Effects of a Family-Participatory Physical Activity Intervention Model on Exercise Self-Efficacy and Physical Activity Levels in Patients with T2DM

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Abstract

Objective To explore the effects of a family-participatory physical activity intervention model on exercise self-efficacy and physical activity level in patients with type 2 diabetes mellitus (T2DM), and to provide a new entry point for physical activity interventions in this population. Methods A total of 92 T2DM patients admitted to the First Affiliated Hospital of Shihezi University between May and August 2024 were selected and randomly assigned by drawing lots to a control group (n=46) and an intervention group (n=46). The control group received routine departmental health education on physical activity, while the intervention group received a family-participatory physical activity intervention. Independent-samples t test, nonparametric tests, and chi-square test were used to compare exercise self-efficacy scores and physical activity status between the two groups before the intervention and 30 days after the intervention. Results Before the intervention, there were no statistically significant differences between the control and intervention groups in exercise self-efficacy, weekly total exercise energy expenditure, or the rate of achieving recommended physical activity. After 1 month of intervention, the intervention group showed better outcomes than the control group in exercise self-efficacy (83.57$±6.08*pointsvs*.71.68±$7.63 points, t=-8.266, P<0.001), weekly total exercise energy expenditure (3542 MET-minute/week vs. 2778 MET-minute/week, Z=-2.498, P=0.012), and rate of achieving recommended physical activity (63.04% vs. 39.13%, $ $2=5.263, P=0.022). Conclusion The family-participatory physical activity intervention model is of significant value in improving exercise self-efficacy and physical activity level in patients with T2DM. It suggests that future nursing practice should incorporate family members as intervention targets, enhance their understanding of physical activity in

diabetes, fully leverage their roles in supervision, encouragement, and accompaniment, and promote the family-participatory nursing model.

Full Text

Effects of the Family Integrated Care Physical Activity Intervention Model on Exercise Self-Efficacy and Physical Activity Levels in Patients with T2DM

Abstract

Objective: To investigate the effects of a family integrated care physical activity intervention model on exercise self-efficacy and physical activity levels in patients with type 2 diabetes mellitus (T2DM), and to provide a novel approach for physical activity interventions in this population.

Methods: Ninety-two T2DM patients admitted to the First Affiliated Hospital of Shihezi University between May and August 2024 were selected and randomly divided into a control group and an intervention group (n=46 each) using a lottery method. The control group received routine physical activity health education, while the intervention group participated in a family integrated care physical activity intervention. Two independent samples t-test, non-parametric tests, and chi-square test were used to compare exercise self-efficacy scores and physical activity levels between the two groups before intervention and after 30 days.

Results: Before intervention, no statistically significant differences were observed between the control and intervention groups in exercise self-efficacy, total weekly exercise energy expenditure, or physical activity attainment rate. After one month of intervention, the intervention group demonstrated significantly better outcomes than the control group in exercise self-efficacy (83.57$\pm$6.08*vs.*71.68$\pm$\$7.63 points, t=-8.266, P<0.001), total weekly energy expenditure (3542 MET-minute/week vs. 2778 MET-minute/week, Z=-2.498, P=0.012), and physical activity attainment rate (63.04% vs. 39.13%, χ^2=5.263, P=0.022).

Conclusion: The family integrated care physical activity intervention model holds significant value for improving exercise self-efficacy and physical activity levels in T2DM patients. These findings suggest that future nursing practice should incorporate family members as intervention targets, enhance their understanding of diabetes-related physical activity, and fully leverage their roles in supervision, encouragement, and companionship to promote family-integrated care models.

Keywords: family integrated care; physical activity; type 2 diabetes; exercise self-efficacy; nursing care

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Introduction

The prevalence of diabetes mellitus in China continues to rise annually with a trend toward younger onset, with type 2 diabetes mellitus (T2DM) remaining the predominant form [1]. Physical activity (PA) benefits glycemic control and improves cardiovascular risk profiles in T2DM patients [2-4]. However, surveys indicate that 16.1% to 48.0% of T2DM patients engage in insufficient physical activity [5-7], with nearly half failing to meet the recommendations in the *Chinese Guidelines for Exercise Therapy in Diabetes* [8]. Consequently, achieving sustained and effective maintenance of recommended physical activity levels represents an urgent challenge in diabetes management.

Existing physical activity interventions primarily focus on technological approaches (mobile applications, wearable devices) [9-10] and educational strategies (health education based on the transtheoretical model, social cognitive theory, and empowerment education) [11-13], while supportive environment research has concentrated mainly on peer support [14-15]. Comprehensive domestic and international studies, including our preliminary research, have confirmed that family support constitutes a major factor influencing physical activity levels in T2DM patients [16-17]. As the primary source of individual support, supportive family behaviors can promote diabetes self-management [18-19], yet this dimension is often overlooked when designing physical activity interventions for T2DM [20]. Family Integrated Care (FIC) represents a family-centered nursing intervention that incorporates family members as study participants, guiding them to provide behavioral, emotional, and decision-making support throughout the intervention process [21], which holds significant implications for chronic disease management. FIC has demonstrated efficacy in managing premature infants, stroke patients, and elderly populations [22-25]. Research by Mo Minglu et al. found that family support, supervision, and encouragement enhanced patient execution in diabetes self-management interventions [26], while Liu Shenglan' s study indicated that patients with higher family support exhibited greater proportions of regular exercise and showed positive effects on exercise behavior, knowledge, skills, and self-efficacy [27].

Therefore, this study aims to examine the impact of a family integrated care physical activity intervention model on exercise self-efficacy and physical activity levels in T2DM patients. Theoretically, this research provides reference and guidance for enhancing physical activity levels in T2DM patients; practically, it promotes the application of family integrated care in diabetes physical activity interventions, offering important guidance for clinical diabetes nursing.

1.1 Study Subjects

Using convenience sampling, 92 T2DM patients admitted to the Endocrinology Department of the First Affiliated Hospital of Shihezi University between May and August 2024 were selected as study participants.

1.1.1 Inclusion and Exclusion Criteria **Inclusion criteria:** (1) Met T2DM diagnostic criteria according to the *Chinese Guidelines for Diabetes Prevention and Treatment (2024 Edition)* [1]; (2) Age $ $18 years; (3) No severe cardiovascular disease or other physical activity contraindications, able to perform physical activity independently; (4) No severe psychiatric disorders or cognitive dysfunction, able to understand and respond appropriately; (5) Primary family caregivers provided informed consent, voluntarily participated in family integrated care training, and committed to supervising and accompanying patients' physical activity for one month post-discharge; (6) Local residents to facilitate follow-up.

Exclusion criteria: (1) First-time T2DM diagnosis, type 1 diabetes, gestational diabetes, or other diabetes types; (2) Patients with acute complications; (3) Patients with cognitive impairment or non-cooperation.

1.1.2 Sample Size Calculation This non-randomized controlled study compared routine physical activity intervention (control) with family integrated care physical activity intervention (intervention), using physical activity attainment rate as the primary outcome. Based on preliminary studies and literature review [5,8,16], we anticipated a 65% attainment rate in the intervention group versus 35% in the control group. With two-sided testing, α=0.05, a 1:1 sample ratio, β=0.2, and power (1-β)=0.8, the calculated sample size was 40 cases per group. Considering potential attrition, we increased the sample by 15%, resulting in 46 cases per group.

Baseline characteristics were comparable between groups (P>0.05), as detailed in .

1.2 Data Collection and Quality Control

Data collectors received standardized training before implementation to ensure homogeneous data collection. The study purpose and significance were explained to all participants to obtain cooperation, with instructions to report any circumstances requiring withdrawal. Questionnaire quality was promptly checked after collection, with verification from patients when questions arose to ensure accuracy. During the intervention, two cases were lost in the control group (4.35% attrition) and one in the intervention group (2.17% attrition), all due to sudden residential changes causing loss of contact.

1.3 Intervention Methods

Both groups received three interventions during hospitalization, one remote intervention within one month post-discharge, and dynamic interventions at other times to address issues promptly.

1.3.1 Control Group Intervention The control group received routine departmental physical activity health education: (1) Pre-exercise assessment of

exercise risks and capacity; (2) Health education through printed materials, lectures, and educational videos explaining physical activity benefits for diabetes management, knowledge, and requirements (type, intensity, duration, frequency); (3) Exercise intervention with personalized plans recommending $ $10 minutes per session, 30-60 minutes daily, $ $150 minutes weekly of moderate-intensity aerobic exercise (jogging, cycling, square dancing) and 2-3 days/week of resistance training (elastic bands, barbells, dumbbells). A WeChat group was established for daily check-ins; (4) Discharge guidance on exercise precautions and regular outpatient follow-up; (5) Post-discharge telephone follow-up on physical activity status and patient supervision.

1.3.2 Intervention Group Methods Building upon routine care, the intervention group received family integrated care physical activity intervention through the following components:

1.3.2.1 Establishing the Family Integrated Care Team: The head nurse served as team leader, establishing a multidisciplinary team including one endocrinology attending physician (medical assessment and exercise prescription review), one diabetes specialist nurse, and five researchers (patient education and family training). All members completed a two-week structured training program covering interpretation of diabetes exercise therapy guidelines and FIC applications in chronic disease management to ensure mastery of core elements and delivery of homogeneous services.

1.3.2.2 Dual-Target Health Education: Family members were included as health education recipients through printed materials, lectures, and videos explaining physical activity benefits and requirements. The "teach-demonstrate-return" three-step method ensured 100% family education attainment.

1.3.2.3 Family-Involved Assessment and Individualized Planning: Families participated in physical activity plan development through: (1) Physicians establishing safe exercise intensity ranges based on HbA1c, complications, and cardiopulmonary function; (2) Specialist nurses and researchers conducting family meetings using motivational interviewing to reach consensus on exercise preferences (traditional exercises like tai chi or modern activities like brisk walking); (3) Developing personalized four-dimensional plans covering type, duration, frequency, and intensity; (4) Multidisciplinary team review ensuring compliance with *Chinese Guidelines for Type 2 Diabetes Prevention and Treatment* exercise prescription standards.

1.3.2.4 Family Accompaniment and Supervision Mechanism: A family WeChat group was established for daily check-ins. Implementation included: (1) Family participation in $ $3 exercise sessions weekly through "synchronous exercise" or "supervisory observation" modes, with $ $80% of planned exercise time; (2) Creating a "family exercise cloud archive" requiring daily uploads of exercise type, duration, heart rate data, and 5-10 second video clips.

1.3.2.5 Emotional Support and Encouragement Strategies: Families pro-

vided supportive supervision using encouragement and listening techniques to address barriers. Specific strategies included: (1) Positive verbal reinforcement during exercise to enhance confidence; (2) Patient listening to difficulties and providing emotional support for problem-solving; (3) Understanding and tolerance during reluctance, using success stories or positive memories to rekindle motivation.

1.3.2.6 Continuous Guidance and Online Interaction: Post-discharge, the WeChat group regularly shared health information, tips, and video tutorials, encouraging sharing of exercise experiences. Weekly online Q&A sessions hosted by specialist nurses and researchers addressed questions and provided personalized guidance.

1.4 Measurement Tools

1.4.1 Exercise Self-Efficacy Scale (ESE) We used the translated version by Pei Li et al. [28], demonstrating good reliability and validity for measuring exercise beliefs. The 18-item scale uses 0-100 scoring (100=complete confidence, 50=moderate confidence, 0=no confidence), with the total score calculated as the mean of all items. Higher scores indicate greater exercise self-efficacy. Cronbach' s α was 0.867 in this study.

1.4.2 International Physical Activity Questionnaire-Long Form (IPAQ-L) The Chinese version of IPAQ-L [29] was used, which has demonstrated reliability in chronic disease populations [30]. The 27-item questionnaire assesses four domains (work, household, transportation, leisure) across three intensity levels (high, moderate, low). Participants reported activity days per week and minutes per day for activities lasting $ $10 minutes. Total weekly energy expenditure was calculated as MET value $\times$ frequency $\times$ duration (MET-min/week). Based on *Chinese Diabetes Exercise Therapy Guidelines*, participants were classified as meeting or not meeting exercise recommendations [30]. Cronbach' s α was 0.798 in this study.

1.5 Statistical Methods

Data were double-checked and entered, with statistical analysis performed using SPSS 26.0. Normality tests preceded formal analysis. ESE scores, normally distributed, were described as mean$\pm$SD and compared using independent samples t-test. IPAQ-L energy expenditure data, skewed in distribution, were described using median and non-parametric tests. Categorical data were expressed as frequency and percentage (%) with chi-square test for between-group comparisons. $P<0.05$ indicated statistical significance.

Results

Baseline characteristics showed no significant differences between control and intervention groups in gender, age, education, or other demographic variables

(P>0.05), establishing comparability.

2.2 Comparison of Exercise Self-Efficacy Between Groups

No significant difference in exercise self-efficacy scores existed between groups before intervention (t=0.337, P=0.737). After implementing routine health education for the control group and family-supported intervention for the intervention group, both groups showed significant improvement in exercise self-efficacy, with the intervention group demonstrating significantly greater improvement than the control group (t=-8.266, P<0.001). Details are presented in .

2.3 Comparison of Physical Activity Between Groups

No significant difference in total weekly energy expenditure existed between groups before intervention (Z=-1.157, P=0.270). Following routine education for the control group and family integrated intervention for the intervention group, both groups showed significant improvement in total energy expenditure, with the intervention group achieving significantly greater improvement (Z=-2.488, P=0.012), as shown in . The intervention group demonstrated significantly higher weekly energy expenditure than the control group across household, transportation, and leisure activities. Regarding intensity, while both groups primarily engaged in low-intensity activity, the intervention group showed significantly greater time in moderate and low-intensity weekly exercise. The intervention group also achieved significantly higher physical activity attainment rate post-intervention (χ^2=5.263, P=0.022), detailed in .

Discussion

3.1 Family Integrated Care Physical Activity Intervention Enhances Exercise Self-Efficacy in T2DM Patients

Our findings demonstrate that the family integrated care physical activity intervention model significantly improves exercise self-efficacy in T2DM patients. Liu Shenglan et al. [27] investigated relationships between family support, exercise behavior, and exercise-related self-efficacy among diabetes patients in Beijing community health centers, concluding that family support positively influences exercise behavior, knowledge, skills, and self-efficacy. As a chronic disease requiring long-term management, diabetes necessitates family support as a crucial resource [31]. Our family integrated care model guided family members to employ emotional support and active listening techniques, helping patients effectively address barriers while reinforcing exercise beliefs. This approach showed significant advantages over conventional health education in enhancing exercise self-efficacy, consistent with previous findings demonstrating positive correlations between self-efficacy and family support levels [32-33]. We recommend incorporating family-based collaborative strategies into future T2DM physical activity interventions: systematically training families to improve support quality while following autonomy-support principles through encouraging

companionship and joint exercise planning, which holds important significance for enhancing patient exercise self-efficacy.

3.2 Family Integrated Care Physical Activity Intervention Improves Physical Activity Levels in T2DM Patients

Our results confirm that family integrated care significantly enhances physical activity levels, evidenced by increased total weekly energy expenditure across transportation, household, and leisure domains, as well as greater time in moderate and low-intensity activities and higher attainment rates. Zhang Jiahui et al. [34] examined family integrated nutrition and exercise management for elderly diabetic patients with sarcopenia, with findings that corroborate our results, demonstrating that family-involved exercise management effectively improves functional outcomes. Traditional health education relies primarily on patient self-management, with limitations including inactive family support systems and underutilized social resources. Our family integrated care model optimized physical activity implementation by incorporating families into health decision-making. In household activities, families increased patient energy expenditure through task allocation (e.g., designing daily cleaning activities). During leisure time, families enhanced energy expenditure through accompaniment and supervision in low-to-moderate intensity activities (walking, brisk walking, jogging, square dancing). Notably, by including families as health education recipients and training them to accurately understand intensity thresholds (3-6 METs) and duration requirements ($ $150 minutes/week) for diabetes-specific physical activity, the model positively moderated the dose-response relationship for moderate-intensity activity, significantly improving attainment rates.

Family integrated care extends holistic nursing by effectively integrating family support systems and strengthening patient-family collaboration to enhance disease management. Based on our findings, we propose the following recommendations: (1) **Construct family support networks:** In clinical diabetes interventions, include family members as health education targets, systematically explaining the clinical value of physical activity in comprehensive diabetes management to improve family cognition of exercise therapy. Establish a tripartite family support model of supervision-motivation-companionship to significantly enhance patient exercise self-efficacy. (2) **Strengthen family decision-making support:** Guide families to participate deeply in exercise plan assessment and development, incorporate daily household activities into physical activity management plans, and establish structured family exercise promotion mechanisms. Specific pathways include developing standardized household task allocation plans, redistributing family tasks while ensuring patient safety, and establishing immediate feedback mechanisms based on behavioral reinforcement theory. During family exercise interventions, employ collaborative exercise modes prioritizing moderate-intensity aerobic activities such as brisk walking, jogging, square dancing, and badminton. (3) **Establish scientific family participation systems:** Implement family exercise log documentation to dynamically

monitor exercise duration, intensity, and frequency, and create dynamic feedback mechanisms between families and medical teams for personalized exercise prescription adjustments.

The family integrated care physical activity intervention model incorporates T2DM patients' family members as collaborative intervention targets, constructing a "patient-family" dyadic health management unit where emotional companionship and daily supervision jointly promote exercise adherence. Empirical evidence demonstrates this intervention significantly improves exercise self-efficacy and physical activity levels. Given its substantial advantages in continuous care, this model holds significant value for promotion and application among chronic disease populations requiring long-term outpatient management. This study has several limitations, including regional sample constraints and short study duration. Future research should employ multi-center sampling, extended follow-up periods, and objective physical activity monitoring tools (e.g., wearable devices) and glycemic measures to comprehensively evaluate intervention effects.

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