Archives of Public Health

RESEARCH

Open Access

The effectiveness of a community-based online low-glycaemic index diet and lifestyle recommendations intervention for people with type 2 diabetes: a randomized controlled trial

Jinhua Chen[1], Lixia Lv[2], Xinyi Zhao[2], Yan Liu[3], Shaozheng Zhong[1], Gu Yu[1], Yijun Wang[1], Chunyan Yang[1], Jun Chen[1], Yongzhen Ye[2], Shuqin Zeng[4], Honglin Luo[5], Danyao Zhang[6], Yuelei Wu[1*] and Shuyi Liu[1*]

Abstract

Background The community health workers (CHWs)-led model is an important strategy for managing type 2 diabetes mellitus (T2DM) in China. However, existing community-based dietary and health education interventions in diabetes management are insufficient. Meanwhile, emerging mobile health (mHealth) has emerged as a promising tool for improving disease management. Current evidence on the combined efficacy of mHealth technologies and CHWs strategies remains limited.

Objective This study evaluates the effectiveness of an online dietary and health education intervention delivered through a tertiary hospital's WeChat official account (WOA) for T2DM patients, examining its influence on glycated hemoglobin (HbA1c) levels, body mass index (BMI), serum lipid profiles, and diabetes-specific quality of life (DSQL).

Methods This randomized clinical trial was conducted in two community health centers in China, enrolling adults diagnosed with T2DM. Participants were randomly assigned to two groups over 3 months. The control group received standard care, while the intervention group accessed online low glycaemic index (GI) dietary and lifestyle recommendations via the WOA. This group was instructed to monitor blood glucose levels, upload daily dietary photos, review health education notifications, and participate in real-time communication with the diabetes management team via the WOA.

Results A total of 178 participants were randomized to the control group (mean [SD] age, 57.07 [10.96] years, n = 89) and the intervention group (mean [SD] age, 57.18 [10.61] years, $n = 89$). After 3 months, significant improvements were observed in the intervention group compared to the control group, with lower HbA1c levels (mean 7.82%, SD 0.43%; $p = 0.001$), BMI (mean 24.35, SD 1.25 kg/m^2; $p < 0.001$), low-density lipoprotein cholesterol (mean 2.38, SD 0.21 mmol/L; $p < 0.001$), and DSQL scores (mean 43.24, SD 7.23; $P < 0.001$), whereas high-density lipoprotein cholesterol (mean

*Correspondence:
Yuelei Wu
13348904520@163.com
Shuyi Liu
liusysc@163.com
Full list of author information is available at the end of the article

1.35, SD 0.37 mmol/L; $p = 0.001$) was significantly higher. Subgroup analysis at 3 months showed that age, education, disease duration, comorbidity, and BMI influenced the effectiveness of HbA1c reduction.

Conclusion Overall, the WOA-based intervention effectively engages patients in community diabetes management, leading to improved glycemic control, weight reduction, lipid metabolism optimization, and better quality of life.

Trial registration ChiCTR2400081045.

Keywords Type 2 diabetes mellitus, Low glycaemic index diet, WeChat, Self-management, Community

Text box 1. Contributions to the literature

- Current community health workers-led approaches to dietary interventions and self-management for diabetes remain insufficient
- A two-center clinical trial utilizing a WeChat official account was conducted to evaluate the effects of a low-glycaemic index diet and lifestyle interventions on glucose control, weight management, serum lipid profiles, and quality of life in T2DM patients
- These results provide a foundation for future strategies to enhance dietary and self-management practices among community-dwelling individuals with poorly controlled T2DM

Background

Diabetes mellitus (DM) has become as one of the most prevalent non-communicable diseases (NCDs), posing significant challenges to both health economics and public health. China, with the world's largest diabetic population (114.4 million in 2017) [1] and a high estimated diabetes prevalence of 10.9% (2013) [2], faces considerable health and economic burdens due to the disease. Type 2 diabetes mellitus (T2DM) constitutes approximately 95% of all diabetes cases [3]. Effective glycemic control is crucial for reducing diabetes complications, including retinopathy, neuropathy, coronary artery disease, and cerebrovascular events. Diabetes management encompasses lifestyle intervention, medication, and self-management, with the latter being essential for maintaining well-controlled blood glucose levels [4, 5]. Self-management involves diabetes health education, medication adherence, dietary therapy, physical activity (PA), and self-monitoring of blood glucose (SMBG) [6]. Among these, dietary modification and PA are recognized as cornerstone strategies in T2DM care [7, 8].

Dietary recommendations focus on both the quantity and quality of carbohydrate (CHO) intake, as these factors directly impacts glucose regulation. The glycaemic index (GI) serves as a quantitative measure to assess the postprandial effect of CHO-containing foods on blood glucose levels. Numerous clinical trials have shown that low-GI diets effectively reduce postprandial blood glucose, improve glycemic control, and decrease truncal fat and weight in patients with T2DM [9–11].

The community health workers (CHWs)-led model has proven effective in screening high-risk factors and implementing lifestyle interventions for NCDs, reducing disease complications, hospitalizations, and health expenditures while improving health outcomes and quality of life [12–15]. Similarly, CHWs-led interventions show potential in diabetes management, with growing evidence supporting their effectiveness [16–18]. However, addressing existing challenges is crucial for future enhancement. Our previous cross-sectional study revealed that most CHWs had limited opportunities to enhance their NCDs-related knowledge and skills through education at tertiary hospitals, domestic academic conferences, or training programs [19]. Additionally, CHWs working in high-stress environments reported significantly lower job satisfaction due to inadequate resources, overwhelming workloads, low pay, and limited career advancement opportunities [20].

Mobile health (mHealth) utilizes mobile technology as a vital public health instrument, enhancing healthcare delivery and promoting wellness. Key components of mHealth include wearable devices, telemedicine, text messaging, and mobile applications, which enable the collection of health data, facilitate feedback, and foster interaction between healthcare providers and patients [21]. WeChat, a user-friendly social networking platform, has become a powerful tool for mHealth interventions, simplifying electronic data collection beyond traditional clinical environments settings. WeChat stands out for its ability to store vast amounts of patient-generated health data, including text, voice, images, and video. Its evolution has introduced convenient, real-time, and device-independent support services, enriching healthcare delivery and communication in clinical practice [22]. Various studies have demonstrated the effectiveness of WeChat-based interventions in enhancing self-management, glycemic control, serum lipid profiles, weight management, and treatment adherence in patients with T2DM [23–25].

The CHWs-led diabetes care model demonstrates potential to enhance clinical outcomes. However, CHWs encounter challenges in providing comprehensive self-management guidance to diabetic patients, particularly regarding diet and exercise. We conducted a 3-month digital intervention through a tertiary hospital's WOA to evaluate its effects on glycemic parameters (fasting glucose and glycated hemoglobin), anthropometric measures (body weight and body mass index), lipid metabolism, and diabetes-specific quality of life in community-dwelling adults with T2DM.

Methods

Study design

This 3-month, two-center, open-label, parallel-group randomized controlled trial (RCT) evaluated the effectiveness of an online low glycemic index (GI) diet and lifestyle modification. The study protocols, consent procedures, and participant engagement processes were approved by the Medical Ethics Committee of Chengdu Integrated TCM & Western Medicine Hospital (approval number: 2023KT26).

Participants

Participants from two community health centers were enrolled in the study between December 30, 2023, and March 23, 2024. Inclusion criteria required: (1) a T2DM diagnosis for at least 6 months, (2) HbA1c levels ranging from 7.0% to 10%, (3) age between 18 and 75 years, (4) access to WeChat notifications on a smartphone, and (5) provision of informed consent and willingness to participate. Exclusion criteria included: (1) other forms of diabetes, such as type 1 or gestational diabetes, (2) severe diabetic complications, (3) cognitive dysfunction, (4) malabsorption disorders, (5) impaired mobility, (6) pregnancy, and (7) involvement in other intervention trials.

Sample size

Based on a previous study [26], a clinically significant HbA1c difference of 0.7% between the intervention and control groups was assumed for sample size estimation. Using a 1:1 randomization ratio and standard deviations (SD) of 1.3 and 0.9 for the intervention and control groups, respectively, 65 participants per group were required to achieve 90% power at a 0.05 significance level. Accounting for a 20% dropout rate during the 3-month follow-up, the recruitment target was set at approximately 78 participants per group.

Randomization and masking

Eligible participants were identified during routine clinic visits at two community health service centers in Chengdu, China, by trained community doctors and nurses. They were randomly allocated in a 1:1 ratio to either an online dietary and lifestyle intervention group or a standard clinic follow-up group, using an online-generated randomization schedule. Given the nature of the intervention, blinding was not feasible for participants in the online dietary-intervention group. However, experimental assistants provided support for the intervention, while data collectors and the statistician remained blinded to group allocations.

Interventions

Control group

After enrollment, participants in the control group received standard care and basic diabetes education from community family doctors and nurses. This included adjustments to diabetic medications, dietary control, SMBG, PA recommendations, and regular follow-ups.

Online low GI diet and lifestyle recommendations intervention group

Participants assigned to the online low-GI diet and lifestyle intervention underwent a supervised three-month dietary adjustment protocol via diabetes management software utilized by the community-hospital team. The software enabled interaction with participants through the hospital's WOA. Participants were registered on the WOA using their electronic identification numbers and received training on its effective use. The program was developed by our interdisciplinary team through focus group, with technical support provided by Donghua Yiwei Technology Co., Ltd.

Community doctors and nurses led the intervention, involving the collection of baseline patient data, software utilization, the promotion of a low-GI diet, health education, and follow-up care. Physicians, dietitians, and diabetes specialist nurses from a tertiary hospital developed the software, designed and refined the program, and provided expert guidance for community healthcare. Prior to recruitment, community doctors and nurses received a 2-day training conducted by a diabetes management team from a tertiary hospital to ensure standardized diabetes management protocols.

During the initial visit for the online low-GI diet and lifestyle intervention, community nurses conducted in-person interviews to collect essential patient data, including gender, age, disease duration, education level, smoking, alcohol consumption, and morbidities, followed by measurements of height, weight, and blood pressure. Concurrently, they evaluated dietary habits, including meal timings and the composition and volume of intake. Participants were instructed to upload pictures of their daily meals to the WOA and to complete blood tests at the hospital within three days. Hospital dietitians, then developed a personalized low-GI diet plan based on the patient's medical background, dietary details, meal photos, and blood test outcomes, which were sent to participants through the WOA. During the follow-up period, participants were encouraged to upload weekly diet photos for the dietitian's review and to receive tailored feedback and adjustments. If participants failed to consistently post photos, community nurses would notify them through the diabetes management software.

The personalized low-GI diet plan included the following guidelines: (1) maintaining consistent timings for three daily meals; (2) incorporating a variety of meats, vegetables, and staple foods in appropriate portions; (3) prioritizing high-quality carbohydrate sources such as oats, whole-grain bread, and corn for breakfast; (4) including diverse grains, buckwheat noodles, potatoes, and Chinese yam in dinners; (5) consuming at least three types of vegetables per meal, totaling five daily, with an emphasis on dark green leafy varieties; (6) adhering to specific recommendations for water intake, meal sequencing, and cooking methods; (7) managing daily caloric intake; and (8) avoiding baked goods, sugary beverages, fried and pickled foods, and rich soups. Additionally, participants received push notifications featuring seasonal low-GI meal examples tailored to different dietary preferences.

Community nurses guided participants on BG monitoring, uploading meal photos, reviewing health educational notifications, and interacting with the diabetes care team through the WOA, thereby ensuring their proficiency in utilizing it.

Community doctors performed weekly evaluations of patients' BG data and provided necessary recommendations. If participants exhibited suboptimal BG control, face-to-face evaluations were conducted to assess overall health status and treatment adherence, including BG monitoring records, dietary habits, and PA. Identified deficiencies prompted adjustments to the treatment plan, including enhanced dietary counseling and more frequent monitoring.

The health education content periodically delivered on the WOA was based on the guideline for the prevention and treatment of type 2 diabetes mellitus in China (2020 edition) [27], covering diabetes fundamentals, complications, risk factors, and comprehensive management strategies. A collaborative team of endocrinologists, nutritionists, diabetes specialist nurses, and community doctors and nurses reviewed and refined the educational materials. Participants engaged in diabetes management discussions with community healthcare providers through the WOA during follow-ups. Community doctors and nurses were also advised to consult with tertiary hospital experts in endocrinology, dietetics, and diabetes nursing for guidance on glucose control and nutrition. Two experimental assistants managed communication with the community-hospital team, assessed questionnaire quality, and monitored the study's progress.

Questionnaire

The questionnaire included two sections. The first section collected general information such as gender, age, education level, disease duration, smoking and alcohol habits, and comorbidities. The second section was the diabetes-specific quality of life (DSQL) questionnaire, which has been adapted for linguistic and cultural relevance to the Chinese context. It is a widely utilized tool in China for evaluating the quality of life in patients with T2DM, demonstrating robust reliability and validity [28, 29]. It comprises four dimensions (physiology, psychology, social, and therapy) with 27 items. Higher scores indicate greater disease impact and lower quality of life.

Outcome indicators and measurements

Outcome indicators were collected at baseline and 3 months. The primary outcome was the difference in the change in HbA1c levels between baseline and 3 months for the 2 groups. Secondary outcomes included changes in FBG, body weight (BW), body mass index (BMI), blood pressure (BP), triglycerides (TG), total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), and DSQL.

Height, BW and BP were measured by the trained nurse at two community health service centers. Height was measured in a standard upright position without stooping. BW was measured in a fasting state, with participants wearing light clothing and no shoes. BMI was calculated as weight (kg) divided by height squared (m^2). BP was the mean of three measurements taken by an automatic electronic device at quiet rest. Fasting blood samples, including BG, HbA1c and blood lipids, were collected after 8 h of fasting. Laboratory tests were performed at Chengdu Integrated TCM & Western Medicine Hospital. Baseline questionnaire and DSQL questionnaire were administered by community nurses.

Statistical analysis

All analyses were conducted using intention-to-treat (ITT) analysis at the participant level. Missing data post-intervention and during follow-up were addressed using analyzed by multiple interpolation. Continuous variables were presented as mean (SD), whereas categorical variables were presented as frequencies and percentages. The normal distribution was verified by the Kolmogorov–Smirnov test or Q-Q plot. Chi-square tests were employed to assess nominal categorical variables. The 2-tailed independent sample t test and Mann–Whitney U test were used to compare the control and intervention groups after 3 months for normally and non-normally distributed variables, respectively. Repeated-measures ANOVA was employed to assess changes in various variables from baseline to follow-up across both groups.

Additionally, since HbA1c was the primary outcome, subgroup analysis was performed to investigate the impact of participants' characteristics on outcomes in different subgroups. All data analyses were carried out using IBM SPSS (version 25, Microsoft, USA). Statistical significance was defined at $p < 0.05$.

Results

Participant characteristics

Of the 302 individuals assessed for eligibility, 178 were successfully enrolled and randomized into the study groups (Fig. 1). At the 3-month follow-up, 7 participants (3 in the intervention group and 4 in the control group) were lost to follow-up. Withdrawals occurred in 5 participants, with 3 from the intervention group and 2 from the control group. An additional 7 participants exited the study due to scheduling conflicts, comprising 4 from the intervention group and 3 from the control group. At the end of the 3-month follow-up, the overall retention rate was 87.6% (156/178).

A total of 178 participants were randomly assigned to the control group (mean [SD] age, 57.07 [10.96] years, $n = 89$) and online low GI diet and lifestyle recommendations intervention group (mean [SD] age, 57.18 [10.61] years, $n = 89$). The control group consisted of 48.4% males and 51.6% females, while the intervention group had 56.1% males and 43.9% females. As shown in Table 1, there were no significant differences in baseline variables between the two groups, including BW, BMI, BP, and clinical features.

Key outcomes and changes at and after 3 months

At 3 months, the intervention group demonstrated significantly reduced FBG (mean 7.24, SD 0.56 mmol/L; $p < 0.001$) and HbA1c (mean 7.82%, SD 0.43%; $p = 0.001$) compared to the control group (FBG: mean 8.02, SD 1.08 mmol/L; HbA1c: mean 8.14%, SD 0.68%). The intervention group had significantly decreased BW (mean 68.85, SD 5.75 kg, $p = 0.01$) and BMI (mean 24.35, SD 1.25 kg/m^2, $p < 0.001$) compared to the control group (BW: mean 71.28, SD 7.82 kg; BMI: mean 25.23, SD 1.22 kg/m^2). Additionally, the intervention group had significantly higher serum HDL-C (mean 1.35, SD 0.37 mmol/L, $p = 0.001$), and reduced BP (systolic BP: mean 117.84, SD 6.23 mmHg, $p < 0.001$; diastolic BP: mean 70.82, SD 8.42 mmHg, $p < 0.001$), as well as lower TG (mean 1.72, SD 0.61 mmol/L, $p < 0.001$), TC (mean 3.81, SD 0.41 mmol/L, $p < 0.001$), LDL-C (mean 2.38, SD 0.21 mmol/L, $p < 0.001$), and DSQL scores (mean 43.24, SD 7.23, $p < 0.001$) compared to the control group (Table 2).

Compared to baseline (Table 2), the control group exhibited a mean change in FBG of −0.65 mmol/L (95% CI −1.35 to −0.05; $p = 0.062$) and in HbA1c of −0.19% (95% CI −0.42 to −0.04; $p = 0.071$). In contrast, the intervention group experienced a mean change

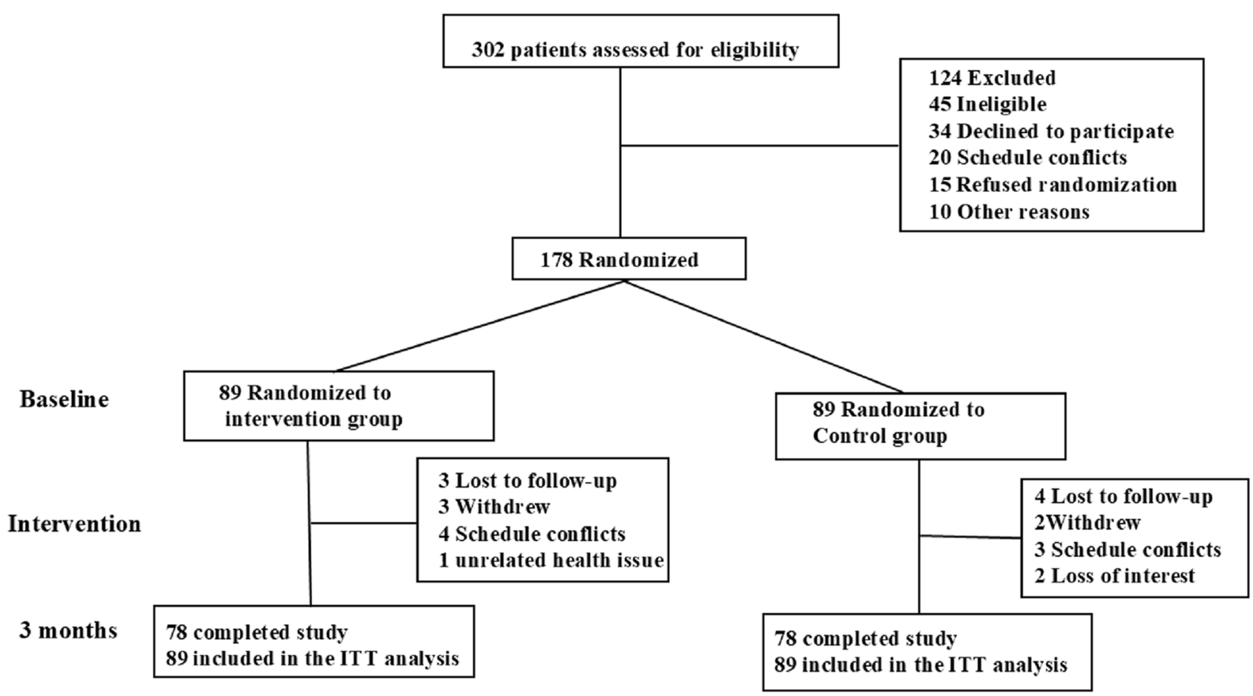

Fig. 1 Study flowchart

Table 1 Characteristics of the patients at baseline

Characteristic	Control group ($n=89$)	Intervention group ($n=89$)	*p* value
Age, mean (SD), y	57.07 ± 10.96	57.18 ± 10.61	0.754[a]
Gender, n (%)			0.452[b]
Male	43 (48.4%)	50 (56.1%)	
Female	46 (51.6%)	39 (43.9%)	
Disease duration, mean (SD), y	4.95 ± 4.42	5.28 ± 3.71	0.315[c]
Education, n (%)			0.362[b]
secondary school or below	14 (15.7%)	15 (16.9%)	
high school	13 (14.7%)	9 (10.1%)	
junior college	31 (34.8%)	40 (44.9%)	
undergraduate	28 (31.5%)	21 (23.6%)	
postgraduate or above	3 (3.3%)	4 (4.5%)	
Smoking, n (%)			0.423[b]
Never	41 (46.1%)	46 (51.7%)	
Former	11 (12.4%)	10 (11.2%)	
Current	37 (41.5%)	33 (37.1%)	
Alcohol consumption, n (%)			0.425[b]
Never	39 (43.8%)	38 (42.7%)	
Former	13 (14.6%)	11 (12.4%)	
Current	37 (41.6%)	40 (44.9%)	
Comorbid illness, n (%)			0.582[b]
≤ 1	78 (87.6%)	79 (88.8%)	
> 1	11 (12.4%)	10 (11.2%)	
BP, mean (SD), mmHg			
Systolic	123.45 ± 8.43	122.55 ± 6.72	0.066[a]
Diastolic	74.23 ± 8.42	73.51 ± 8.73	0.112[a]
BW, mean (SD), kg	71.82 ± 8.35	71.58 ± 6.73	0.556[a]
BMI, mean (SD), kg/m^2	25.73 ± 1.68	25.63 ± 1.23	0.431[a]
FBG, mean (SD), mmol/L	8.67 ± 1.32	8.72 ± 1.12	0.132[c]
HbA1c, mean (SD), %	8.33 ± 0.81	8.23 ± 0.64	0.203[a]
TC, mean (SD), mmol/L	4.64 ± 0.71	4.57 ± 0.62	0.332[a]
TG, mean (SD), mmol/L	2.45 ± 1.03	2.47 ± 0.89	0.632[a]
HDL, mean (SD), mmol/L	1.21 ± 0.45	1.19 ± 0.34	0.234[a]
LDL, mean (SD), mmol/L	2.83 ± 0.74	2.73 ± 0.66	0.352[a]
DSQL, mean (SD)	49.18 ± 9.45	48.14 ± 8.43	0.453[a]

Comorbidities, including hypertension, coronary artery disease, and chronic obstructive pulmonary disease, were reported at screening

[a] *t* test

[b] Chi-square test

[c] Mann-Whitney *U* test

in FBG of −1.48 mmol/L (95% CI −1.76 to −1.20; $p < 0.001$) and in HbA1c of −0.41% (95% CI −0.67% to −0.15%; $p < 0.001$). Additionally, the intervention group showed significant mean changes from baseline in BW (95% CI −4.32 to −1.14; $p < 0.001$), BMI (95% CI −1.56 to −1.00; $p < 0.001$), systolic BP (95% CI −6.82 to −2.60; $p < 0.001$), diastolic BP (95% CI −3.53 to −1.61; $p < 0.001$), TG (95% CI −1.45 to −0.05; $p < 0.001$), TC (95% CI −1.07 to −0.45; $p < 0.001$), HDL-C (95% CI 0.11 to 0.21; $p < 0.001$), LDL-C (95% CI −0.42 to −0.28; $p < 0.001$) and DSQL scores (95% CI −6.12 to −3.68; $p < 0.001$).

Subgroup Analysis

At 3 months, subgroup analysis revealed that the intervention group achieved significantly greater reductions in HbA1c compared to the control group among the following subgroups: female (mean difference 0.35, 95% CI 0.09 to 0.61), individuals aged 56 years or younger (mean difference 0.47, 95% CI 0.21 to 0.72), those with

Table 2 Key outcomes and changes at and after 3 months

Characteristic	mean (SD)	*P* value	Mean Change (95% CI)	*P* value[b]
SBP, mm Hg		0.000		
Control group	122.52 ± 6.54		−0.93 (−2.12 to 0.26)	0.112
Intervention group	117.84 ± 6.23		−4.71 (−6.82 to −2.60)	0.000
DBP, mm Hg		0.000		
Control group	75.19 ± 10.23		−0.96 (−1.48 to 0.36)	0.321
Intervention group	70.82 ± 8.42		−2.69 (−3.53 to −1.61)	0.000
BW, kg		0.010		
Control group	71.28 ± 7.82		−0.54 (−1.31 to −0.23)	0.062
Intervention group	68.85 ± 5.75		−2.73 (−4.32 to −1.14)	0.000
BMI, kg/m^2		0.000		
Control group	25.23 ± 1.22		−0.50 (−1.03 to 0.03)	0.068
Intervention group	24.35 ± 1.25		−1.28 (−1.56 to −1.00)	0.000
FBG, mmol/L		0.000		
Control group	8.02 ± 1.08		−0.65 (−1.35 to 0.05)	0.062
Intervention group	7.24 ± 0.56		−1.48 (−1.76 to −1.20)	0.000
HbA1c, %		0.001		
Control group	8.14 ± 0.68		−0.19 (−0.42 to 0.04)	0.071
Intervention group	7.82 ± 0.43		−0.41 (−0.67 to −0.15)	0.000
TC, mmol/L		0.000		
Control group	4.42 ± 0.54		−0.22 (−0.52 to 0.08)	0.062
Intervention group	3.81 ± 0.41		−0.76 (−1.07 to −0.45)	0.000
TG, mmol/L		0.000		
Control group	2.38 ± 0.73		−0.07(−0.15 to 0.01)	0.752
Intervention group	1.72 ± 0.61		−0.75 (−1.45 to −0.05)	0.000
HDL-C, mmol/L		0.001[a]		
Control group	1.17 ± 0.23		−0.04 (−0.11 to 0.03)	0.623
Intervention group	1.35 ± 0.37		0.16 (0.11 to 0.21)	0.000
LDL-C, mmol/L		0.000		
Control group	2.82 ± 0.39		−0.01 (−0.31 to 0.29)	0.253
Intervention group	2.38 ± 0.21		−0.35 (−0.42 to −0.28)	0.000
DSQL		0.000		
Control group	49.02 ± 9.15		−0.16 (−0.65 to −0.33)	0.342
Intervention group	43.24 ± 7.23		−4.90 (−6.12 to −3.68)	0.000

[a] Mann-Whitney *U* test

[b] ITT analysis

undergraduate or above education (mean difference 0.48, 95% CI 0.21 to 0.75), patients with a disease duration of five years or less (mean difference 0.51, 95% CI 0.24 to 0.77), those with one or no comorbidities (mean difference 0.33, 95% CI 0.12 to 0.53), and those with a BMI exceeding 24.00 (mean difference 0.35, 95% CI 0.15 to 0.55) (Fig. 2).

Adverse Events

Hypoglycemic events occurred in 3 participants (3.37%) of the intervention group and 4 (4.49%) of the control group. Constipation was reported by 3 (3.37%) in the control group and 5 (5.62%) in the intervention group. Diarrhea was noted in 4 (4.49%) of the control group and 7 (7.87%) of the intervention group. Headaches were experienced by 3 (3.37%) in the control group and 4 (5.62%) in the intervention group. No statistically significant differences in symptomatic adverse effects were observed between the groups ($p > 0.05$ for all comparisons, Table 3).

Discussion

This two-center, two-parallel-group RCT evaluated the effectiveness of an online low GI diet and lifestyle intervention, facilitated by community nurses and doctors, in community T2DM patients. The findings revealed that

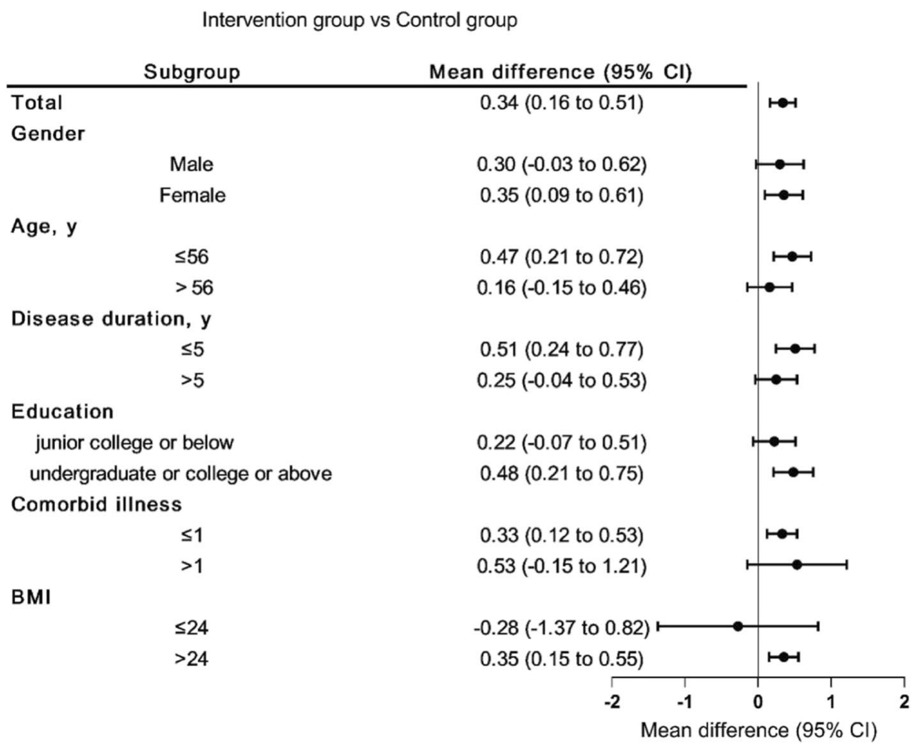

Fig. 2 Subgroup analysis of HbA1c at 3 months by ITT analysis

Table 3 Adverse events

	Control group (*n* = 89)	Intervention group (*n* = 89)	*p* value
Hypoglycemia	4 (4.49%)	3 (3.37%)	0.700
Constipation	3 (3.37%)	5 (5.62%)	0.469
Diarrhea	4 (4.49%)	7 (7.87%)	0.303
Headache	3 (3.37%)	5 (5.62%)	0.469

the intervention significantly improved glycemic control, body weight, serum lipid profiles, and diabetes-related quality of life.

Traditional face-to-face consultations between healthcare providers and patients have long been used to enhance self-management skills. RCTs involving face-to-face interventions have demonstrated that low-GI diets effectively reduce HbA1c, FBG, BMI, TC, while increasing LDL levels in people with diabetes [30]. However, limited research has explored the impact of online low-GI diet interventions on blood glucose, body weight, and lipids in individuals with T2DM. Previous studies have highlighted the potential of WeChat-based mHealth interventions to improve diabetes management and metabolic outcomes [23–25]. In light of the integration of chronic disease care into community management under the leadership of CHWs, we initiated a hospital-community collaboration, utilizing the hospital's WOA to deliver an online nutrition and lifestyle intervention tailored to our local community.

The online dietary intervention in our study exerted a moderate effect on HbA1c levels compared to other digital health research. A 6-month web-based RCT achieved a more substantial decrease in HbA1c (1.6%) [23], and a family-centered WeChat intervention reported a −0.69% change in HbA1c after 1 year [24]. In our trial, participants in the online low-GI diet and lifestyle recommendations group did not reach the target HbA1c level (< 7%), with a reduction of only 0.41%. Nonetheless, the HbA1c improvement aligns with that observed in other low-GI diet intervention research. A meta-analysis of 29 studies involving 1,617 diabetes patients indicated that low-GI diets can decrease HbA1c by an average of 0.31% [31].

Studies have previously shown that a 1% and 0.67% decrease in HbA1c corresponds to a 37% and 21% reduction in the risk of diabetic microvascular complications, respectively [32, 33]. In our study, a 0.41% decline in HbA1c levels was anticipated to mitigate microvascular complications. The mechanisms underlying the glycemic control benefits of low-GI diets include alleviating inflammation, increasing beneficial gut bacteria, delaying glucose absorption, and maintaining insulin homeostasis [34–36]. Furthermore, an HbA1c reduction of 0.3%

to 0.4% is considered clinically significant in the development of antihyperglycemic medications [37]. Concurrently, the UK prospective diabetes study (UKPDS) validated that historical HbA1c levels exert a more pronounced legacy effect on the relative risk of mortality than more recent values [38]. Specifically, a 1% increase in HbA1c 20 years before death was linked to a 36% higher relative mortality risk, compared to an 8% increase for similar levels five years prior to death. Therefore, our online low-GI diet intervention, which achieved a reduction in HbA1c, serves as a benchmark for future initiatives aimed at improving diabetes management in community.

This study revealed that an online low-GI dietary intervention resulted in a modest but statistically significant improvement in achieving target HbA1c levels. Although the intervention was delivered through a hospital-community collaboration on WeChat, a popular social media application in China, the limited HbA1c reduction observed may be explained by several factors. First, age posed a barrier to digital healthcare engagement, with participants' ages spanning from 31 to 75 years, averaging at 57 years, and 32.6% being over 65 years old. While they were not familiar with WOA operations, they were proficient in using basic functions such as messaging, video viewing, and sharing moments. Second, WeChat-based follow-ups faced limitations due to time constraints, procedural complexity, patient mistrust, and legal concerns [39]. Third, the intervention emphasized dietary modifications rather than intensive medication adjustments or rigorous glucose monitoring, which may have impacted adherence and behavioral changes. Fourth, participants generally preferred in-person clinical visits over virtual clinics. Despite these challenges, the intervention achieved improvements in the primary outcome (HbA1c) as well as secondary outcomes including body weight, serum lipid profiles, and quality of life.

The research indicates that adhering to an online low-GI diet led to a decrease in FBG by 1.48 mmol/L. Elevated FBG levels, exceeding 5.6 mmol/L, were linked to mortality from cancer, vascular diseases, and other non-cancerous, non-vascular causes [40]. Moreover, patients with FBG levels of 7 mmol/L or higher exhibited higher hazard ratio (HR) for mortality compared to those with levels below 7 mmol/L (HR: 2.16 vs. 1.51). Intensive glycemic control, targeting FBG levels between 4.4 and 7.0 mmol/L, significantly reduced excess mortality risk in patients with T2DM [27]. Therefore, even modest reductions in FBG, though not yet reaching optimal targets, contribute to improved long-term outcomes due to their cumulative beneficial effects.

Another key finding of this study was the notable effectiveness of the online low-GI dietary intervention in promoting weight loss after 3 months. In overweight and obese T2DM patients, weight reduction demonstrated a consistent, dose-dependent correlation with declines in HbA1c levels, with an average reduction of 0.1 percentage points in HbA1c for every kilogram of weight lost [41]. Retrospective studies have shown that that metabolic and bariatric surgery in insulin-treated T2DM patients led to substantial reductions in insulin dependency and even disease remission [42].The intervention group in this study achieved significant weight loss (2.73 kg) and a reduction in BMI (1.28 kg/m^2), highlighting the critical role of weight management in improving glycemic outcomes.

A key therapeutic goal in diabetes management is optimizing serum lipid profiles. At 3 months, the online low-GI dietary intervention demonstrated significant improvements, including an increase in HDL-C and reductions in TG, TC, and LDL-C. A low-GI diet enhances insulin sensitivity, reduces hepatic glucose output, lowers serum lipid concentrations, and mitigates cardiovascular risk in diabetic patients [43, 44]. Notably, HDL-C has been identified as an independent protective factor against coronary heart disease (CHD). A six-month low-GI diet intervention increased HDL-C by 4.7%, potentially reducing CHD risk by 4–11% in the intention-to-treat group and 6–19% in the completer group [44]. Consequently, the 13% HDL-C improvement observed in our study may significantly reduce the long-term risk of CHD.

The DSQL scale has proven to be an effective tool for evaluating patient health across physical, psychological, social, and therapeutic dimensions. In this study, the observation group exhibited lower DSQL scores, indicating that an online low-GI dietary intervention combined with lifestyle guidance significantly enhances quality of life, possibly attributable to improved emotional well-being. This online nutrition and health education program provided T2DM patients with real-time feedback on diabetes management, thereby enhancing their emotional state and alleviating symptoms of anxiety and depression.

We conducted a prespecified subgroup analysis to assess whether participants characteristics influenced HbA1c levels. At 3 months, the online dietary intervention group demonstrated better glycemic control compared to the control group among females, participants aged 56 or younger, those with an undergraduate or higher education, individuals with a disease duration of 5 years or less, those with one or fewer comorbidities, and those with a BMI exceeding 24. Previous research suggests that females exhibit greater sensitivity to the metabolic effects of GI diets than males [45]. Additionally, older individuals often face greater challenges in modifying behaviors and may be less resistant to using mobile technology compared to younger participants [43], potentially explaining this disparity. Participants with higher educational attainment typically possess stronger socioeconomic status and self-management skills, fostering positive interactions with community healthcare providers through online platforms. The effectiveness of interventions appears greater in the early to moderate stages of T2DM, as indicated by disease duration and comorbidity profiles. Moreover, a dose-dependent relationship between weight loss and HbA1c reduction was observed in overweight and obese T2DM patients [41].

Our study's primary strength lies in the integration of an online dietary intervention and hospital-community interaction via the WeChat platform, offering a cost-effective and accessible approach to community diabetes management. However, several limitations should be acknowledged. First, the sample size was relatively small, which may limit the generalizability of the findings. Second, the follow-up duration was short, potentially insufficient to observe sustained changes in habits and lifestyle among community patients. Third, the lack of systematic evaluation of participant compliance represents a limitation, as the absence of a targeted adherence questionnaire hinders the collection of robust data on intervention engagement. Fourth, the lack of a food frequency questionnaire to assess dietary patterns is another limitation, as this tool could provide more detailed insights into participants' nutritional intake. Fifth, physical activity levels were not measured before or after the intervention, which could have offered valuable context regarding the intervention's impact on overall lifestyle changes. Future studies should address these limitations by incorporating larger, more diverse cohorts, extending follow-up periods, and utilizing comprehensive assessment tools to evaluate compliance, dietary habits, and physical activity.

Conclusion

The integration of an online low-GI diet with lifestyle guidance effectively enhances glycemic control, promotes weight loss, optimize lipid metabolism, and improves quality of life in patients with T2DM. This WOA-based intervention not only encourages active participation in community health management but also empowers patients to strengthen their self-management capabilities, offering a practical approach to diabetes care.

Abbreviations

CHWs	Community health workers
T2DM	Type 2 diabetes mellitus
WOA	WeChat official account
GI	Glycaemic index
BW	Body weight
BMI	Body mass index
BP	Blood pressure
FBG	Fasting blood glucose
HbA1c	Glycated hemoglobin
TC	Total cholesterol
TG	Triglycerides
HDL-C	High-density lipoprotein cholesterol
LDL-C	Low-density lipoprotein cholesterol
DSQL	Diabetes specific quality of life
NCD	Non-communicable diseases
PA	Physical activity
SMBG	Self-monitoring of blood glucose
CHO	Carbohydrate
RCT	Randomized controlled trial
ITT	Intention to treat

Acknowledgements

We would like to thank all patients who participated in the study. Thanks to our research team as well.

Authors' contributions

LL and LY designed this study and revised the manuscript. LS and WY supervised and conducted the study. CJ wrote the main manuscript text. ZX and ZS reviewed and edited the manuscript. YG and WY visualized all figures and tables. YC, CJ, YY, ZD, ZS and LH performed investigation, organized and analyzed the data. All authors read and approved the final manuscript.

Funding

1."Xinglin Scholars" Scientific Research Program of Chengdu University of Traditional Chinese Medicine: Grant ID 158 and 159.
2. Chengdu Science and Technology Project: Grant ID 2022-YF05-01384-SN

Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

This study was approved by the ethics committee of Chengdu Integrated TCM & Western Medicine Hospital (protocol no. 2023KT26). All subjects in this study were voluntary and expressed informed consent prior to the questionnaires. We confirm that the investigation was carried out in accordance with the relevant guidelines and regulations.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Author details

[1]Department of General Practice, Chengdu Integrated TCM & Western Medicine Hospital, Chengdu 610041, China. [2]Department of Endocrinology and Metabolism, Chengdu Integrated TCM & Western Medicine Hospital, Chengdu 610041, China. [3]Department of Clinical Nutrition, Chengdu Integrated TCM & Western Medicine Hospital, Chengdu 610041, China. [4]Shiyang Community Health Service Center, Chengdu Hi-Tech Zone, Chengdu 610041, China. [5]Zhonghe Community Health Service Center, Chengdu Hi-Tech Zone, Chengdu 610041, China. [6]North Sichuan Medical College, Nanchong 637000, China.

Received: 17 August 2024 Accepted: 21 February 2025
Published online: 06 March 2025

References

1. International Diabetes Federation. IDF Diabetes Atlas. 8th edition. Brussels, Belgium: International Diabetes Federation; 2017. Accessed 12 Jun 2024. Available from: https://diabetesatlas.org/atlas/eighth-edition/.

2. Wang L, Gao P, Zhang M, Huang Z, Zhang D, Deng Q, et al. Prevalence and ethnic pattern of diabetes and prediabetes in China in 2013. JAMA. 2017;317(24):2515–23.
3. Hu C, Jia W. Diabetes in China: Epidemiology and Genetic Risk Factors and Their Clinical Utility in Personalized Medication. Diabetes. 2018;67(1):3–11.
4. Blondon K, Klasnja P, Coleman K, Pratt W. An exploration of attitudes toward the use of patient incentives to support diabetes self-management. Psychol Health. 2014;29(5):552–63.
5. El-Gayar O, Timsina P, Nawar N, Eid W. Mobile applications for diabetes self-management: status and potential. J Diabetes Sci Technol. 2013;7(1):247–62.
6. Brzan PP, Rotman E, Pajnkihar M, Klanjsek P. Mobile Applications for Control and Self Management of Diabetes: A Systematic Review. J Med Syst. 2016;40(9):210.
7. Bray GA, Bourchard C. Handbook of obesity-clinical applications: behavioral approaches to the treatment of obesity. New York: Marcel Dekker; 2004.
8. Ryan DH, Espeland MA, Foster GD, et al. Look AHEAD (Action for Health in Diabetes): design and methods for a clinical trial of weight loss for the prevention of cardiovascular disease in type 2 diabetes. Control Clin Trials. 2003;24(5):610–28.
9. Li D, Zhang P, Guo H, Ling W. Taking a low glycemic index multi-nutrient supplement as breakfast improves glycemic control in patients with type 2 diabetes mellitus: a randomized controlled trial. Nutrients. 2014;6(12):5740–55.
10. Stenvers DJ, Schouten LJ, Jurgens J, et al. Breakfast replacement with a low-glycaemic response liquid formula in patients with type 2 diabetes: a randomised clinical trial. Br J Nutr. 2014;112(4):504–12.
11. Pavithran N, Kumar H, Menon AS, Pillai GK, Sundaram KR, Ojo O. The Effect of a Low GI Diet on Truncal Fat Mass and Glycated Hemoglobin in South Indians with Type 2 Diabetes-A Single Centre Randomized Prospective Study. Nutrients. 2020;12(1):179.
12. Mistry S, Harris E, Harris M. Community Health Workers as Healthcare Navigators in Primary Care Chronic Disease Management: a systematic review. J Gen Intern Med. 2021;36(9):2755–71.
13. Jacob V, Chattopadhyay SK, Hopkins DP, Reynolds JA, Xiong KZ, Jones CD, et al. Economics of Community Health Workers for Chronic Disease: findings from community guide systematic reviews. Am J Prev Med. 2019;56(3):e95–106.
14. Crespo R, Christiansen M, Tieman K, Wittberg R. An emerging model for Community Health Worker-Based chronic Care Management for patients with High Health Care costs in rural Appalachia. Prev Chronic Dis. 2020;17:E13.
15. Kangovi S, Mitra N, Grande D, Huo H, Smith RA, Long JA. Community Health Worker support for disadvantaged patients with multiple chronic Diseases: a Randomized Clinical Trial. Am J Public Health. 2017;107(10):1660–7.
16. Hansotte E, Andrea SB, Weathers TD, Stone C, Jessup A, Staten LK. Impact of community health workers on diabetes management in an urban United States Community with high diabetes burden through the COVID pandemic. Prev Med Rep. 2024;39: 102645.
17. Shah MK, Wyatt LC, Gibbs-Tewary C, Zanowiak JM, Mammen S, Islam N. A Culturally Adapted, Telehealth, Community Health Worker Intervention on Blood Pressure Control among South Asian Immigrants with Type II Diabetes: Results from the DREAM Atlanta Intervention. J Gen Intern Med. 2024;39(4):529–39.
18. Babagoli MA, Nieto-Martínez R, González-Rivas JP, Sivaramakrishnan K, Mechanick JI. Roles for community health workers in diabetes prevention and management in low- and middle-income countries. Cad Saude Publica. 2021;37(10): e00287120.
19. Chen J, Yu G, Li W, et al. A situational analysis of human resource and non-communicable diseases management for community health workers in Chengdu, China: a cross-sectional study. BMC Health Serv Res. 2023;23(1):1097.
20. Chen J, Wang Y, Du W, Liu S, Xiao Z, Wu Y. Analysis on the relationship between effort-reward imbalance and job satisfaction among family doctors in China: a cross-sectional study. BMC Health Serv Res. 2022;22(1):992.
21. DeNicola N, Grossman D, Marko K, Sonalkar S, Butler Tobah YS, Ganju N, et al. Telehealth interventions to improve obstetric and gynecologic health outcomes: a systematic review. Obstet Gynecol. 2020;135(2):371–82.
22. Ye J. Transforming and facilitating health care delivery through social networking platforms: evidences and implications from WeChat. JAMIA Open. 2024;7(2):ooae047.
23. Xia SF, Maitiniyazi G, Chen Y, et al. Web-Based TangPlan and WeChat Combination to Support Self-management for Patients With Type 2 Diabetes: Randomized Controlled Trial. JMIR Mhealth Uhealth. 2022;10(3): e30571.
24. Feng Y, Zhao Y, Mao L, et al. The Effectiveness of an eHealth Family-Based Intervention Program in Patients With Uncontrolled Type 2 Diabetes Mellitus (T2DM) in the Community Via WeChat: Randomized Controlled Trial. JMIR Mhealth Uhealth. 2023;11: e40420.
25. Ye H, Lin L, Zhong D, et al. The impact of telehealth education on self-management in patients with coexisting type 2 diabetes mellitus and hypertension: a 26-week randomized controlled trial. J Endocrinol Invest. 2024;47(9):2361–9.
26. Zhang L, He X, Shen Y, et al. Effectiveness of Smartphone App-Based Interactive Management on Glycemic Control in Chinese Patients With Poorly Controlled Diabetes: Randomized Controlled Trial. J Med Internet Res. 2019;21(12): e15401.
27. Chinese Diabetes Society. Guideline for the prevention and treatment of type 2 diabetes mellitus in China (2020 edition). Chin J Diabetes Mellitus. 2021;13(4):315–409.
28. Hu Z, Qin L, Xu H. Association between diabetes-specific health literacy and health-related quality of life among elderly individuals with prediabetes in rural Hunan Province, China: a cross-sectional study. BMJ Open. 2019;9(8): e028648.
29. Wu C, Ge YL, Zhang XY, et al. The influence of hypoglycemia on the specific quality of life in type 2 diabetes mellitus: a comparative cross-sectional study of diabetics with and without hypoglycemia in Xi'an, China. Health Qual Life Outcomes. 2021;19(1):151.
30. Zafar MI, Mills KE, Zheng J, et al. Low-glycemic index diets as an intervention for diabetes: a systematic review and meta-analysis. Am J Clin Nutr. 2019;110(4):891–902.
31. Chiavaroli L, Lee D, Ahmed A, et al. Effect of low glycaemic index or load dietary patterns on glycaemic control and cardiometabolic risk factors in diabetes: systematic review and meta-analysis of randomised controlled trials. BMJ. 2021;374: n1651.
32. UK Prospective Diabetes Study (UKPDS) Group. Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). Lancet. 1998;352(9131):837–53.
33. ADVANCE Collaborative Group, Patel A, MacMahon S, et al. Intensive blood glucose control and vascular outcomes in patients with type 2 diabetes. N Engl J Med. 2008;358(24):2560–72.
34. Zhao R, Li N, Liu W, et al. Low glycemic index potato biscuits alleviate physio-histological damage and gut dysbiosis in rats with type-2 diabetes mellitus induced by high-sugar and high-fat diet and streptozotocin. J Nutr Biochem. 2023;119:109401.
35. Cai X, Wang L, Wang X, et al. Effect of high dietary fiber low index diet on intestinal flora, blood glucose and inflammatory response in T2DM patients. Biomed Res. 2017;28(21):9371–5.
36. Yusof BN, Talib RA, Kamaruddin NA, Karim NA, Chinna K, Gilbertson H. A low-GI diet is associated with a short-term improvement of glycaemic control in Asian patients with type 2 diabetes. Diabetes Obes Metab. 2009;11(4):387–96.
37. U.S. Food and Drug Administration. Guidance for Industry: Diabetes Mellitus: Developing Drugs and Therapeutic Biologics for Treatment and Prevention. Silver Spring, MD: U.S. Food and Drug Administration; 2008. Available from: https://www.fda.gov/media/71289/download.
38. Lind M, Imberg H, Coleman RL, Nerman O, Holman RR. Historical HbA1c values may explain the type 2 diabetes legacy effect: UKPDS 88. Diabetes Care. 2021;44(10):2231–7.
39. Zhang Y, Li X, Luo S, et al. Use, Perspectives, and Attitudes Regarding Diabetes Management Mobile Apps Among Diabetes Patients and Diabetologists in China: National Web-Based Survey. JMIR Mhealth Uhealth. 2019;7(2): e12658.
40. Emerging Risk Factors Collaboration, Sarwar N, Gao P, et al. Diabetes mellitus, fasting blood glucose concentration, and risk of vascular disease: a collaborative meta-analysis of 102 prospective studies. Lancet. 2010;375(9733):2215–22.

41. Gummesson A, Nyman E, Knutsson M, Karpefors M. Effect of weight reduction on glycated haemoglobin in weight loss trials in patients with type 2 diabetes. Diabetes Obes Metab. 2017;19(9):1295–305.
42. Abi Mosleh K, Ghusn W, Salameh Y, et al. Shedding more than weight: Metabolic and bariatric surgery and the journey to insulin independence in insulin-treated type 2 diabetes. J Gastrointest Surg. 2024;28(10):1613–21.
43. Seckiner S, Bas M, Simsir IY, et al. Effects of Dietary Carbohydrate Concentration and Glycemic Index on Blood Glucose Variability and Free Fatty Acids in Individuals with Type 1 Diabetes. Nutrients. 2024;16(9):1383.
44. Jenkins DJ, Kendall CW, McKeown-Eyssen G, et al. Effect of a low-glycemic index or a high-cereal fiber diet on type 2 diabetes: a randomized trial. JAMA. 2008;300(23):2742–53.
45. Vitale M, Costabile G, Bergia RE, et al. The effects of Mediterranean diets with low or high glycemic index on plasma glucose and insulin profiles are different in adult men and women: Data from MEDGI-Carb randomized clinical trial. Clin Nutr. 2023;42(10):2022–8.

Publisher's Note