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Review

# Comparative efficacy of social media delivered health education on glycemic control: A meta-analysis

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ABSTRACT

*Objective:* To compare outcomes associated with patient education about glycemic control via group chat versus patient education as usual among individuals with diabetes in China.
*Methods:* We searched the following databases both in English and in Chinese languages: PubMed, CNKI, Wanfang database, VIP database, and CBM for articles published up to Jan 1, 2018. The studies were screened by two independent reviewers. Using criteria from the risk of bias assessment tool developed by Cochrane Collaboration to assess the risk of bias of eligible studies. A meta-analysis of studies was performed using comprehensive meta-analysis version 3.0.
*Results:* Twenty-five unique randomized clinical trials, including 2,838 patients, were identified. The education delivered via group chat had large overall pooled effect sizes in improving glucose control measured by hemoglobin A1c [Hedges' g = −0.81, 95% CI: (−0.98, −0.64)], fasting blood glucose [Hedges' g = −1.11, 95% CI: (−1.37, −0.85)], and 2 h postprandial blood glucose [Hedges' g = −0.98, 95% CI: (−1.20, −0.76)]. Additionally, patient education delivered via group chat has shown consistently superior outcomes in glucose control in short-term (0–3 months), mid-term (3–6 months) and longer-term (6–12 months).
*Conclusions:* Educational interventions via group chat had a superior outcome in blood glucose control compared to education as usual in China. Educational interventions via group chat had superior short-term, mid-term, and longer-term outcomes in blood glucose control compared to education as usual in China.


**What is known?**

- As smartphone technologies increasingly become ubiquitous, there has been growing interest in the potential utility of smartphone solutions (such as online chatroom) in health and disease management.
- Several studies have shown patient education delivered via group chatroom had better glucose outcomes, compared to education as usual.
- Patient education is a critical component of successful blood glucose management.

**What is new?**

- We estimated the pooled effect size of educational interventions for glucose control delivered via social media compared to education as usual among those with diabetes in China.
- Educational interventions delivered via online group chatroom are more efficacious in controlling glucose in the short-term, mid-term, and long-term, compared to education as usual.
- The current meta-analyses included objectively measured glucose control outcomes (i.e., hemoglobin A1c, fasting blood glucose, and 2 h postprandial blood glucose) only.

## 1. Introduction

Diabetes mellitus is an urgent public health problem [1].

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Globally, the number of patients with diabetes has increased fourfold between 1980 and 2014 [2]. More than 1.5 million death can be directly attributed to diabetes [3]. Furthermore, higher-than-optimal blood glucose level causes an additional 2.2 million deaths, by increasing the risks of cardiovascular and other diseases [4]. At the same time, poorly controlled diabetes can lead to complications, such as heart attack, kidney failure, sudden stroke, cerebral arteriosclerosis, fundus disease, limb loss, and nerve damage [3]. Thus, there is an urgent need to prevent diabetes and improve a person's ability to manage blood glucose better.

China is the second-largest contributor to diabetes in the world, with yearly costs associated with diabetes estimated to reach $51 billion [5]. With 110 million individuals with diabetes, China has become the country with the most diabetes patients in the world [6]. Unfortunately, due to the rapid economic development, an exponential increase in the availability of high-calorie diets, and in sedentary lifestyles, the number of Chinese persons with diabetes is expected to grow.

Although health education can effectively improve chronic disease self-management [7,8], diabetes remains one of the most challenging chronic diseases to self-manage [9]. Successful diabetes self-management requires an ongoing comprehensive lifestyle change and constant monitoring of blood sugar levels. Moreover, recognizing and managing hypo-and hyperglycemia symptoms can be challenging. While studies have shown that health education is effective in helping patients and their family caregivers better manage their diabetes, face-to-face education sessions can be time-consuming and difficult to update the educational materials frequently.

Recently, mobile and internet technologies have emerged as a complementary medium for health education delivery [10–12]. For example, short message services (SMS), social networking tools (such as Twitter and YouTube), and internet webpages are becoming more popular for patient health education. Most mobile services allow users to send messages to the individual as well as a group of people, share photos and files, post microblogs, and voice or video chat with friends using computers or smartphones. Therefore, these mobile services have the potential for rapid dissemination, strong personalized interaction, timely delivery of up-to-date educational content. Those technologies are particularly relevant to diabetes education because they may address practical challenges associated with delivering face-to-face education such as time, cost, and scalability [10,13].

In China, WeChat and QQ are the two most dominant mobile services for group messaging [14]. According to the latest data, WeChat has about 1.1 billion active monthly subscribers and QQ has over 800 million active users (Tencent announcement in 2019). About 35% of WeChat users reported using the application for longer than 4 h per day.

Early research studies have demonstrated how group chat functionality can be exploited as a useful health education intervention tool [15–17]. Although there has been an increase in intervention studies examining the efficacy of education via group chat for individuals with diabetes, it remains unknown if these interventions can lead to clinically meaningful efficacy in improving blood glucose control. Therefore, we conducted meta-analyses to assess the comparative efficacy of health education through group chat programs on glycemic control over typical education in China. As mentioned previously, in the current study, we focused on WeChat and QQ, the two dominant mobile applications in China.

## 2. Materials and methods

### 2.1. Data sources and search strategy

We conducted comprehensive, systematic literature searches using all possible combinations of the following keywords: group chat, WeChat, QQ, education, diabetes, diabetes mellitus, blood glucose, hemoglobin A1c(HbA1c), fasting blood glucose (FBG), and 2 h postprandial blood glucose(2hPBG). We searched five databases: PubMed, CNKI (China Knowledge Resource Integrated Database), CBM(The Chinese biomedical literature database), China Wanfang Digital Database, and VIP database. We did not apply any language restrictions and included all relevant articles up to January 1st, 2018. We also reviewed the reference lists of eligible studies to increase the yield of our search. To organize a vast amount of literature and to facilitate collaboration among research team members, we used EndNote version 17, a reference management software.

### 2.2. Eligibility criteria and study selection

To be included in the current analyses, a study must (1) be a randomized controlled trial, (2) study individuals diagnosed with diabetes or with uncontrolled blood glucose, (3) include social media delivered education intervention (i.e., WeChat or QQ), (4) incorporate active control condition of education as usual (i.e., no wait-list conditions), (5) measure outcomes using an objective measure of blood glucose control (i.e., HbA1c, FBG, or 2hPBG).

Two reviewers (Caifang Chen and Ling Wang) searched databases and assessed the initial eligibility by scanning titles of the articles. After excluding unrelated study titles, abstracts of the articles were reviewed to exclude studies that do not meet the study criteria.

### 2.3. Data extraction and quality assessment

Caifang Chen and Ling Wang extracted data, using a standardized data extraction form. Data extracted for the current analyses included: (1) authors, (2) publication year, (3) study setting (i.e., inpatient, outpatient, and community at the time of initial intervention delivery), (4) diabetes types [i.e., with Type 1 vs. Type 2 vs. Gestational diabetes vs. impaired glucose tolerance] (5) identification of diabetes [e.g., the WHO diabetes association's standard published in 1999 vs. physician's diagnose from medical record], [18], (6) sample demographic distribution (e.g., sample size, mean age, gender distribution), (7) characteristics of the intervention [e.g., frequency of contacts, and who moderate the chat groups], (8) comparison conditions, (9) duration of intervention and follow-up, (10) outcome measures (HbA1c, FBG, and 2hPBG) and (11) modes of outcomes data collection (blood sample vs. self-report).

Each of Caifang Chen and Ling Wang assessed the risk of bias for an individual article, using criteria from the risk of bias assessment tool developed by the Cochrane Collaboration. This tool assesses possible sources of bias in randomized trials including (1) the adequate generation of allocation sequence, (2) the concealment of allocation to conditions, (3) the prevention of knowledge of the allocated intervention (i.e., masking of assessors), and (4) the treatment of incomplete outcome data, which was assessed as positive when intention-to-treat analyses were conducted (i.e., all randomized patients were included in the analyses). Any disagreement related to the extracted data and to the risk of bias score was resolved through discussion with a third reviewer (CL).

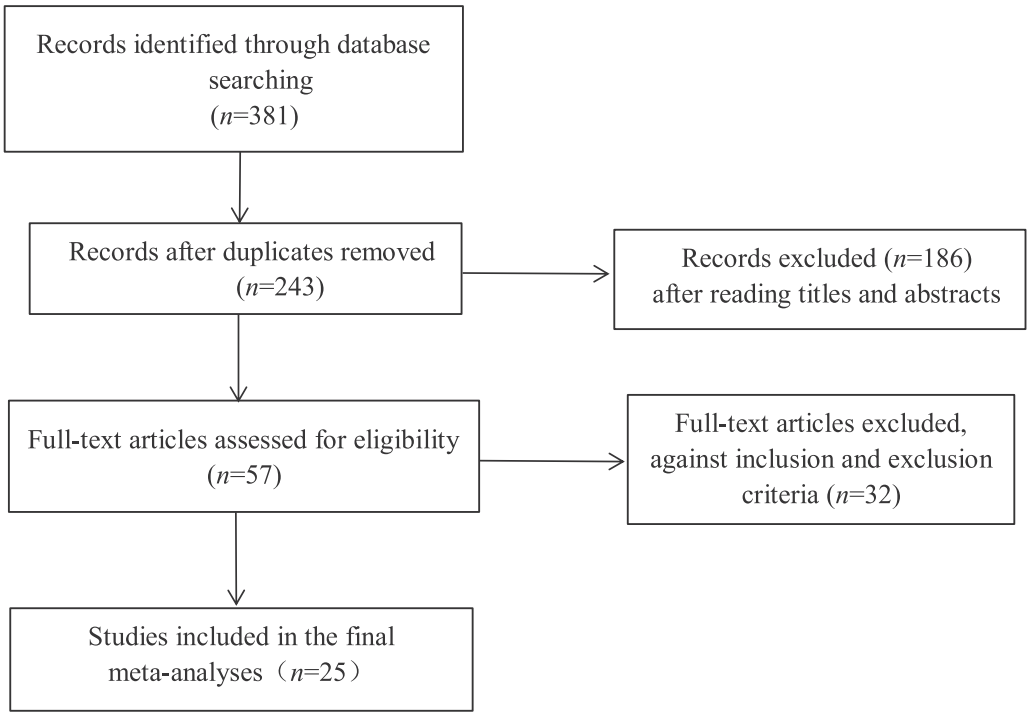


**Fig. 1.** Flowchart of inclusion of studies.

### 2.4. Data synthesis and analysis

Analyses were performed using comprehensive meta-analysis version 3.0. For each comparison of outcomes, we calculated the effect size (Hedges' g). Hedges' g was calculated by subtracting the average serum glycaemic control outcomes of the intervention group from that of the control group. The result was then divided by the pooled standard deviation. Because several studies had relatively small sample sizes, we corrected the effect size for small sample bias [19]. Furthermore, Hedges' g for each of the outcome measures was estimated separately (HgA1C, FBG, and 2hPBG).

### 2.5. Heterogeneity and subgroup analyses

$I^2$-statistic was used as an indicator of heterogeneity of effect sizes. A value of 0% indicates no observed heterogeneity, and larger values indicate increasing heterogeneity, with 25% as low, 50% as moderate, and 75% as high heterogeneity. We also calculated 95% confidence intervals (CI) around $I^2$ [20].

### 2.6. Risk of publication bias

Publication bias was tested using several methods. We first inspected the funnel plot on primary outcomes. Duval and Tweedies' trim [21] is an estimate of the effect size after the publication bias has been taken into account. Egger's test of the intercept was used to quantify the bias captured by the funnel plot and tested whether it was significant [22,23]. We also estimated Failsafe N, the hypothetical number of missing studies to make the combined effect size statistically insignificant [24]. Finally, we performed leave-one-out analyses [25] or each study, to estimate the magnitude of influence of each study on pooled effect size.

### 2.7. Subgroup and sensitivity analyses

Subgroup analyses were conducted according to the mixed-effects model [26]. For continuous variables, we used meta-regression to examine whether there was a significant relationship between the continuous variable and effect size [26]. We did not find statistically significant variation in the magnitude of pooled effect size associated with a study characteristic.

## 3. Results

### 3.1. Selected studies

Fig. 1 describes the study selection processes. Initial searches identified 243 unique articles. A total of 186 studies were excluded though reviewing titles and abstracts. Among the 57 remaining articles, 32 were excluded after the full-text review (Appendix A). Twenty-five unique studies were identified to be eligible in the current meta-analyses. Characteristics of studies included in the current analyses are presented in Table 1.

### 3.2. Characteristics of the included studies and quality assessment

The current meta-analyses included pooled data from 2837 participants: 1419 participants were in intervention groups and 1,418 were in control groups. The majority of study participants were recruited from inpatient hospital settings (64%). The follow-up period ranged between 3 and 12 months. The majority of studies ($n$ = 19) compared a typical face-to-face education programs vs. face-to-face education augmented with group chat education. Six studies compared education via group chat versus the typical face-to-face education program.

### 3.3. Outcome measures

While most studies collected more than one blood glucose outcomes, 16 studies included all three outcome measures (HgA1c, FBG, and 2hPBG) (Table 1). Fourteen studies collected these outcomes through a venous blood test, seven studies used patients'

**Table 1**
Characteristics of included studies.

| Authors (year) | Country | Aim of the study | Design and methods | Sample and settings | Key findings | Quality[a)] |
|---|---|---|---|---|---|---|
| Cheng XL et al.(2014) [27] | China | To explore the patients with diabetes mellitus by using multiple −media form such as WeChat can improve these patients' cognitive level, clinical symptoms and the quality of life. | Randomized controlled trial | 42 diabetic patients received interactive continuous care on the WeChat platform, including case sharing, peer education and updating of health knowledge (Treatment). 38 diabetic patients accepted 1 regular education within 6−12 months (Control). Inpatient. | HbA1c: Tre: pre/post:9.42 ± 0.88/5.67 ± 0.96; Con: pre/post: 9.50 ± 1.23/8.65 ± 2.32 FBG Tre: pre/post:9.82 ± 2.61/6.20 ± 1.20; Con: pre/post:9.76 ± 2.43/8.21 ± 1.05 2hPBG Tre: pre/post: 15.73 ± 3.20/9.52 ± 1.32; Con: pre/post:15.56 ± 1.56/13.86 ± 0.95 | - - - + |
| Dai GQ et al. (2017) [28] | China | To investigate the effect of WeChat health education platform on blood glucose control in community diabetic patients. | Randomized controlled trial | 50 diabetic patients received interactive continuous care on the WeChat platform, including psychological guidance, diet guidance, exercise therapy, medication guidance, to guide patients to self-monitoring (Treatment). 50 diabetic patients accepted face-to-face education once a month (Control). Community Health Center. | HbA1c: Tre: pre/post: 8.69 ± 1.45/6.24 ± 1.16 Con: pre/post: 8.67 ± 1.43/7.35 ± 1.25 FBG Tre: pre/post: 8.52 ± 1.34/6.35 ± 1.28 Con: pre/post: 8.53 ± 1.37/7.48 ± 1.41 2hPBG Tre: pre/post: 12.42 ± 1.48/8.26 ± 1.25 Con:pre/post: 12.39 ± 1.36/10.34 ± 1.41 | + - - + |
| Feng XF et al. (2017) [29] | China | To explore the value of WeChat in the management of patients with diabetes. | Randomized controlled trial | 57 diabetic patients received the WeChat education besides the regular health education (Treatment). 58 diabetic patients accepted six 45 -minute long diabetes education and nursing on-site (Control). Outpatient. | HbA1c: Tre: pre/post: 9.52 ± 1.27/7.01 ± 1.01 Con: pre/post: 9.63 ± 1.24/7.66 ± 1.13 FBG Tre: pre/post: 9.71 ± 1.79/6.54 ± 1.46; Con: pre/post: 9.58 ± 1.43/7.22 ± 1.63 2hPBG Tre: pre/post: 17.10 ± 2.12/8.25 ± 1.64 Con:pre/post: 17.33 ± 2.05/10.34 ± 2.12 | + - - + |
| Li XQ et al. (2016) [30] | China | To explore the application of group management in the follow-up of type 2 diabetes patients. | Randomized controlled trial | 50 diabetic patients received the WeChat education besides the regular health education, including assistance in short/long term goals setting, update diabetes health knowledge, develop a lifestyle program (Treatment). 50 diabetic patients accepted regular education in-hospital and 6 telephone follow-up (Control). Inpatient. | HbA1c: Tre: pre/post: 9.69 ± 2.11/7.04 ± 1.35 Con: pre/post: 8.58 ± 2.79/7.72 ± 1.27 FBG Tre: pre/post: 9.66 ± 4.16/6.56 ± 1.58; Con: pre/post: 9.16 ± 3.78/8.38 ± 2.14 2hPBG Tre: pre/post:16.7 ± 5.42/9.14 ± 2.45 Con:pre/post: 16.21 ± 4.50/10.26 ± 3.58 | - - - + |
| Liu CJ et al. (2016) [31] | China | To explore the effect of WeChat terminal education on out-of-hospital management of young and middle-aged diabetic patients. | Randomized controlled trial | 60 diabetic patients received the WeChat education, besides the regular health education, including uploaded diabetes related knowledge, video, pictures and notices, one-to-one education and nurse targeted guidance (Treatment). 60 diabetic patients accepted a regular education and telephone follow up (Control). Discharge from hospital. | HbA1c: (3 months) Tre: pre/post: 8.95 ± 2.31/7.44 ± 1.42 Con: pre/post: 8.92 ± 2.17/8.47 ± 1.83 HbA1c: (6 months) Tre: pre/post::8.95 ± 2.31/6.98 ± 1.24; Con: pre/post: 8.92 ± 2.17/7.79 ± 1.28 | + - - - |
| Liu DM et al. (2016) [32] | China | To evaluate the effectiveness of WeChat-based transitional care in diabetic. | Randomized controlled trial | 34 diabetic patients received the WeChat education, besides the regular health education including sent knowledge review with text, images, voice, video and groups discussion in 2/ weekly for 3 months (Treatment). 34 diabetic patients accepted 2 telephone follow-up (Control). Inpatient. | FBG Tre: pre/post: 10.71 ± 1.64/7.13 ± 1.63; Con: pre/post: 10.51 ± 1.51/9.62 ± 1.56 2hPBG Tre: pre/post: 15.63 ± 3.41/9.52 ± 2.56; Con:pre/post: 16.14 ± 3.36/11.44 ± 3.24 | + - - - |
| Lv LX et al. (2016) [33] | China | To explore the feasibility of implementing health education management mode for young and middle-aged diabetic patients on the joint WeChat public platform, as well as the education model in the influence on knowledge mastery, self-management ability and control of glucose and lipid metabolism | Randomized controlled trial | Besides the control patients obtained, 40 diabetic patients received regularly diabetes related information, and exchanged interaction with HCPs on the WeChat public platform (Treatment). 40 diabetic patients accepted some traditional educational meetings, telephone interviews and follow-up consultations (Control). Inpatient | HbA1c: Tre: pre/post: 9.38 ± 3.56/6.39 ± 1.69; Con: pre/post: 9.52 ± 3.84/7.23 ± 2.15 FBG Tre: pre/post: 9.72 ± 2.71/6.28 ± 2.59; Con: pre/post: 9.57 ± 2.64/7.79 ± 2.92 2hPBG Tre: pre/post: 15.35 ± 3.46/11.97 ± 2.63; Con:pre/post: 16.11 ± 3.53/13.46 ± 3.96 | - - - + |

**Table 1** (*continued*)

| Authors (year) | Country | Aim of the study | Design and methods | Sample and settings | Key findings | Quality[a)] |
|---|---|---|---|---|---|---|
| Luo J et al. (2016) [34] | China | To investigate the effect of WeChat follow-up on the behavior and self-management ability of patients with type 2 diabetes. | Randomized controlled trial | 100 diabetic patients received regular weekly follow-ups by WeChat, including documents, audio, and video (Treatment). The control group (100/200) with Outpatient follow-up and family treatment model.<br>Inpatient. | FBG (6 months)<br>Tre: pre/post: 6.04 ± 0.46/6.45 ± 0.48;<br>Con: pre/post: 6.42 ± 0.42/7.03 ± 0.58<br>FBG (12 months)<br>Tre: pre/post: 6.04 ± 0.46/5.93 ± 0.82;<br>Con: pre/post: 6.42 ± 0.42/7.46 ± 1.09<br>2hPBG (6 months)<br>Tre: pre/post: 7.38 ± 0.75/7.68 ± 0.64;<br>Con: pre/post: 7.68 ± 0.67/8.67 ± 0.65<br>2hPBG (12 months)<br>Tre: pre/post: 7.38 ± 0.75/8.11 ± 1.02;<br>Con: pre/post: 7.68 ± 0.67/9.41 ± 1.30 | + - - + |
| Shi XF et al. (2017) [35] | China | To explore the effect of extended nursing based on WeChat platform on self-management behavior and blood glucose of middle-aged and young diabetic patients. | Randomized controlled trial | Besides the control patients obtained, 78 diabetic patients acquired a variety of diabetes medication, diet, exercise, blood glucose monitoring, psychological counseling on the WeChat platform during hospitalization and after discharge, and a telephone interview occurred once a week (Treatment). The control group (80/158) with regular education during hospitalization and regular follow-up after discharge.<br>Inpatient. | HbA1c:<br>Tre: pre/post: 8.82 ± 1.81/6.96 ± 1.54<br>Con: pre/post:8.94 ± 1.89/8.41 ± 1.72<br>FBG<br>Tre: pre/post: 8.53 ± 1.41/5.19 ± 1.21;<br>Con: pre/post: 8.69 ± 1.45/7.54 ± 1.37<br>2hPBG<br>Tre: pre/post: 10.92 ± 1.53/8.31 ± 1.36<br>Con:pre/post: 11.07 ± 1.58/10.47 ± 1.59 | + - - + |
| Si L et al. (2016) [36] | China | To investigate the effect of WeChat group peer support education on blood glucose and self-management ability of diabetic patients. | Randomized controlled trial | 30 diabetic patients acquired a peer support education with WeChat group (Treatment). The control group (30/60) with face-to-face education by a diabetes education nurse monthly.<br>Outpatient. | HbA1c:<br>Tre: pre/post: 8.78 ± 1.10/6.73 ± 0.62<br>Con: pre/post:8.65 ± 1.04/7.41 ± 0.91<br>FBG<br>Tre: pre/post: 8.53 ± 1.61/6.27 ± 0.74;<br>Con: pre/post: 8.51 ± 1.45/7.24 ± 1.03<br>2hPBG<br>Tre: pre/post: 12.43 ± 1.84/8.79 ± 1.41;<br>Con:pre/post: 12.11 ± 1.96/10.49 ± 1.47 | + - - + |
| Sun XR et al. (2016) [37] | China | To investigate the effect of WeChat on continuous nursing of newly diagnosed diabetic patients. | Randomized controlled trial | 40 diabetic patients received the WeChat education, besides the regular education, including text, speech short letter, video, pictures, etc. sent 2 times a week, for 3 months. Nursing members to keep chatting online 30 min a day (Treatment). The control group (40/80) with regular education: gave the patient and family 1 time health education when they after discharge.<br>Inpatient. | HbA1c:<br>Tre: pre/post:9.58 ± 2.35/7.01 ± 1.12;<br>Con: pre/post: 9.73 ± 2.12/8.54 ± 2.3<br>FBG<br>Tre: pre/post: 10.39 ± 2.87/6.57 ± 1.37;<br>Con: pre/post: 11.04 ± 3.01/7.96 ± 2.28<br>2hPBG<br>Tre: pre/post: 13.91 ± 3.76/8.29 ± 2.16<br>Con:pre/post: 13.96 ± 3.48/11.09 ± 4.29 | - - - + |
| Tang PY et al. (2016) [38] | China | To explore through the WeChat circle of friends to carry out intensive education and guidance intervention for young and middle-aged diabetic patients, the effect of diabetes on the disease control. | Randomized controlled trial | Besides the control patients obtained, 30 diabetic patients received an implementation of Intensive Intervention and education by WeChat (Treatment). The control group (40/80) with regular education: 1 h diabetes talk every two months.<br>Community. | HbA1c:<br>Tre: pre/post: 9.7 ± 2.7/6.6 ± 1.3;<br>Con: pre/post: 9.9 ± 2.5/8.0 ± 1.4<br>FBG<br>Tre: pre/post: 11.0 ± 4.4/7.2 ± 2.2<br>Con: pre/post: 10.6 ± 4.2/9.6 ± 2.9<br>2hPBG<br>Tre: pre/post: 16.2 ± 4.5/8.2 ± 3.3;<br>Con: pre/post: 15.8 ± 4.8/11.9 ± 3.5 | - - - + |
| Wang LJ et al. (2016) [39] | China | To explore the influence of WeChat education on the quality of life and blood glucose control of patients with type 2 diabetes. | Randomized controlled trial | 48 diabetic patients received the WeChat education, besides the regular education, weekly to patients and so on. The control group (47/95) with regular education: hospitalization education (five carriages): diet, exercise, medication, monitoring, psychological, etc. And 2 times telephone after discharge.<br>Inpatient. | HbA1c:<br>Tre: pre/post: 9.42 ± 1.66/6.85 ± 0.42<br>Con: pre/post:8.89 ± 1.35/7.59 ± 0.62 | + - - - |
| Wu CZ et al. (2016) [40] | China | To discuss application effect of WeChat multimedia platform in health education for type 2 diabetes patients. | Randomized controlled trial | 60 diabetic patients received diabetes related knowledge once a week by WeChat, Besides the knowledge of the control patients obtained (Treatment). 60 diabetic patients accepted a lesson about diabetes every Saturday and one large classroom instruction every month (Control).<br>Inpatient. | HbA1c:<br>Tre: pre/post:9.40 ± 1.23/8.03 ± 1.12;<br>Con: pre/post:9.50 ± 0.21/9.08 ± 1.07<br>FBG<br>Tre: pre/post:7.26 ± 0.97/6.78 ± 0.48;<br>Con:pre/post:8.12 ± 1.53/7.78 ± 0.14<br>2hPBG<br>Tre: pre/post: 9.02 ± 1.56/8.11 ± 1.02<br>Con: pre/post:9.75 ± 0.36/8.24 ± 1.51 | + - - + |

(*continued on next page*)

**Table 1** (*continued* )

| Authors (year) | Country | Aim of the study | Design and methods | Sample and settings | Key findings | Quality[a)] |
|---|---|---|---|---|---|---|
| Yang LL et al. (2015) [41] | China | To explore a new model of diabetic education for young and middle-aged patients, and improve their ability of disease management. | Randomized controlled trial | Besides the regular education, 61 diabetic patients received a series of health educations by WeChat, including diabetes knowledge, dietary guidance, medication knowledge, psychological nursing and prevention of complications, and to solve corresponding problems (Treatment). The control group (59/120) with regular education: medication, diet, exercise and monitoring of blood sugar according to the doctor for guidance. Outpatient. | HbA1c (3 months):<br>Tre: pre/post: 9.49 ± 1.75/7.46 ± 0.59<br>Con: pre/post:9.01 ± 1.60/8.06 ± 1.00<br>HbA1c (6 months)<br>Tre: pre/post: 9.49 ± 1.75/6.92 ± 0.72<br>Con: pre/post:9.49 ± 1.75/6.92 ± 0.72<br>FBG (3 months):<br>Tre:pre/post:9.70 ± 2.18/7.23 ± 0.69; Con:pre/post:10.08 ± 2.45/8.40 ± 0.99<br>FBG (6 months):<br>Tre: pre/post: 9.70 ± 2.18/6.62 ± 0.70<br>Con: pre/post: 10.08 ± 2.45/7.43 ± 0.99<br>2hPBG (3 months)<br>Tre: pre/post:12.10 ± 2.93/9.76 ± 1.28<br>Con: pre/post:12.82 ± 3.00/11.41 ± 1.73<br>2hPBG (6 months)<br>Tre: pre/post: 12.10 ± 2.93/9.00 ± 0.85<br>Con:pre/post: 12.82 ± 3.00/10.72 ± 1.69 | + - - - |
| Yang SH et al. (2015) [42] | China | To investigate the effect evaluation of WeChat platform in self-management of type 2 diabetes mellitus. | Randomized controlled trial | Besides the regular education, 51 diabetic patients received some health knowledge 1 time/3 days by WeChat, including text, video, and image forms (Treatment). The control group (51/102) received a common education during hospitalization, a diabetes activities once a month after discharged.<br>Inpatient. | HbA1c:<br>Tre: pre/post: 8.0 ± 1.2/6.9 ± 0.5;<br>Con: pre/post: 8.1 ± 1.1/7.5 ± 0.5<br>FBG<br>Tre: pre/post: 8.79 ± 1.66/7.34 ± 1.31<br>Con: pre/post: 8.38 ± 1.64/8.39 ± 1.35 | - - - + |
| Yu DL et al. (2016) [43] | China | To explore the effect of application of WeChat combined with "micro sugar management software in out hospital blood glucose continuity of management of patients with 2 diabetes mellitus. | Randomized controlled trial | The administrator to upload diabetes self-management knowledge and to answer patient questions to give targeted health guidance by WeChat after discharge in the treatment group (48/98). The control group with a telephone follow-up to give the answers for the patients' self-management after discharge weekly (50/98).<br>Inpatient. | HbA1c:<br>Tre (different value):1.30 ± 1.80<br>Con(different value): 0.60 ± 0.70 | - - - + |
| Yuan L et al. (2017) [44] | China | To explore the effect of the family doctor using mobile phone WeChat to manage diabetic patients in the community. | Randomized controlled trial | Besides the regular education, there were at least three pieces of on-line interaction between HCPs and patients (100/200) in the treatment group. 100 Diabetes patients saw the family doctor at least once every 3 months in the control group.<br>Community center. | HbA1c:<br>Tre: pre/post: 8.47 ± 0.92/7.49 ± 0.91<br>Con: pre/post: 8.33 ± 0.97/8.12 ± 0.87<br>FBG<br>Tre: pre/post: 9.01 ± 1.2/7.85 ± 0.63<br>Con: pre/post: 8.99 ± 0.97/8.63 ± 0.74 | + - - - |
| Zeng L et al. (2015) [45] | China | To explore the effect of WeChat platform in diabetes health education. | Randomized controlled trial | Besides the control patients obtained, 40 diabetic patients received a series of diabetes-related knowledge by WeChat, including diabetes-related research focus, new research projects, new guidelines, cases; insulin, blood glucose control operation, and video (Treatment). The control group with regular education: a one-on-one talk, and received some health education materials (40/80).<br>Inpatient. | FBG<br>Tre: pre/post: 9.56 ± 0.52/6.52 ± 0.42<br>Con: pre/post: 9.73 ± 0.48/7.48 ± 0.38<br>2hPBG<br>Tre: pre/post: 13.21 ± 5.18/9.48 ± 3.61<br>Con:pre/post: 12.39 ± 4.69/10.79 ± 1.45 | + - - + |
| Zhang YL et al. (2017) [46] | China | To explore the effects WeChat health educational intervention on middle aged and young type 2 diabetes mellitus. | Randomized controlled trial | Besides the regular education, there were group discussions or on- to-one talk, 2 to 4 times/1–2 weeks after discharge, then once a week by WeChat in the treatment group (60/120). The control group with regular education: DM health education, diet care, oral、skin care, reasonable exercise, medicine care. (60/120).<br>Inpatient. | HbA1c (6 months):<br>Tre: pre/post:9.55 ± 1.38/7.07 ± 0.94;<br>Con: pre/post: 9.43 ± 1.13/8.72 ± 1.21<br>HbA1c (12 months)<br>Tre: pre/post: 9.55 ± 1.38/6.63 ± 0.97<br>Con: pre/post: 9.43 ± 1.13/8.35 ± 1.05<br>FBG (6 months):<br>Tre: pre/post: 9.76 ± 1.28/7.54 ± 1.58;<br>Con: pre/post: 9.55 ± 1.31/8.19 ± 1.34;<br>FBG (12 months):<br>Tre: pre/post: 9.76 ± 1.28/7.14 ± 1.42<br>Con: pre/post: 9.55 ± 1.31/7.90 ± 1.36<br>2hPBG (6 months)<br>Tre: pre/post: 15.02 ± 1.89/10.17 ± 1.42<br>Con:pre/post: 14.88 ± 1.66/11.23 ± 1.87 | + - - - |

**Table 1** (*continued*)

| Authors (year) | Country | Aim of the study | Design and methods | Sample and settings | Key findings | Quality[a)] |
|---|---|---|---|---|---|---|
| | | | | | 2hPBG (12 months)<br>Tre: pre/post: 15.02 ± 1.89/9.30 ± 1.43<br>Con:pre/post: 14.88 ± 1.66/10.80 ± 1.88 | |
| Wu WZ et al. (2016) [47] | China | To explore an effective and simple health education model for postpartum rehabilitation of gestational diabetes mellitus. | Randomized controlled trial | The treatment group (170/342) with real-time lifestyle guidance and 24 h online management on the WeChat platform. 172 diabetic patients accepted a traditional education (Control).<br>Outpatient. | HbA1c (4.5 months):<br>Tre: pre/post: 5.49 ± 0.16/5.47 ± 0.23<br>Con: pre/post: 5.54 ± 0.34/5.53 ± 0.35;<br>HbA1c (10.5 months)<br>Tre: pre/post: 5.49 ± 0.16/5.54 ± 0.28;<br>Con: pre/post: 5.54 ± 0.34/5.66 ± 0.17<br>FBG (4.5 months):<br>Tre: pre/post: 5.59 ± 0.84/5.46 ± 0.83;<br>Con: pre/post: 5.49 ± 0.92/5.85 ± 0.89;;<br>FBG (10.5 months):<br>Tre: pre/post: 5.59 ± 0.84/5.20 ± 0.55<br>Con: pre/post: 5.49 ± 0.92/6.02 ± 0.84<br>2hPBG (4.5 months)<br>Tre: pre/post: 88.30 ± 3.50/86.42 ± 3.60<br>Con:pre/post: 87.61 ± 3.55/87.64 ± 3.49_<br>2hPBG (10.5 months)<br>Tre: pre/post: 88.30 ± 3.50/84.03 ± 3.83<br>Con: pre/post: 87.61 ± 3.55/86.14 ± 3.50 | + - - + |
| Huang XY et al. (2016) [48] | | To investigate the effect of WeChat on nutrition instructions to women of advanced maternal age with gestational diabetes mellitus. | Randomized controlled trial | 40 diabetic patients received the WeChat education for dietary guidance, besides the regular education (Treatment). The control group with regular education: attended the health education lecture and accepted nutrition guidance (40/80).<br>Outpatient. | HbA1c:<br>Tre: pre/post: 7.7 ± 1.1/6.9 ± 1.6;<br>Con: pre/post: 7.5 ± 1/7.8 ± 1.3<br>FBG<br>Tre: pre/post: 7.7 ± 2.2/6.6 ± 2.3;<br>Con: pre/post: 7.8 ± 2.4/8.4 ± 3.2<br>2hPBG<br>Tre: pre/post: 12.2 ± 4.5/8.9 ± 3.2;;<br>Con: pre/post: 11.2 ± 3.8//12.6 ± 4.1 | - - - + |
| Su JX et al. (2017) [49] | China | To explore the effect of prevention intervention on blood glucose control in prediabetic patients. | Randomized controlled trial | Besides the regular education, 30 diabetic patients received the QQ and WeChat education with one follow-up weekly for diet, moderate exercise, regular work and rest, smoking cessation, limit alcohol, monitoring of blood sugar (Treatment). 30 diabetic patients accepted regular education: popularity of pre-diabetes knowledge, regular monitoring of blood sugar, diabetes-related material (Control).<br>Outpatient. | HbA1c:<br>Tre: pre/post: 6.41 ± 0.47/5.51 ± 0.46<br>Con: pre/post: 6.11 ± 1.20/5.94 ± 1.10<br>FBG<br>Tre: pre/post: 6.50 ± 0.45/5.31 ± 0.40<br>Con: pre/post: 6.45 ± 0.50/5.88 ± 0.88<br>2hPBG<br>Tre: pre/post: 9.05 ± 1.04/6.48 ± 0.22;<br>Con: pre/post: 9.08 ± 1.03/8.48 ± 1.08 | - - - + |
| Xiang GZ et al. (2017) [50] | China | To explore and discuss the effect of Internet model combined with health education pathway in the initial clinical diagnosis of type 2 diabetes mellitus. | Randomized controlled trial | The treatment group (50/100) with an online health management before admission, during hospitalization and after discharge on the WeChat platform. The control group with regular education: 5 times a week lectures during hospitalization (50/100).<br>Inpatient. | HbA1c:<br>Tre: pre/post: 9.01 ± 1.01/6.06 ± 1.08<br>Con: pre/post: 9.01 ± 1.01/7.26 ± 1.32<br>FBG<br>Tre: pre/post: 11.2 ± 1.32/5.4 ± 0.72<br>Con: pre/post: 11.2 ± 1.32/6.81 ± 1.02<br>2hPBG<br>Tre: pre/post: 16.67 ± 5.12/7.03 ± 1.4;<br>Con: pre/post: 16.67 ± 5.12/9.01 ± 2.5 | - - - + |
| Zhao XJ et al. (2014) [51] | China | To investigate the effects of network visit on self-efficacy and glucose metabolism in patients with type 2 diabetes mellitus. | Randomized controlled trial | Besides regular education, 50 diabetic patients received the QQ education. Follow-up weekly for drug information, life tips and diet, medication errors and other information, and give individual guidance (Treatment). 50 diabetic patients received the regular education: one-to-one targeted guidance (Control).<br>Inpatient. | HbA1c:<br>Tre: pre/post: 9.5 ± 2.3/7.0 ± 1.0<br>Con: pre/post: 9.5 ± 1.9/8.1 ± 1.6 | + - - + |

*Note*: a): In this column a positive or negative sign is given for four quality criteria, respectively: the adequate generation of allocation sequence; concealment of allocation to conditions; blinding of assessors; and intention-to-treat analysis. A positive sign was given when the article meet the criteria, otherwise, a negative sign was assigned. Tre: treatment (means WeChat/QQ group); Con: control (means control group); HbA1c = hemoglobin A1c, FBG = fasting blood glucose, 2hPBG = 2 h postprandial blood glucose.

self-report and three studies did not report how the outcomes were measured.

### 3.4. Quality of the studies included in the current meta-analyses

The quality of studies included in the current meta-analyses varied. Only one study reported all four quality criteria. Ten studies included two or three criteria. The remaining 13 studies reported none or only one of the four criteria. The majority of studies reported intent-to-treat analyses (20 out of 25 studies) and adequate generation of allocation sequence (16 out of 25 studies). However, none of the studies reported concealment of allocation to conditions and blinding of assessors (Table 1).

**Table 2**
The pooled effect size of the major group chat education outcomes (HbA1c, FBG, 2hPBG).

| Follow up time period | Effect size and 95% confidence interval | | | | | Test of null (2-tail) | | Heterogeneity | | | Measures of publication bias | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *n* | Hedges' g | Standard error | Variance | 95% CI | *Z* | *P* | *Q* | *df (Q)* | *P* | Egger's regresion intercept | Egger's regresion intercept |
| HgA1c | | | | | | | | | | | | |
| 0–3 months | 10 | −0.75 | 0.08 | 0.01 | (−0.91, −0.58) | −9.00 | <0.001 | | | | | |
| 3–6 months | 9 | −0.77 | 0.17 | 0.03 | (−1.09, −0.44) | −4.62 | <0.001 | | | | | |
| 6–12 months | 3 | −1.14 | 0.23 | 0.05 | (−1.58, −0.70) | −5.06 | <0.001 | | | | | |
| Overall | 22 | −0.81 | 0.09 | 0.01 | (−0.98, −0.64) | −9.38 | <0.001 | 2.71 | 2.00 | 0.260 | Intercept = −4.99 *P* = 0.005 | Trimmed study = 0 |
| FBS | | | | | | | | | | | | |
| 0–3 months | 11 | −1.13 | 0.16 | 0.03 | (−1.45, −0.81) | −6.89 | <0.001 | | | | | |
| 3–6 months | 7 | −0.75 | 0.12 | 0.01 | (−0.98, −0.52) | −6.47 | <0.001 | | | | | |
| 6–12 months | 2 | −2.29 | 0.53 | 0.28 | (−3.32, −1.26) | −4.35 | <0.001 | | | | | |
| Overall | 20 | −1.11 | 0.13 | 0.02 | (−1.37, −0.85) | −8.36 | <0.001 | 10.52 | 2.00 | 0.005 | Intercept = −5.34 *P* = 0.270 | Trimmed study = 3 |
| 2hPBG | | | | | | | | | | | | |
| 0–3 months | 12 | −0.93 | 0.12 | 0.01 | (−1.16, −0.70) | −7.77 | <0.002 | | | | | |
| 3–6 months | 4 | −1.41 | 0.37 | 0.14 | (−2.14, −0.69) | −3.81 | <0.001 | | | | | |
| 6–12 months | 2 | −1.89 | 1.80 | 3.25 | (−5.43, 1.65) | −1.05 | 0.295 | | | | | |
| Overall | 18 | −0.98 | 0.11 | 0.01 | (−1.20, −0.76) | −8.62 | <0.001 | 1.80 | 2.00 | 0.407 | Intercept = −6.37 *P* = 0.770 | Trimmed study = 5 |

*Note:* HbA1c = hemoglobin A1c, FBG = fasting blood glucose, 2hPBG = 2 h postprandial blood glucose.

### 3.5. Comparative efficacy of group chat education on hemoglobin A1c

Table 2 describes the pooled effect sizes of major outcomes. The overall effect size of education via group chat over control conditions measured with HgA1c was large [Hedges' g = −0.81, 95% CI: (−0.98, −0.64)]. Moreover, the magnitude of the effect of treatment group on HgA1c grew over time (Table 2).

### 3.6. Comparative efficacy of group chat education on fasting blood glucose

The overall effect size of education via group chat over control conditions measured with FBG was large [Hedges' g = −1.11, 95% CI: (−1.37, −0.85)] (Table 2). Hedges' g at 0–3 months, 3–6 months, and 6–12 months were −1.13 [95% CI: (−1.45, −0.81)], −0.75 [95% CI: (−0.98, −0.52)], and −2.29 [95% CI: (−3.32, −1.26)] (Table 2), respectively.

### 3.7. Comparative efficacy of group chat education on 2-h postprandial blood glucose levels

The overall effect size of education via group chat over control conditions measured with 2hPGB was large [Hedges' g = −0.98, 95% CI: (−1.20, −0.76)]. Moreover, the magnitude of the effect of treatment group on 2hPGB grew over time(Table 2). The 95% confidence interval was generally wide, especially at 6–12 months follow up. This may be explained by the small number of studies ($n = 2$) that measured longer-term follow-up outcomes.

### 3.8. Subgroup analyses

We conducted a small number of moderator analyses to examine how characteristics related to study design (i.e., study setting, patient populations, how diabetes mellitus was diagnosed, mode of outcomes data collection). We did not find significant subgroup differences associated with differential effect sizes.

## 4. Discussion

The primary findings of this study are that, compared to typical face-to-face patient education, patient educations delivered via or augmented with group chat were associated with significantly improved glucose management (i.e., FBG, 2hPBG, and HbA1c). Moreover, the superior outcomes associated with education via group chat were sustained for up to one year.

There may be several reasons why educational interventions via group chat showed robustly and sustained comparative efficacy over education as usual. First, educations via group chat may have allowed more frequent reminders about educational content than typical face-to-face educations. Frequent reinforcement of educational content may have enhanced the participants' understanding of diabetes self-management regimen and increased motivation to follow the self-care recommendations. Secondly, participants in the intervention group were allowed to ask questions to the interventionist publicly using group chat. Observing such interaction between other participants and the interventionist could have increased the sense of belonging and normalized one's personal challenges with glucose control among all participants.

The current meta-analysis has some limitations. First, many studies included in this meta-analysis did not report how they ensured intervention and comparison conditions are comparable. For example, those in intervention groups were likely to have more frequent interaction with the interventionist than those in comparison groups. Therefore, the robust outcomes observed in these studies may be due to the increased attention rather than the educational medium (i.e., group chat vs. face-to-face). Second, certain clinical and structural characteristics known to be associated with the ability to self-manage diabetes were not commonly reported. For example, the complexity of the treatment regimen is known to impact one's ability to self-manage diabetes [52,53]. Another example would be access to quality diabetes care. No study included in the current meta-analysis reported these characteristics. Therefore, we were not able to examine how such clinical and structural characteristics may have impacted the efficacy of educational interventions.

Despite those limitations, our study fills the significant knowledge gap about the potential utility of social media in health education for those with diabetes. As mentioned previously, patient education via group chat presents many advantages over typical face-to-face patient education. These advantages include increased opportunities for wide and targeted reach, personalizing educational content, improved patient satisfaction, and better peer-to-peer support.

New technology-driven modalities of patient education present valid challenges, however. First, populations that need education most urgently may not be familiar with or have access to technologies. For example, elderly populations experience high rates of

chronic conditions such as diabetes. Therefore, they may benefit from technology-driven interventions. Yet, at the same time, elderly patients with diabetes may not be familiar with commonly used technologies and need additional help to fully benefit from technology-driven health education. Secondly, issues of security and privacy remain problematic in social media-driven health education. Lastly, some participants may prefer in-person education over group chat and consider the former to be more caring and personalized than the latter.

## 5. Conclusion

Our meta-analysis showed patient education via group chat had a superior and sustained improvement in blood glucose control compared to typical face-to-face education among individuals with diabetes in China. Further studies are needed to develop high-quality educational programs that take full advantage of the recent development of technology.

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## CRediT authorship contribution statement

**Caifang Chen:** Conceptualization, Methodology, Data curation, Writing - original draft. **Ling Wang:** Investigation, Validation, Visualization. **Han-Lin Chi:** Data curation. **Wenfeng Chen:** Investigation. **Mijung Park:** Conceptualization, Methodology, Formal analysis, Writing - original draft, Writing - review & editing, Supervision.

## Declaration of competing interest

There is no conflict of interest to declare.

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## Appendices. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijnss.2020.04.010.

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