Postprint: Analysis of Comprehensive Control Status at Different Time Points in Patients with Type 2 Diabetes After Community Self-Management Intervention

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Abstract

Background Diabetes self-management constitutes a crucial approach for mitigating disease impact and improving prognosis. Currently, research on diabetes self-management predominantly focuses on short-term effect evaluation post-intervention, with limited reports on long-term follow-up.

Objective To evaluate the effects of self-management group activities on blood glucose, blood pressure, blood lipids, and body mass index in patients with type 2 diabetes at various time points following intervention.

Methods In 2014, 500 adult patients with type 2 diabetes were recruited in Fangshan District, Beijing, and randomly assigned to a control group (n=241) and an intervention group (n=259). The control group received conventional diabetes follow-up services, whereas the intervention group received a 3-month diabetes self-management group activity intervention. Surveys were conducted at baseline, upon completion of the 3-month intervention, 2 years post-intervention, and 5 years post-intervention to collect demographic information, disease data, height, weight, blood pressure, blood glucose, and blood lipid measurements. Generalized estimating equations were employed to analyze the main effect of group activities and the interaction effect between group activities and different time points post-intervention.

Results After covariate adjustment, a significant interaction effect was observed between group activity intervention and time post-intervention on body mass index (β=-0.33, 95%CI: -0.62 ~ -0.05), fasting blood glucose (β=-1.03, 95%CI: -1.71 ~ -0.35), and triglycerides (β=-0.54, 95%CI: -0.93 ~ -0.14): pre-intervention, the intervention group' s BMI was 0.31 kg/m2 lower than the control group' s, decreasing to 0.64 kg/m2 lower at 3 months post-intervention; pre-intervention, the intervention group' s fasting blood glucose was 0.19 mmol/L higher than

the control group' s, becoming 0.84 mmol/L lower at 2 years post-intervention; pre-intervention, the intervention group' s triglyceride level was 0.03 mmol/L higher than the control group' s, dropping to 0.51 mmol/L lower at 5 years post-intervention. No statistically significant differences were observed between the two groups in glycated hemoglobin, blood pressure, high-density lipoprotein cholesterol, or low-density lipoprotein cholesterol (P>0.05).

Conclusion Self-management group activities demonstrate short-term efficacy in BMI control among patients with type 2 diabetes, and may exert sustained long-term effects on fasting blood glucose and triglyceride control.

Full Text

Analysis of Comprehensive Disease Control Among Type 2 Diabetes Patients at Different Time Points Following Community Self-Management Intervention

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Abstract

Background: Diabetes self-management is a critical skill for reducing disease burden and improving outcomes. Current research primarily focuses on short-term intervention effects, with limited reports on long-term effectiveness.

Objective: To evaluate the impact of group-based self-management education on blood glucose, blood pressure, blood lipids, and body mass index (BMI) at different time points following intervention.

Methods: In 2014, 500 adults with type 2 diabetes were recruited from 17 communities across 4 streets in Fangshan District, Beijing, and randomly assigned to control (n=241) and intervention (n=259) groups. The control group received routine diabetes follow-up services, while the intervention group participated in a 3-month group-based self-management program. Surveys were conducted at baseline, immediately post-intervention (3 months), and at 2-year and 5-year follow-ups to collect demographic information, disease status, anthropometric measurements (height, weight, blood pressure), and laboratory data (blood glucose, lipids). Generalized estimating equations were used to analyze both the main effects of the intervention and its interaction effects with time.

Results: After adjusting for covariates, significant interaction effects between the intervention and time were observed for BMI (β = -0.33, 95%CI: -0.62 to -0.05), fasting plasma glucose (β = -1.03, 95%CI: -1.71 to -0.35), and triglycerides (β = -0.54, 95%CI: -0.93 to -0.14). Specifically, the intervention group's BMI was 0.31 kg/m^2 lower than controls at baseline and 0.64 kg/m^2 lower at 3 months post-intervention. Fasting glucose was 0.19 mmol/L higher in the intervention group at baseline but 0.84 mmol/L lower at the 2-year follow-up. Triglycerides were 0.03 mmol/L higher at baseline but 0.51 mmol/L lower at the 5-year follow-up. No significant differences were found between groups for HbA1c, blood pressure, HDL-C, or LDL-C (P>0.05).

Conclusion: Group-based self-management education demonstrates short-term effects on BMI control and potential long-term benefits for fasting glucose and triglyceride management in type 2 diabetes patients.

Keywords: Diabetes mellitus, type 2; Self-management; Community; Follow-up; Long-term effect

Introduction

The global prevalence of diabetes mellitus has increased dramatically in recent years. An estimated 463 million people worldwide had diabetes in 2019, with projections reaching 700 million by 2045. China faces a particularly severe epidemic, with 120 million patients in 2019—the highest globally—and an expected increase to 150 million by 2045. The chronic and incurable nature of diabetes necessitates that patients become the primary managers of their own disease. Self-management education represents a crucial strategy for mitigating disease impact and improving prognosis by enhancing patients' knowledge, self-efficacy, and healthy behaviors, ultimately leading to better glycemic control and quality of life. However, current research has significant limitations, with most studies evaluating short-term outcomes (within 6 months) and few reporting long-term effectiveness.

While some 12-18 month follow-up studies have demonstrated that group-based self-management interventions can reduce blood glucose levels, others have failed to replicate these findings. Similarly, inconsistent conclusions exist regarding long-term effects on blood pressure and lipid profiles. Building upon a 2014 community-based diabetes self-management trial in Fangshan District, Beijing, this study conducted a 5-year follow-up to examine the effects of group-based self-management activities on glycemic, blood pressure, lipid, and BMI outcomes, with particular attention to interaction effects between the intervention and post-intervention time points.

Methods

1.1 Study Subjects Data were derived from a community-based diabetes self-management trial conducted in Fangshan District, Beijing, in 2014. During March 2014, 510 patients with type 2 diabetes were recruited from 17 communities/villages across 4 streets through posters, telephone notifications, and home visits. Inclusion criteria included: clinically diagnosed type 2 diabetes patients aged 18 years or older. Exclusion criteria comprised: acute disease episodes or severe illness, psychiatric disorders, pregnancy, diabetic nephropathy or other severe complications, and participation in other studies. Ten individuals declined participation, resulting in a final sample of 500 patients randomly assigned to intervention (n=251) and control (n=249) groups using simple randomization. The study was approved by the Ethics Committee of the National Center for Chronic and Noncommunicable Disease Control and Prevention (Approval No.: 201909), and all participants provided informed consent.

1.2 Intervention Methods The intervention group participated in self-management group activities from July to November 2014. Patients were organized into 17 groups (15-18 members each) based on their communities/villages. Groups met weekly for 1.5-2 hours per session, completing 8 sessions over 3 months. Each session followed a structured format: reviewing previous content, reporting on self-management plan completion, problem-solving, learning new material, sharing experiences, demonstrating self-management skills, peer practice, and developing new self-management plans. Topics included blood glucose monitoring, acute and chronic complications, dietary adjustment, exercise, medication management, coping with negative emotions, communication skills, and healthy lifestyle habits. Two group leaders facilitated each session following guidelines from "Self-Management Practices for Chronic Disease Patients—Diabetes." Both groups received quarterly diabetes follow-up services per national basic public health requirements, including follow-up assessments (blood pressure, fasting glucose, weight measurements, disease status inquiry, lifestyle evaluation, medication review), categorized interventions (medication guidance, regimen adjustments, referral recommendations, health education), and physical examinations (routine physical check-up, oral, vision, hearing, and motor function assessments) according to the National Basic Public Health Service Specifications (2011 Edition).

1.3 Data Collection Data were collected at baseline, immediately post-intervention (3 months), and at 2-year and 5-year follow-ups. Trained investigators used a structured community diabetes health survey questionnaire to collect demographic and disease information through face-to-face interviews, including age, sex, education level, marital status, disease duration, and treatment modalities. Anthropometric measurements included height, weight, systolic blood pressure (SBP), and diastolic blood pressure (DBP). Height and weight were measured using a stadiometer and scale (precision 0.1 cm and 0.1 kg), with BMI calculated as weight (kg)/height $(m)^2$. Blood pressure

was measured three times at 1-minute intervals using an Omron HEM-1000 electronic sphygmomanometer, with the average of the last two measurements recorded. Fasting venous blood samples (5.5 ml) were collected and analyzed by local laboratories for fasting plasma glucose (FPG), glycated hemoglobin (HbA1c), high-density lipoprotein cholesterol (HDL-C), triglycerides (TG), and low-density lipoprotein cholesterol (LDL-C) using a Toshiba 40FR automatic biochemical analyzer and enzyme methods with Shanghai Rongsheng reagent kits.

1.4 Quality Control Uniform survey questionnaires, research protocols, and operation manuals were developed for all four surveys. Investigators received standardized training in measurement techniques and were certified before data collection. Completed questionnaires underwent dual verification by investigators and quality control staff. Standardized equipment was used for all physical examinations, with regular on-site supervision and timely correction of identified issues. Group activities implemented attendance tracking to ensure participation rates, and activity logs were maintained after each session to monitor intervention fidelity.

1.5 Statistical Analysis Data were double-entered using Epidata 3.1, cleaned, and matched to create the final database. Statistical analyses were performed using SAS 9.4. Age, SBP, DBP, HDL-C, LDL-C, and BMI followed approximately normal distributions and were described as mean ± standard deviation, with group differences compared using independent samples t-tests. Disease duration, FPG, HbA1c, and TG were non-normally distributed and described as median (P25, P75), with group differences compared using Wilcoxon rank-sum tests. Categorical data were presented as percentages and compared using chi-square tests.

Generalized estimating equations (GEE) for repeated measures were employed with an unstructured correlation matrix to analyze main effects of the intervention and interaction effects with post-intervention time, both before and after covariate adjustment. Beta coefficients and 95% confidence intervals were calculated. Two-sided tests were performed with α=0.05.

Results

2.1 Basic Characteristics In 2014, 500 participants completed baseline and post-intervention surveys (intervention group: n=259; control group: n=241). The intervention group included 84 men (32.43%) with a mean age of 62.07$\pm$7.09$years; the control group included 90 men (37.34\pm\$8.07$ years. No significant differences were observed between groups in sex, age, education level, disease duration, or treatment modality (P>0.05). At the 2-year follow-up in 2016, 343 participants were retained (intervention: n=204; control: n=139), with no significant inter-group differences except in medical insurance type (P<0.01). At the 5-year follow-up in 2019, 362 participants were retained

(72.40% retention rate). Reasons for loss to follow-up included refusal (n=32), death (n=36), inability to contact (n=5), mobility limitations (n=5), relocation (n=2), hospitalization (n=2), time constraints (n=1), and unknown reasons (n=55). The 5-year sample included 187 intervention and 175 control participants with no significant differences in baseline characteristics (P>0.05). Detailed characteristics are presented in Table 1 .

2.2 Changes in Diabetes Comprehensive Control At baseline, no significant differences existed between groups in FPG, HbA1c, SBP, DBP, HDL-C, TG, LDL-C, or BMI (P>0.05). GEE analysis revealed no significant main effects of group assignment on any outcome measures (P>0.05). However, time since intervention showed statistically significant effects on all outcomes (P<0.05). Detailed results are presented in Table 2 .

2.3 Main and Interactive Effects of Group Activities and Post-Intervention Time Given that attrition may compromise randomization balance, we further analyzed main and interaction effects after adjusting for patient characteristics and physiological indicators. Significant interaction effects between group and time were observed for BMI control: the between-group BMI difference post-intervention differed from baseline by -0.33 kg/m^2 (95%CI: -0.62 to -0.05). Specifically, the intervention group' s BMI was 0.31 kg/m^2 lower than controls at baseline and 0.64 kg/m^2 lower at 3 months post-intervention.

For FPG control, a significant group-by-time interaction was found: the between-group FPG difference at 2-year follow-up differed from baseline by -1.03 mmol/L (95%CI: -1.71 to -0.35). The intervention group' s FPG was 0.19 mmol/L higher than controls at baseline but 0.84 mmol/L lower at the 2-year follow-up.

For TG control, a significant interaction was observed at 5-year follow-up: the between-group TG difference differed from baseline by -0.54 mmol/L (95%CI: -0.93 to -0.14). The intervention group's TG was 0.03 mmol/L higher at baseline but 0.51 mmol/L lower than controls at the 5-year follow-up.

No significant interaction effects were found for other indicators (P>0.05), and no significant main effects of group assignment were observed (P>0.05). Detailed results are presented in Table 3 .

Discussion

The World Health Organization emphasizes that patient-centered health education is essential for effective disease management, helping patients manage their conditions, prevent complications, and improve quality of life. Diabetes self-management education represents an appropriate technology for alleviating the diabetes burden. Such interventions address knowledge, attitudes, and behaviors: they improve diabetes knowledge awareness, increase self-efficacy by approximately 20% to enhance disease management confidence, and promote

healthy behaviors including foot self-examination, medication adherence, and regular glucose monitoring. Thus, diabetes self-management education provides comprehensive benefits superior to traditional knowledge-based health education.

Previous studies have demonstrated that diabetes self-management education can reduce HbA1c, FPG, total cholesterol, LDL-C, BMI, and waist circumference. Our 5-year follow-up of 500 type 2 diabetes patients revealed no significant between-group differences in FPG, HbA1c, SBP, DBP, HDL-C, TG, LDL-C, or BMI when time effects were not considered, consistent with two previous follow-up studies. However, after accounting for time, we identified significant interaction effects between the self-management intervention and post-intervention time. Although both groups showed increasing trends in FPG and BMI and decreasing TG over time, the intervention group' s BMI increase was significantly attenuated in the short term (3 months), FPG increase was significantly lower at 2 years, and TG reduction was significantly greater at 5 years compared to controls. These findings suggest that group-based self-management education has short-term benefits for BMI control and potential long-term effects on FPG and TG management beyond routine care.

The self-management program was comprehensive, covering monitoring, diet, exercise, medication, psychological support, and lifestyle habits, providing holistic support for behavior change. Grounded in peer support and empowerment theories, the intervention maximized peer support by using group leaders and members from the same communities who were familiar with each other, facilitating experience sharing. The empowerment approach gave patients autonomy in developing management plans, enhancing motivation. This comprehensive, interactive, and low-cost intervention demonstrates strong potential for community dissemination.

The lack of observed effects on HbA1c, blood pressure, HDL-C, and LDL-C aligns with some previous studies. This may reflect challenges in maintaining long-term intervention effects. Research indicates that while self-management improves HbA1c initially, benefits diminish over time without reinforcement. Our 3-month intervention without subsequent booster sessions may have led to behavior decay due to reduced supervision and encouragement, highlighting the importance of establishing long-term maintenance mechanisms.

We also observed deteriorating control across both groups over time, with decreasing achievement rates for all indicators, particularly LDL-C (only 17.33% in the intervention group and 18.05% in controls achieved targets at 5 years). National data show similar declining trends in glycemic control among diagnosed type 2 diabetes patients in China from 2009-2012. While intensive glycemic control reduces microvascular complications, its cardiovascular benefits are limited in older patients with long disease duration and multiple risk factors. Comprehensive management including blood pressure control, lipid modification, and antiplatelet therapy is necessary to reduce cardiovascular events and mortality. Despite guidelines emphasizing comprehensive control since 2008, our

findings reveal persistently poor control, possibly due to inadequate patient self-management awareness, limited community physician engagement, and insufficient clinician attention to cardiovascular prevention. This underscores the ongoing challenges in diabetes management in China.

This study utilized GEE analysis, which appropriately accounts for correlations among repeated measurements. However, several limitations should be noted. First, attrition may have compromised randomization and introduced unknown bias. Second, we did not collect data on antihypertensive and lipid-lowering medication use, potentially confounding blood pressure and lipid results. Third, participants were recruited from Fangshan communities and may not be representative of the broader population, limiting generalizability.

In conclusion, group-based self-management education demonstrates significant interaction effects with time, showing short-term benefits for BMI control and potential long-term effects on fasting glucose and triglycerides. Further research is needed to validate these long-term effects and optimize intervention sustainability.

Author Contributions: XIA Zhang conceptualized and designed the study, performed statistical analysis, interpreted results, drafted and revised the manuscript. MAO Fan, JIANG Ying-ying, and DONG Wen-lan were responsible for data collection, organization, quality control, and manuscript review. DONG Jian-qun secured funding, supervised quality control and manuscript review, and provided overall supervision.

Conflict of Interest: The authors declare no conflict of interest.

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