Effect of IKAP Model Combined with OEP on Fall Prevention in Elderly Patients with Diabetes Mellitus and Sarcopenia

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Abstract

Objective: To investigate the effect of the Information-Knowledge-Attitude-Practice (IKAP) model combined with the Otago Exercise Program (OEP) on fall prevention in elderly diabetic patients with sarcopenia. Methods: A total of 108 elderly diabetic patients with sarcopenia hospitalized in the Department of Endocrinology and Metabolism at the Second Affiliated Hospital of Nanchang University from May 2021 to May 2022 were selected. Based on their willingness to undergo OEP exercise training, they were divided into a control Group A and an intervention (Group B + Group C). The intervention (Group B + Group C) was further randomly divided into intervention Group B and intervention Group C using a random number table method, with 36 cases in each group. Control Group A received routine care, intervention Group B received routine care + OEP, and intervention Group C received routine care + OEP + IKAP model care. The three groups were compared in terms of blood glucose levels [fasting plasma glucose (FPG), 2-hour postprandial glucose (2hPG), and glycated hemoglobin (HbA1c)], muscle mass and strength [Appendicular Skeletal Muscle Mass Index (ASMI) and grip strength], balance [Berg Balance Scale (BBS) score], mobility [Timed Up and Go Test (TUGT)], fall efficacy [Modified Falls Efficacy Scale (MFES) score], fall incidence, and quality of life [Diabetes Specific Quality of Life Scale (DSQL) score]. Results: After intervention, the levels of FPG, 2hPG, and HbA1c in all three groups decreased over time, and at 3, 6, and 9 months after intervention, the levels of FPG, 2hPG, and HbA1c in intervention Group C were lower than those in intervention Group B and control Group A, while intervention Group B was lower than control Group A ($P<0.05$). After intervention, ASMI and grip strength in all three groups increased over time, and at 3, 6, and 9 months after intervention, ASMI and grip strength in intervention Group C were higher than those in intervention Group B and control Group A, while intervention Group B was higher than control Group A (P<0.05). After intervention, BBS scores in all three groups increased over time, while TUGT decreased over time, and at 3, 6, and 9 months after intervention, BBS scores in intervention Group C were higher than those in intervention Group B and control Group A, while intervention Group B was higher than control Group A; simultaneously, TUGT in intervention Group C was shorter than that in intervention Group B and control Group A, while intervention Group B was shorter than control Group A (all P<0.05). After intervention, MFES scores in all three groups increased over time, while DSQL scores decreased over time, and at 3, 6, and 9 months after intervention, MFES scores in intervention Group C were higher than those in intervention Group B and control Group A, while intervention Group B was higher than control Group A; simultaneously, DSQL scores in intervention Group C were lower than those in intervention Group B and control Group A, while intervention Group B was lower than control Group A (all P<0.05). The fall incidence during the follow-up period in intervention Group C [0%] was lower than that in intervention Group B [11.11% (4/36)] and control Group A [30.56%], and intervention Group B was lower than control Group A (all P<0.05). Conclusion: The IKAP model combined with OEP can steadily reduce blood glucose, enhance muscle mass and strength, improve balance and mobility, increase fall efficacy, effectively prevent falls, and thereby help improve overall quality of life in elderly diabetic patients with sarcopenia.

Full Text

Preamble

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Title

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Abstract

Objective: To investigate the effect of the Information-Knowledge-Attitude-Practice (IKAP) model combined with the Otago Exercise Program (OEP) on fall prevention in elderly patients with diabetes mellitus and sarcopenia.
Methods: A total of 108 elderly patients with diabetes mellitus and sarcopenia hospitalized in the Department of Endocrinology and Metabolism at the Second Affiliated Hospital of Nanchang University between May 2021 and May 2022 were selected. Patients were divided into control group A and intervention (B+C) group based on their willingness to undergo OEP exercise training. The intervention (B+C) group was further randomized into intervention group B and intervention group C using a random number table method, with 36 patients in each group. Control group A received routine nursing care, intervention group B received routine nursing care plus OEP, and intervention group C received routine nursing care plus OEP combined with IKAP model nursing. The three groups were compared regarding blood glucose levels [fasting plasma glucose (FPG), 2-hour postprandial glucose (2hPG), and glycosylated hemoglobin (HbA1c)], muscle mass and strength [appendicular skeletal muscle mass index (ASMI) and grip strength], balance [Berg Balance Scale (BBS) score], mobility [Timed Up and Go Test (TUGT)], fall efficacy [Modified Fall Efficacy Scale (MFES) score], fall incidence, and quality of life [Diabetes-Specific Quality of Life Scale (DSQL) score].
Results: Following intervention, FPG, 2hPG, and HbA1c levels in all three groups decreased over time. At 3, 6, and 9 months post-intervention, group C showed significantly lower FPG, 2hPG, and HbA1c levels compared to group B and control group A, while group B showed lower levels than control group A ($P<0.05$). ASMI and grip strength increased over time in all groups, with group C demonstrating higher values than group B and control group A at each time point, and group B higher than control group A ($P<0.05$). BBS scores increased while TUGT decreased over time across all groups. At 3, 6, and 9 months, group C exhibited higher BBS scores and shorter TUGT than group B and control group A, with group B showing better performance than control group A (all $P<0.05$). MFES scores increased while DSQL scores decreased over time in all groups. Group C achieved higher MFES scores and lower DSQL scores than group B and control group A at each assessment point, with group B outperforming control group A (all $P<0.05$). The fall incidence during follow-

up was 0% in group C, significantly lower than 11.11% (4/36) in group B and 30.56% in control group A, with group B also lower than control group A (all $P<0.05$).

Conclusion: The IKAP model combined with OEP can effectively stabilize and reduce blood glucose levels, enhance muscle mass and strength, improve balance and mobility, increase fall efficacy, and prevent falls in elderly patients with diabetes mellitus and sarcopenia, thereby contributing to improved overall quality of life.

Keywords: IKAP Model; OEP; Elderly; Diabetes Mellitus; Sarcopenia; Falls

Introduction

Diabetes mellitus is a common age-related metabolic disorder. Patients with insulin resistance (IR) experience disrupted muscle protein synthesis and metabolism, leading to decreased skeletal muscle strength and mass, which increases the risk of sarcopenia. Epidemiological data indicate that the prevalence of sarcopenia among elderly diabetic patients in Asia ranges from 7% to 29.30%. The presence of sarcopenia not only exacerbates diabetes but also increases the risk of adverse health outcomes including frailty, falls, fractures, disability, infection, and mortality. Specifically, elderly diabetic patients with sarcopenia have nearly three times higher fall risk compared to diabetic patients without sarcopenia. Fall-related injuries requiring hospitalization incur average treatment costs ranging from 111 to 26,532 RMB, imposing substantial economic burden on families and severely impacting patients' quality of life. Therefore, fall prevention requires urgent attention and intensified efforts.

The Otago Exercise Program (OEP), developed by Campbell and colleagues at the University of Otago in New Zealand, is an evidence-based, home-based exercise intervention designed specifically for fall prevention in older adults, focusing on progressive strength and balance training. However, clinical implementation often emphasizes exercise training alone, lacking systematic and scientific planning, which raises concerns about long-term sustainability and patient compliance. The Information-Knowledge-Attitude-Practice (IKAP) model extends the traditional KAP theory by first assessing patient information and needs, then providing health knowledge to foster positive health beliefs that translate into sustained health behaviors. This approach transforms patients from passive recipients of exercise prescriptions to active participants who develop habitual exercise routines, promoting long-term intervention sustainability. The IKAP model has demonstrated effectiveness in managing various chronic conditions including lumbar disc herniation, chronic obstructive pulmonary disease, hypertension, breast cancer, and diabetes mellitus. However, its applicability and effectiveness in managing elderly diabetic patients with sarcopenia remain unexplored. This study investigates the effect of combining the IKAP model with OEP for fall prevention in this population.

Methods

1.1 General Information

We enrolled 108 elderly patients with diabetes mellitus and sarcopenia hospitalized in the Department of Endocrinology and Metabolism at the Second Affiliated Hospital of Nanchang University between May 2021 and May 2022. Inclusion criteria were: (1) diagnosis of type 2 diabetes mellitus according to the *Chinese Guidelines for the Prevention and Treatment of Type 2 Diabetes Mellitus (2020 Edition)* and sarcopenia according to the Asian Working Group for Sarcopenia consensus criteria: reduced muscle mass (ASMI <7.00 kg/m^2 for men, <5.40 kg/m^2 for women); reduced muscle strength (grip strength <26 kg for men, <18 kg for women); impaired physical performance (gait speed <0.80 m/s); with diagnosis requiring criterion plus or ; (2) age $ $60 years; (3) ability to walk independently; (4) clear consciousness and normal communication ability; and (5) voluntary participation with signed informed consent. Exclusion criteria comprised: (1) diabetic foot; (2) hepatic or renal dysfunction; (3) severe psychiatric disorders or malignant tumors; and (4) severe osteoarticular diseases limiting physical activity.

Patients were allocated to control group A or intervention (B+C) group based on willingness to participate in OEP training. The intervention (B+C) group was further randomized into intervention group B and intervention group C using a random number table, with 36 patients in each group. Control group A comprised 21 males and 15 females, aged 60–80 years (mean 73.48$±4.21*years*), *withBMI*18–35*kg/m*^{2}$ (mean 23.01$±2.27*kg/m*{2}), *diseaseduration*3–25*years*(*mean*14.37±1.42*years*), *including*8*smokers*, 7*alcoholusers*, 19*withhypertension*,
(mean 23.08$±2.28*kg/m*{2}), *diseaseduration*4–25*years*(*mean*14.41±1.43*years*), *including*9*smokers*, 6*alcoholusers*, 18*withhypert*
(mean 23.12$±2.30*kg/m*^{2}), *diseaseduration*3–26*years*(*mean*14.38±$1.41 years), including 10 smokers, 8 alcohol users, 17 with hypertension, and 9 with coronary heart disease. Baseline characteristics showed no statistically significant differences among the three groups (P>0.05), ensuring comparability. This study was approved by the hospital's Medical Ethics Committee.

1.2 Interventions

Control Group A received routine nursing care comprising: (1) Dietary counseling: individualized one-on-one education using the Balanced Diet Pagoda guidelines, with macronutrient distribution of 50–60% carbohydrates, 15–20% protein, and 25–30% fat. Patients were instructed to consume varied foods with increased vegetables and fruits, control total caloric intake based on BMI, and use food exchange portions to plan daily meals. Elderly diabetic patients with sarcopenia required 1.2 g/kg/day protein to maintain optimal muscle status. (2) Exercise guidance: individualized exercise plans designed to avoid breathlessness, including walking, brisk walking, Tai Chi, Wuqinxi, and Baduanjin, performed 1 hour postprandially for approximately 30 minutes with family accompaniment to prevent hypoglycemia. (3) Medication management: oral hypoglycemic agents or insulin administered according to blood glucose levels, with detailed education on medication precautions. Vitamin D supplementation was prescribed to support bone and muscle calcium content, while medications exacerbating sarcopenia were minimized. (4) Self-monitoring: patients were instructed to monitor blood glucose regularly, at least twice weekly for fasting glucose, and daily if using insulin. (5) Psychological support: specialized diabetes nurses and rehabilitation therapists provided counseling, listened to patients' concerns, offered timely comfort, encouraged continued exercise training, and helped build confidence.

Intervention Group B received routine nursing care plus OEP. The OEP intervention protocol is detailed in .

Intervention Group C received routine nursing care plus OEP combined with IKAP model nursing. Upon enrollment, an intervention research team was established comprising 10 members: 1 associate chief physician, 1 associate chief nurse, 1 head nurse, 5 diabetes specialist nurses, 1 rehabilitation therapist, and 1 graduate student. Role assignments were: associate chief nurse responsible for project guidance and overall progress monitoring; head nurse coordinating intervention implementation; associate chief physician responsible for patient diagnosis and physical function assessment; diabetes specialist nurses and rehabilitation therapist implementing interventions; and graduate student responsible for participant recruitment, data collection, and analysis. The IKAP model nursing protocol is detailed in .

All three groups received 1 week of inpatient intervention followed by 7 weeks of post-discharge intervention, with follow-up assessments at 3, 6, and 9 months.

** OEP Exercise Training Program**

Exercise Component	Content	Duration and Frequency
Warm-up	Head, neck, back stretching, trunk movements, ankle exercises	5-minute warm-up before each session

Exercise Component	Content	Duration and Frequency
Strength Training	Hip extensors, abductors, knee flexors/extensors, quadriceps, ankle plantarflexors/dorsiflexors	Approximately 30 minutes per session, at least 3 times weekly; progressive load increase
Balance Training	Knee bending, backward walking, figure-8 walking, sideways walking, toe-heel standing, toe-heel walking, single-leg standing, toe walking, heel walking, toe-heel backward walking, sit-to-stand, stair climbing	Approximately 30 minutes per session, at least 2 times weekly

Exercise Component	Content	Duration and Frequency
Walking Training	Walking at usual pace, combining indoor and outdoor walking. Patients should wear loose clothing and comfortable shoes, inspect their feet, and select appropriate walking amplitude and speed based on individual condition.	

** IKAP Model Intervention Strategy**

Component	Intervention Content	Implementation
Information (I)	Within 24 hours of admission: collect general data, assess fall efficacy using MFES, evaluate balance using BBS, perform TUGT. Assess personal information including physical condition, psychological status, family economic situation, and fall prevention needs (disease knowledge, smoking cessation guidance, exercise guidance, nutrition guidance, medication guidance, psychological guidance). Develop personalized fall prevention intervention plans based on patient information.	Diabetes specialist nurse/Rehabilitation therapist

Component	Intervention Content	Implementation
Knowledge (K)	Diabetes knowledge: epidemiology, concepts, classification, etiology, pathogenesis, clinical manifestations, complications, laboratory tests, treatment. Smoking cessation education: tobacco hazards, impact of smoking on diabetic complications, cessation methods, effective control of active and passive smoking. Exercise knowledge and skills: purpose and importance of OEP and other exercises; methods including warm-up, strength and balance training techniques, timing, and frequency; exercise modalities (walking, brisk walking, square dancing, Tai Chi) with individualized selection. Dietary knowledge: calculate daily caloric needs based on BMI, follow varied and nutritious principles, regular meals, increased water intake. Medication knowledge: efficacy and adverse effects of oral hypoglycemic agents and insulin, importance of medication adherence, risks of self-discontinuation or dose adjustment. Provide clearly labeled medication boxes with timing, dosage, and frequency; educate on proper insulin injection technique. Daily life knowledge: wear soft-soled shoes, inspect foot skin, maintain clean and dry living environment, install handrails and non-slip mats in bathrooms to prevent falls; family accompaniment during exercise; carry snacks to prevent hypoglycemia.	Diabetes specialist nurse/Rehabilitation therapist

Component	Intervention Content	Implementation
Attitude (A)	Case sharing: successful and unsuccessful fall prevention cases and their relationship with disease and quality of life; encourage patients to express feelings. Peer education (experience exchange): patient symposiums for sharing fall prevention self-management experiences (e.g., "How do I prevent falls in daily life?" "How do I manage my diet?"). Personal reflection: encourage daily reflection (e.g., "Why can't I exercise three times weekly?" "Why do I miss medications?" "Why is diabetes management so stressful?"); identify at least three fall risk factors and seek professional consultation.	Diabetes specialist nurse/Rehabilitation therapist

Component	Intervention Content	Implementation
Practice (P)	WeChat public account: regularly push knowledge about diabetes with sarcopenia and fall prevention methods through short videos or illustrated articles; set patient reminder functions. WeChat communication group: invite patients to join fall prevention exchange group on discharge day; manage patients post-discharge through check-ins, supervision, education, and communication. Monthly telephone/WeChat follow-up: inquire about recent condition, exercise execution, mobility and balance; reinforce weak areas based on inpatient intervention; answer questions and provide guidance; schedule home visits. Home visits at 3, 6, 9 months: assess fall prevention management based on exercise records; reinforce healthy lifestyle and correct disease management (balanced diet, regular exercise, adequate sleep, medication adherence, positive mood); encourage family involvement in patient management and daily behavior supervision; complete questionnaires; schedule outpatient appointments and next home visit.	Diabetes specialist nurse/Rehabilitation therapist

1.3 Evaluation Indicators

1.3.1 Blood Glucose Levels

Before intervention and at 3, 6, and 9 months post-intervention, 5 mL of venous blood was collected. FPG and 2hPG levels were measured using the glucose oxidase method, and HbA1c was determined using latex-enhanced immunoturbidimetry on an automatic biochemical analyzer.

1.3.2 Muscle Mass and Strength

Before intervention and at 3, 6, and 9 months post-intervention, appendicular skeletal muscle mass was measured using dual-energy X-ray absorptiometry, and ASMI was calculated as: ASMI = appendicular skeletal muscle mass (kg) / height $(m)^2$. Grip strength was measured using a dynamometer, with three measurements taken for each hand and the maximum value recorded.

1.3.3 Balance and Mobility

Before intervention and at 3, 6, and 9 months post-intervention, balance was assessed using the Berg Balance Scale (BBS) developed by Katherine Berg et al. The Chinese version validated by Jin Dongmei et al. demonstrated excellent reliability (intraclass correlation coefficient 0.968–0.985) and inter-rater reliability (0.992–0.998). The 14-item scale includes tasks such as sit-to-stand, standing unsupported, reaching forward, turning, stepping, and single-leg stance, scored 0–4 points each (0=unable to perform, 4=independent and safe), with total scores ranging 0–56. Higher scores indicate better balance: 0–20=poor balance, 21–40=moderate balance, <40 indicates fall risk, and 41–56=good balance with independent ambulation. Mobility was measured using the Timed Up and Go Test (TUGT), which has demonstrated excellent discriminative validity (0.985–0.993) and test-retest reliability (0.934). The test measures time taken to rise from a 46-cm chair with armrests, walk 3 m, turn, return, and sit down.

1.3.4 Fall Efficacy, Fall Incidence, and Quality of Life

Before intervention and at 3, 6, and 9 months post-intervention, fall self-efficacy was measured using the Chinese version of the Modified Fall Efficacy Scale (MFES) revised by Hao Yanping et al., which demonstrated a Cronbach's α coefficient of 0.977 and content validity coefficient of 0.637–0.926. The 14-item scale comprises 9 indoor and 5 outdoor activities, each scored 0–10 (0=no confidence, 5=moderate confidence, 10=complete confidence), with the mean score calculated. Lower scores indicate poorer fall efficacy and higher fall risk. Fall incidence during follow-up was recorded, calculated as: fall incidence = number of fallers / total number of patients. Quality of life was assessed using the Diabetes-Specific Quality of Life Scale (DSQL), which includes 27 items across four dimensions: physiological function (12 items), social relations (4 items), psychological/spiritual aspects (8 items), and treatment (3 items). Each item is scored 1–5 (1=not at all, 5=extremely severe), with total scores ranging 27–135; higher scores indicate poorer quality of life.

1.4 Statistical Analysis

Statistical analysis was performed using SPSS 26.0 software. Normally distributed continuous data were expressed as mean ± standard deviation ($\bar{x} \pm s$). Comparisons among multiple groups used ANOVA, while within-group pre-post comparisons used paired t-tests. Categorical data were expressed as percentages (%) and analyzed using ^{2} tests. $P<0.05$ was considered statistically significant.

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Results

2.1 Comparison of Blood Glucose Levels Among Three Groups

Following intervention, FPG, 2hPG, and HbA1c levels in all three groups decreased over time. At 3, 6, and 9 months post-intervention, group C demonstrated significantly lower FPG, 2hPG, and HbA1c levels compared to group B and control group A, while group B showed lower levels than control group A (P<0.05). Detailed results are presented in .

** Comparison of Blood Glucose Levels Among Three Groups (x̄ ± s)**

Group	FPG (mmol/L)	2hPG (mmol/L)	HbA1c (%)					
	Pre	3mo	6mo					
Control A	8.60$±0.74	8.15±0.89[a]	7.68±0.64[ab]	7.08±0.65[abc]	13.20±1.37	11.92±1.35[a]	9.17±0.84[ab]	8.19±0.56

Note: aP<0.05 vs. pre-intervention; bP<0.05 vs. 3 months; cP<0.05 vs. 6 months.

2.2 Comparison of Muscle Mass and Strength Among Three Groups

Following intervention, ASMI and grip strength in all three groups increased over time. At 3, 6, and 9 months post-intervention, group C demonstrated significantly higher ASMI and grip strength compared to group B and control group A, while group B showed higher values than control group A (P<0.05). Detailed results are presented in .

** Comparison of Muscle Mass and Strength Among Three Groups (x̄ ± s)**

Group	n	ASMI (kg/m^2)	Grip Strength (kg)						
		Pre	3mo						
Control A	36	4.58$±0.42	4.79±0.45[a]	5.02±0.48[ab]	5.26±0.50[abc]	21.13±2.10	22.18±2.18[a]	23.28±2.32[a]	2

Note: aP<0.05 vs. pre-intervention; bP<0.05 vs. 3 months; cP<0.05 vs. 6 months.

2.3 Comparison of Balance and Mobility Among Three Groups

Following intervention, BBS scores increased while TUGT decreased over time in all three groups. At 3, 6, and 9 months post-intervention, group C demonstrated significantly higher BBS scores and shorter TUGT compared to group B and control group A, while group B showed better performance than control group A (all P<0.05). Detailed results are presented in .

** Comparison of Balance and Mobility Among Three Groups (x̄ ± s)**

Group	n	BBS (points)	TUGT (seconds)
		Pre	3mo
Control A	36	35.42$±3.11\|37.05±3.57^a\|38.70±3.74^{ab}\|40.36±3.91^{abc}\|25.49±2.48\|24.31±2.40^a|23.11±2	

Note: aP<0.05 vs. pre-intervention; bP<0.05 vs. 3 months; cP<0.05 vs. 6 months.

2.4 Comparison of Fall Efficacy, Fall Incidence, and Quality of Life Among Three Groups

Following intervention, MFES scores increased while DSQL scores decreased over time in all three groups. At 3, 6, and 9 months post-intervention, group C demonstrated significantly higher MFES scores and lower DSQL scores compared to group B and control group A, while group B showed better outcomes than control group A (all P<0.05). During the follow-up period, fall incidence was 0% in group C, significantly lower than 11.11% (4/36) in group B and 30.56% (11/36) in control group A (^{2}=4.235, P=0.040; ^{2}=12.984, P<0.001), with group B also lower than control group A (^{2}=4.126, P=0.042). Detailed results are presented in .

** Comparison of Fall Efficacy and Quality of Life Among Three Groups (points, x̄ ± s)**

Group	MFES Score	DSQL Score
	Pre	3mo
Control A	5.02$±0.48\|5.45±0.52^a\|5.91±0.57^{ab}\|6.39±0.62^{abc}\|95.42±8.74\|91.23±8.31^a\|86.38±7.49^{ab}|80	

Note: aP<0.05 vs. pre-intervention; bP<0.05 vs. 3 months; cP<0.05 vs. 6 months.

Discussion

The seventh national census revealed that in 2020, China's population aged $ $60 years reached approximately 260.4 million (18.70% of the total population), with about 30% having diabetes mellitus, of which type 2 diabetes accounts for over 95%. Type 2 diabetes is characterized by hyperglycemia, IR, and relative insulin deficiency. IR represents a potential mechanism underlying sarcopenia, as it activates the ubiquitin-proteasome pathway, promoting muscle protein degradation while impairing glucose metabolism in muscle cells, reducing intracellular energy supply and muscle contractility. Additionally, age-related changes in the hypothalamic-pituitary-adrenal axis, hypothalamic-pituitary-gonadal axis, and insulin-like growth factor 1 (IGF1) signaling pathways contribute to sarcopenia development by altering muscle strength, bone strength, and mobility. Sarcopenia manifests as weakness, muscle wasting, slow gait, walking difficulty, and increased fall risk. Falls often result in fractures, which increase hospitalization costs, cause functional decline, activity limitation, anxiety/depression, and reduced quality of life. Therefore, enhancing health management for elderly diabetic patients with sarcopenia to reduce falls and improve muscle strength and quality of life represents an urgent priority.

The Otago Exercise Program (OEP), developed by Campbell et al. at the University of Otago, is a personalized, evidence-based, home-based exercise intervention targeting fall prevention through progressive strength and balance training. However, clinical practice reveals that elderly patients generally have lower education levels, limited and fragmented medical knowledge, poor comprehension, and passive acceptance of medical advice, resulting in poor sustainability and compliance with home-based exercise. The IKAP model extends traditional KAP theory by first assessing patient information and needs, then providing health knowledge to foster positive beliefs that translate into sustained health behaviors. This approach transforms patients from passive recipients to active participants who develop habitual exercise routines. Originally proposed by Harvard professor Mayo in 1950 and later refined by Chinese scholar Luo Shali, the IKAP model has been successfully applied in managing cardiovascular diseases, cancers, metabolic disorders, and chronic respiratory diseases. Our findings demonstrate that following intervention, all three groups showed decreasing FPG, 2hPG, and HbA1c levels over time, with group C achieving the best glycemic control, followed by group B, then control group A ($P<0.05$). This effect occurs because routine nursing establishes healthy lifestyle habits that promote blood glucose reduction. OEP enhances insulin sensitivity by increasing muscle mass and reducing IR, thereby accelerating skeletal muscle glucose uptake and utilization. Exercise directly stimulates skeletal muscle, increasing capillary density and promoting glucose transporter-4 (GLUT4) gene expression and protein content, which facilitates glucose transport. Muscle contraction and hypoxia during exercise enhance GLUT4 mobilization, improving IR. Post-exercise glucose uptake and utilization persist for hours, contributing to stable glycemic control. However, some patients lack proper understanding of disease knowledge and OEP, leading to medication non-adherence, continued smoking/alcohol use, or discontinuation of OEP when symptoms improve. The IKAP model addresses this by ensuring patients understand the importance of healthy lifestyles, strict OEP adherence, and fall prevention, fostering beliefs that translate into long-term behaviors through mobile and intelligent follow-up platforms (WeChat public account, communication groups, telephone/WeChat follow-up, home visits), enabling sustained glycemic control.

Clinical practice guidelines identify exercise programs targeting muscle strength and balance as the most effective fall prevention interventions. Our results show that ASMI, grip strength, BBS scores, and MFES scores increased over time while TUGT decreased across all groups, with group C showing the greatest improvements, followed by group B, then control group A (all $P<0.05$). Furthermore, group C had 0% fall incidence during follow-up, significantly lower than group B (11.11%) and control group A (30.56%), with group B also lower than control group A (all P<0.05). These improvements result from OEP's ability to enhance myofibrillar protein synthesis, increase muscle cross-sectional area, improve muscle strength and fiber composition, and enhance proprioceptive sensitivity, balance coordination, and motor control. Long-term OEP strengthens lower extremity muscles and ankle/foot coordination, maintaining dynamic stability and improving balance and mobility. OEP also enhances inter-muscular coordination, improving walking efficiency, endurance, and activity levels. By improving balance, lower extremity strength, and mobility, OEP reduces fear of falling and fall risk. The IKAP model complements these effects by comprehensively assessing patient physical and psychological information, promoting acceptance of health education through the knowledge-attitude-practice framework, encouraging active disease management, modifying unhealthy behaviors, and sustaining OEP adherence for long-term benefits.

Our findings also demonstrate that DSQL scores decreased over time in all groups, with group C achieving the lowest scores, followed by group B, then control group A (all P<0.05). OEP improves quality of life by relieving muscle spasms, balancing proprioception, reducing mental stress, and enhancing physical function. Exercise stimulates the sympathetic and parasympathetic nervous systems to release acetylcholine, producing calming effects that alleviate anxiety and depression. The KAP-based health education helps patients comprehensively understand their condition, adopt positive coping strategies, adjust negative attitudes, reduce symptom burden, and improve overall quality of life.

Conclusion

The IKAP model combined with OEP effectively stabilizes and reduces blood glucose levels, enhances muscle mass and strength, improves balance and mobility, increases fall efficacy, and prevents falls in elderly patients with diabetes mellitus and sarcopenia, thereby contributing to improved overall quality of life.

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Note: Figure translations are in progress. See original paper for figures.