nocturnal hypoglycemia incidence between the two groups revealed a statistically significant difference ($\chi^2 = 5.21$, $P < 0.05$), indicating that a coordinated nursing intervention combining a low-carbohydrate diet and exercise guidance can reduce the incidence of nocturnal hypoglycemia in elderly patients with diabetes. See Table 3.

Table 3 Comparison of Nocturnal Hypoglycemia Incidence Between the Two Groups

Category	Number of cases	Incidence (%)
Control group	11	18.33
Observation Group	3	5.00
χ^2 value		5.21
P-value		<0.05

4. Discussion

Elderly patients with type 2 diabetes face various challenges, including reduced insulin secretion, increased insulin resistance, and diminished ability to live independently. These factors make blood glucose control more difficult and increase the risk of complications such as hypoglycemia and a reduced quality of life. Diabetes care should not focus solely on short-term blood glucose control but must also adopt a long-term health management perspective, comprehensively addressing the patient's psychological well-being, social functioning, and ability to perform daily activities. Traditional diabetes care emphasizes blood glucose monitoring and medication while neglecting individualized dietary and exercise guidance. Therefore, how to improve glucose metabolism and enhance quality of life in elderly patients with type 2 diabetes through a synergistic care program combining a low-carbohydrate diet and exercise guidance has become a key issue in clinical practice.

The results of this study show that after 12 weeks of intervention, both fasting blood glucose and 2-hour postprandial blood glucose levels in the intervention group were significantly lower than those in the control group, indicating that a low-carbohydrate diet combined with exercise guidance has a synergistic effect on blood glucose control. By controlling total carbohydrate intake and its composition, and reducing the consumption of foods with a high glycemic load, a low-carbohydrate diet can reduce the amplitude of postprandial blood glucose fluctuations, resulting in a more gradual change in blood glucose levels. Combined with regular exercise at an appropriate intensity, this approach promotes the uptake and utilization of glucose by skeletal muscle, improves the body's insulin sensitivity, and further enhances the effectiveness of blood glucose control [6]. Furthermore, designing exercise programs according to the principle of gradual progression—to prevent excessive intensity from causing adverse effects in elderly patients—enables patients to maintain long-term exercise safely, thereby keeping blood glucose improvements within a relatively stable range.

From the perspective of quality of life, diabetes is a chronic condition that imposes psychological, social, and physiological burdens on the lives of older adults. These burdens stem not only from the disease itself but also from the stress associated with long-term treatment and management. Improvements in quality of life are one of the key indicators for evaluating the effectiveness of diabetes treatment [7]. For elderly patients, diabetes management involves not only regulating blood glucose levels but also addressing their psychological well-being, level of social participation, and enhancement of self-efficacy. Research findings show that patients in the observation group scored significantly higher than those in the control group in terms of mental health, physical function, social adaptation, and treatment adherence. The combined care approach of a low-carbohydrate diet and exercise guidance not only improved patients' physiological indicators but also enhanced their subjective well-being and psychosocial adaptability. Regular dietary and exercise interventions provide patients with clear lifestyle guidelines, reduce anxiety caused by uncertainty, and increase their confidence in treatment and willingness to follow medical advice. This, in turn, encourages patients to participate more actively in family, community, and social activities, thereby enhancing their overall quality of life.

Nocturnal hypoglycemia is one of the most common and severe complications in the treatment of patients with diabetes, particularly among the elderly. It not only increases health risks but also has a profound impact on patients' quality of life. Nocturnal hypoglycemia may cause acute symptoms such as dizziness, palpitations, and confusion; in severe cases, it may lead to more serious health issues such

as coma or death^[8]. Therefore, the prevention and management of nocturnal hypoglycemia are critical components of diabetes treatment. The results of this study indicate that the incidence of nocturnal hypoglycemia was significantly lower in the observation group than in the control group, suggesting that a combined care approach involving a low-carbohydrate diet and exercise guidance can reduce the occurrence of nocturnal hypoglycemia. This effect may be attributed to the low-carbohydrate diet's rational distribution of carbohydrate intake, which helps avoid excessive fluctuations in nocturnal blood glucose levels. A well-planned low-carbohydrate diet can reduce nocturnal blood glucose fluctuations and prevent the sharp rise and subsequent sharp drop in blood glucose levels caused by excessive carbohydrate intake. Exercise intervention helps regulate glucose metabolism and prevents hypoglycemic reactions caused by excessive exercise. It also effectively mitigates the risk of exercise-induced hypoglycemia through daily blood glucose monitoring and timely adjustments to exercise intensity.

In summary, the synergistic nursing strategy developed in this study—combining a low-carbohydrate diet intervention with exercise guidance—is implemented using community nursing resources. With clear operational procedures and relatively simple intervention content, it is suitable for long-term adherence by elderly patients and holds practical value for widespread implementation. This nursing model integrates dietary care as its foundation, exercise guidance as its method, and follow-up management as its core, thereby providing continuous and systematic care to elderly patients with diabetes and contributing to improved management of community-based diabetic patients. However, this study has limitations: the small sample size and short intervention duration do not fully reflect the effects of long-term intervention, and since all participants were from the same region, the generalizability of the results requires further verification. Future studies could expand the sample size and follow-up period to further refine this collaborative care strategy.

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