The Effect of Online Support of an Internet Plus Shared Care Diabetes Management Model on Metabolic Indicators for Patients With Type 2 Diabetes During the COVID-19 Pandemic

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Abstract

**Purpose:** This study aimed to explore the influences of online support of an Internet plus Shared Care diabetes management model on metabolic indicators and the differences before and after the coronavirus disease 2019 (COVID-19) pandemic.

**Method:** Type 2 diabetes patients who visited the Peking University First Hospital Internet plus Shared Care clinic from May 18, 2020 to June 20, 2020 (after the COVID-19 pandemic subsided) were enrolled in the study. The age, gender, usage of insulin, and duration of diabetes of the patients were collected. The glycosylated hemoglobin (HbA1c), interval between two consecutive visits, communication frequencies with online diabetes educators through an app, online self-monitoring of blood glucose (SMBG) and upload count and SMBG pairing count (before–after meal) were collected before (prior to January 20, 2020) and after (from May 18, 2020 to June 20, 2020) the COVID-19 pandemic for logistic regression analysis. The R-3.4.4 and TWANG programs were used for analysis. The group of patients whose HbA1c did not change during the pandemic was the control group, while the group of patients with improved HbA1c was the dependent variable. Independent variables included age, gender, duration of disease, insulin usage, online communication amount, SMBG count, and SMBG pairing count. Propensity score matching (PSM) was applied with age, duration, gender, body mass index (BMI), HbA1c, low density lipoprotein-cholesterol (LDL-C), and blood pressure (BP) at baseline as the concomitant variable. After the PSM weighting, the average treatment effect (ATE) of post-pandemic BMI, HbA1c, LDL-C, and BP was compared with the baseline.

**Results:** A total of 387 patients were enrolled in the study including 184 female (47.5%). The baseline values were the following: age, 61.7±9.4 year; duration of diabetes, 11.7±8.2 years; BMI, 25.9±3.8Kg/m²; HbA1c, 7.2±1.3%; LDL-C, 2.49±0.85mmol/L; systolic BP, 130.8±14.9 mmHg; and diastolic BP, 81.1±40.9 mmHg. Among variables, online communication amounted to a statistically significant contribution to the HbA1c improvement after the COVID-19 pandemic (OR=2.178, p=0.003). During the pandemic, each patient received 18 (3, 56) times online communication support per quarter. Patients were divided into four groups by quartiles: Q1 (more than 56 times/quarter, n=95), Q2 (18–56 times/quarter, n=97), Q3 (3–18 times/quarter, n=93), and Q4 (0–3 times/quarter, n=102). After PSM, post-pandemic data showed significant differences. Between-group variance was found in HbA1c (Q1 vs. Q3, -0.42±0.16%, p=0.009; Q1 vs. Q4, -0.53±0.15%, p=0.0009) and BMI (Q1 vs. Q3, -1.2±0.5, p=0.02; Q1 vs. Q4 -1.5±0.7, p=0.01) of patients.

**Conclusion:** During the COVID-19 pandemic, high-quality online support of the Internet plus Shared Care diabetes management model can significantly improve the HbA1c and BMI of type 2 diabetes patients.

Introduction

China experienced the first coronavirus disease 2019 (COVID-19) case in the early part of 2020. The government implemented measures to restrict travel and streamline medical resources to limit the spread of infection. The quarantine and reassigned medical resources significantly affected lives of patients with chronic conditions such as diabetes. Patients could not visit hospitals regularly. For most patients, the interval between two consecutive visits was 4–6 months during the period of COVID-19, before work resumed in May 2020 in the Shared Care model clinic in Peking University First Hospital (PKUFH). Thus, self-management by the patients was the dominant determinant for control of diabetes during the pandemic. It was important to implement effective remote measures.

Because patients could not have glycosylated hemoglobin (HbA1c) tested every three months during the pandemic, remote glucose uploads, an online glucose diary, and communication support played important roles for patient care.
The Internet plus Shared Care diabetes management in PKUFH had a multidisciplinary team including endocrinologist, dietitian, diabetes educators, nurses, physical therapist, and online management team of diabetes educators. The model was patient-centered and the purpose was to continuously improve self-management of patients by providing both online and offline support, in order to improve their metabolic indicators and delay complications\(^1\). Patients received three times more online support than offline face-to-face education, which had a great impact on the HbA1c of patients. The online communication support had a positive effect on diabetic metabolic indicators during the COVID-19 pandemic. This study aimed to explore the effect of online communication support on the changes of metabolic indicators before and after the pandemic.

**Materials And Methods**

**Objective:**

A total of 387 patients with type 2 diabetes, who had visited the Internet plus Shared Care diabetes management model in PKUFH after the COVID-19 pandemic (from May 18, 2020 to Jun 20, 2020) were enrolled. The enrolled patients were diagnosed as type 2 diabetes based on the diabetes diagnostic criteria of WHO 2019. There were 203 males and 184 females, ages 61.66 ± 9.43 years. The duration of diabetes since diagnosis was 11.7 ± 8.2 years and the body mass index (BMI) was 25.9 ± 3.8 kg/m\(^2\). The HbA1c test, interval between two consecutive visits, insulin usage, communication frequencies with online diabetes educators through an app, online self-monitoring of blood glucose (SMBG), and before–after meal SMBG pairing count were also collected for analyses.

**Method:**

1. The implementation of the Internet plus Shared Care diabetes management model consisted of a closed loop of continuous care: offline (in-hospital) and online (out-of-hospital) self-support management.

**Offline support of self-management**

The model was firstly implemented in PKUFH in October 2016. In this model, type 2 diabetes patients visited the clinic quarterly to receive comprehensive services and education on self-management of diabetes. At each subsequent visit, various data including HbA1c, blood biochemistry, blood pressure, lipid panel, and Urinary Albumin Creatinine Ratio (UACR) were collected. Patients also received multidisciplinary support from the clinic. The assessments and individualized plans were summed as consultation records in the personal file of the patients and uploaded to the secure system for unified management.

**Online support of self-management**

Between two offline visits, well-trained diabetes educators provided online care while patients were at home. Patients downloaded an app, in which they could carry out multiple self-management activities, including uploading blood glucose in real-time (with iHealth BG1 smart glucometer connected to the phone), receiving high or low glucose alerts, keeping an integrated glucose diary, uploading a food and exercise log with pictures, learning about diabetes, and communicating with other patients. Problem-solving-oriented communication was led by well-trained diabetes educators. For patients who did not have the app, communication via a telephone call or message was the alternative plan. The communication content and time length were automatically recorded to the system.

2. Grouping
The patients were divided into four groups based on the amount of online communication support they received pre-pandemic (before Jan 20, 2020) and post pandemic (between May 18 and Jun 20, 2020). All 387 patients were divided into Q1 (number of communication times more than 56, n=95), Q2 (communication times 19–56, n=97), Q3 (communication times 3–18, n=93) and Q4 (communication times were less than 3, n=102).

3. Methods for metabolic indicators

HbA1c: Borate affinity high performance liquid chromatography method, achievement criteria < 7%.

Low-density lipoprotein cholesterol (LDL-C): Physical chemistry, achievement criteria < 2.60 mmol/L.

Blood pressure (BP): Collected in resting state and with the patient in a sitting position. BP was measured by a nurse with a sphygmomanometer, averaged after two measures, with achievement criteria < 140/90 mmHg.

Statistics

We used SPSS 22.0 for statistical analysis, and R 3.4.4 and the TWANG package (package source code: https://rdrr.io/rforge/twang/) for propensity score matching (PSM).

While measurement data conforming to the normal distribution were represented by analysis of variance (ANOVA) to compare the differences between groups, the data which were not conforming to the normal distribution were represented by the median (upper and lower quartile) [M(P25~P75)]. Non-parametric test was used to compare differences between groups. Enumeration data were described in percentage, and Chi-square test was used to compare differences between groups.

Patients whose HbA1c did not improve after the pandemic were considered as the control group and improvement of HbA1c after the pandemic was used as the dependent variable. Age of patient, duration of diabetes since diagnosis, gender, whether the patient used insulin, online communication support, online self-glucose monitoring, and uploading SMBG count and SMBG pairing count (before and after meal) were used as variables for logistic regression analysis.

This study is a retrospective study. To avoid the influence of the case distribution or baseline difference, we used age, gender, diabetes duration, and baseline metabolic indicators (BMI, HbA1c, LDL-C, systolic BP, diastolic BP) as a covariate to analyze the propensity score weighting for the four groups. Analysis was also carried out to compare the changes in BMI, HbA1c, LDL-C, and BP from baseline (population average treatment effect (ATE)) for follow-up after the pandemic. After the propensity score was weighted, the absolute standardized difference between groups was significantly improved. In this study, Stop method was es.mean. The inspection level was α=0.05.

Results

Baseline biological characteristics and metabolic indicators of enrolled patients

There was no statistically significant difference in blood glucose, BP, blood lipids, and other indicators of the enrolled patients between the four groups at baseline. The differences in age, gender, course of diabetes, and BMI at baseline were statistically significant (P < 0.05). The baseline data of the enrolled patients are shown in Table 1.
Table 1
Baseline clinical data of study subjects. Measurement data are represented by ($\bar{x} \pm s$) and enumeration data are represented by median (upper and lower quartile).

| Index                                      | All (n=387) | Q1(n=95) | Q2(n=97) | Q3(n=93) | Q4(n=102) | F      | P      |
|--------------------------------------------|-------------|----------|----------|----------|----------|--------|--------|
| Age (year)                                 | 61.66±9.43  | 62.51±9.18 | 60.27±9.17 | 60.4±8.52 | 63.35±10.41 | 2.644  | 0.049  |
| Female (%)                                 | 47.5% (184) | 58.9% (56) | 49.5% (48) | 37.6% (35) | 44.1% (45) | 9.242a | 0.026  |
| Duration of diabetes (year)                | 11.7±8.2    | 10.5±7.7  | 11.7±8.1  | 10.8±7.6  | 13.7±8.9  | 3.08   | 0.027  |
| Date interval between two visits (day)     | 177.7±39.8  | 182.1±43.5 | 174.7±33.4 | 176.4±35.3 | 177.8±45.7 | 0.599  | 0.616  |

**Follow-up before the COVID-19 pandemic**

| BMI (kg/m$^2$)                             | 25.9±3.8    | 25.3±3.6  | 25.4±4    | 25.7±3.1  | 27±4.3   | 3.45   | 0.017  |
| HbA1c (%)                                  | 7.2±1.3     | 7.1±1.4   | 7.2±1.4   | 7.2±1.3   | 7.2±1.2  | 0.197  | 0.89   |
| HbA1c<7% Achievement rate (%)              | 60.0%       | 57.7%     | 55.9%     | 52.9%     | 56.6%    | 1.071a | 0.78   |
| LDL-C (mmol/L)                             | 2.49±0.85   | 2.42±0.81 | 2.47±0.82 | 2.43±0.71 | 2.61±1.03 | 0.916  | 0.43   |
| LDL-C<2.6 mmol/L Achievement rate (%)      | 56.8%       | 55.7%     | 58.1%     | 51.0%     | 55.3%    | 1.154a | 0.76   |
| SBP (mmHg)                                 | 137.4±17.9  | 135.1±17  | 137.3±17.1 | 135.9±17.9 | 141.1±19.2 | 1.782  | 0.15   |
| DBP (mmHg)                                 | 80.8±12.6   | 80.6±13.1 | 81.7±14.2 | 80.5±10.9 | 80.6±12.2 | 0.163  | 0.92   |
| BP(140/80)mmHg Achievement rate (%)        | 33.7%       | 28.9%     | 38.7%     | 30.4%     | 32.8%    | 2.456a | 0.48   |

**Follow-up after the COVID-19 pandemic**

| BMI (kg/m$^2$)                             | 25.7±3.9    | 24.5±3.4  | 25.4±4    | 25.9±3.2  | 27.1±4.4 | 6.928  | <0.01  |
| HbA1c (%)                                  | 6.8±1.1     | 6.5±1     | 6.6±1     | 6.8±1     | 7.1±1.2  | 6.646  | <0.01  |
| HbA1c<7% Achievement rate (%)              | 87.4%       | 69.1%     | 72.0%     | 52.9%     | 70.0%    | 28.019a| <0.01  |
| LDL-C (mmol/L)                             | 2.35±0.77   | 2.45±0.77 | 2.33±0.77 | 2.27±0.69 | 2.35±0.82 | 0.856  | 0.46   |
| LDL-C<2.6 mmol/L Achievement rate (%)      | 58.9%       | 62.9%     | 67.7%     | 60.8%     | 62.5%    | 1.737a | 0.63   |

Note: BMI: body mass index; HbA1c: glycosylated hemoglobin; LDL-C: low-density lipoprotein cholesterol. 1 mmHg=0.133 kPa; a$\chi^2$ value
Analysis of factors for the improvement of HbA1c of type 2 diabetes patients after the COVID-19 pandemic

After binary regression analysis, only the number of online self-management support exceeding 32 times (OR=2.178, p=0.003) significantly increased the probability of improvement in HbA1c in the Internet plus Shared Care diabetes management model. The results are shown in Table 2.
| Variables                        | OR  | 95% CI          | p    |
|---------------------------------|-----|-----------------|------|
| **Gender**                      |     |                 |      |
| Male                            | 1   |                 |      |
| Female                          | NA  | NA              | 0.710|
| **Age (year)**                  |     |                 |      |
| age > 75                        | NA  | NA              | 0.290|
| 60 < age ≤ 75                   | NA  | NA              | 0.235|
| 45 < age ≤ 60                   | NA  | NA              | 0.075|
| Age ≤ 45                        | NA  | NA              | 0.957|
| **Duration (year)**             |     |                 |      |
| Duration > 15                   | NA  | NA              | 0.880|
| 10 < Duration ≤ 15              | NA  | NA              | 0.495|
| 5 < Duration ≤ 10               | NA  | NA              | 0.961|
| Duration ≤ 5                    | NA  | NA              | 0.973|
| **Insulin**                     |     |                 |      |
| Used insulin                    | 1   |                 |      |
| Not used insulin                | NA  | NA              | 0.658|
| **Date interval between two visits** |     |                 |      |
| interval > 200                  | NA  | NA              | 0.572|
| 180 < interval ≤ 200            | NA  | NA              | 0.793|
| 145 < interval ≤ 180            | NA  | NA              | 0.231|
| Interval ≤ 145                  | NA  | NA              | 0.361|
| **Online communication (OC)**   |     |                 |      |
| OC > 32                         | 2.178 | (1.311, 3.617) | 0.003|
| 7 < OC ≤ 32                     | 1.371 | (0.818, 2.299) | 0.231|
| OC ≤ 7                          | 1   |                 |      |
| **Online blood glucose monitoring (OBGM)** |     |                 |      |
| OBGM > 93                       | NA  | NA              | 0.153|
| 33 < OBGM ≤ 93                  | NA  | NA              | 0.130|
| 3 < OBGM ≤ 33                   | NA  | NA              | 0.401|
Comparison of metabolic indicators of patients in each group during follow-up visits after the COVID-19 pandemic

After the analysis of propensity score weighting method, HbA1c (Q1 vs Q3 -0.42±0.16%, p=0.009; Q1 vs Q4 -0.53±0.15%, p=0.0009) and BMI (Q1 vs Q3 -1.2±0.5, p=0.02; Q1 vs Q4 -1.5±0.7, p=0.01) of the patients were significantly different between groups. There was no significant difference between groups in the changes of LDL-C, systolic BP, and diastolic BP (P>0.05).

Table 3
HbA1c and BMI differences of average treatment effect (ATE) between groups of follow-up patients after the COVID-19 pandemic

| ATE          | HbA1c,%       | Estimate | Std. Error | t     | p      |
|--------------|---------------|----------|------------|-------|--------|
| Q1 vs. Q2    | -0.2737       | 0.1639   | 1.67       | 0.0959|
| Q1 vs. Q3    | -0.4262       | 0.1633   | 2.61       | <0.01 |
| Q1 vs. Q4    | -0.5317       | 0.1588   | 3.349      | <0.01 |
| Q2 vs. Q3    | -0.1525       | 0.1816   | 0.84       | 0.402 |
| Q2 vs. Q4    | -0.2579       | 0.1776   | 1.453      | 0.147 |
| Q3 vs. Q4    | -0.1054       | 0.177    | -0.596     | 0.552 |

| ATE          | BMI, Kg/m2    | Estimate | Std. Error | t     | p      |
|--------------|---------------|----------|------------|-------|--------|
| Q1 vs. Q2    | -0.889        | 0.6577   | 1.352      | 0.178 |
| Q1 vs. Q3    | -1.252        | 0.5488   | 2.281      | 0.023 |
| Q1 vs. Q4    | -1.5771       | 0.6551   | 2.407      | 0.017 |
| Q2 vs. Q3    | -0.363        | 0.6318   | 0.575      | 0.566 |
| Q2 vs. Q4    | -0.6881       | 0.7261   | 0.948      | 0.344 |
| Q3 vs. Q4    | -0.3251       | 0.6291   | -0.517     | 0.606 |

Discussion
The COVID-19 pandemic has become the biggest challenge for humankind in 2019–2020. We are not certain if patients with diabetes are more vulnerable to the virus, but many studies show that in gender- and age-matched patients, diabetes patients who have been infected by COVID-19 had a less optimistic prognosis\(^2\). Therefore, the primary prevention of COVID-19 is necessary for patients with diabetes\(^3\). As chronic hyperglycemia and chronic inflammation are two important physiological factors that inhibit immunity\(^4\), and hyperglycemic status can also lead to an increased risk of secondary infection\(^5\), patients with diabetes should receive proper management for better blood glucose control\(^6\).

The COVID-19 pandemic has brought greater challenges for diabetes management specifically. In China, the quarantine that inhibited the outbreak also reduced the availability of medical resources and support for diabetes patients\(^7\). In addition, the unpredictable virus breakout and the consequent social isolation altered diets and exercise of patients and increased their mental stress\(^8\)–\(^9\). Strategies needed to be adjusted accordingly to provide effective diabetes management. Currently, remote patient management has become one of the most effective and prevalently recommended methods for diabetes management during the COVID-19 period\(^10\)–\(^12\).

To reduce the fluctuation of metabolic indicators of the patients, it is necessary to launch a remote management system to support them. During the COVID-19 pandemic, there was little evidence-based medical guidance facilitating the establishment of remote patient management\(^13\).

A systematic review showed that mHealth intervention for patients with type 2 diabetes could be effective to improve HbA1c in a short-term basis\(^14\). However, the heterogeneity and limited evidence affected the reliability of the inferences of the study. Given the multiple forms of implementation of online management, there may not be a single best solution, but an array of methods to meet the needs and challenges of different regions.

The Internet plus Shared Care diabetes management model in PKUFH was composed of both online and offline patient management. In addition to the regular three-month visit to the out-patient clinic to receive multidisciplinary diabetes assessment and education, the model featured online services that played an important role. Patients received reminders to monitor paired glucose records (before and after meal), and patients could ask questions accordingly about their glucose diary, diet, and exercise, and also could get in-time individualized response and self-management support from a well-trained online educator team. All members of that team were evaluated regularly. The goal was to enable patients to develop better self-management skills and behavior modification strategies through online services in order to reach better metabolic indicators and delay complications. Currently, there are 17 hospitals in Beijing that have established the Shared Care diabetes management model, which covers over 7000 patients with a high cost-effective ratio. The model enables diabetes patients in the area to receive continuous diabetes education and self-management support during the COVID-19 pandemic.

According to a previous study on type 2 diabetes patients conducted in China, age, sex, BMI, diabetes course, and diabetes education were independent factors in blood sugar control\(^15\). However, our study shows that gender, age, and duration of diabetes are not predictive factors for HbA1c improvement in people with type 2 diabetes after the outbreak. The differences of the factors, affecting glucose metabolism before and after the outbreak, suggested that we cannot follow the general management methods to control diabetes during a pandemic. The ADA joint position stated that for the self-management support for type 2 diabetics, it is recommended to evaluate and adjust the support strategy at four key periods: during diagnosis, annual assessment, at the emergence of new complex factors affecting self-management, and during need for changes in disease management\(^16\). During an outbreak, the diabetes management team should intervene and respond appropriately in a timely manner. The number of online
communications, rather than the number of on-line blood glucose monitoring uploads, was associated with the improvement of HbA1c levels in patients after the outbreak. Hence, in the Shared Care management model during the COVID-19 pandemic, blood glucose monitoring only is not enough for better metabolic results. Online communication is strongly recommended to improve patient care.

In addition, the study found that with the increase in the number of online communications, the improvement of BMI after the outbreak was statistically significant, while blood lipids and BP did not show significant changes. This study did not include body composition analysis, so the reduction of BMI after the outbreak was not equivalent to an improvement in body fat rate. Daily physical activities of patients were reduced after social isolation during the pandemic; hence the tendency of sarcopenia (reduction of muscle) was also noteworthy. Thus, regular assessment of the patient's movements is needed, with particular attention paid to changes in the nutritional and body composition of individuals with significantly reduced BMI. Other management indicators such as blood lipids and BP were not the intervention goals of this study. To improve the overall effect of integrated management of Internet plus Shared Care model in the future, it is necessary to coordinate more smart tools and implement relevant management strategies.

**Conclusion**

Diabetes management has faced an unprecedented challenge during the COVID-19 outbreak. To maintain metabolic control in patients with diabetes during the pandemic, we adopted an online self-management support strategy, based on the Internet plus Shared Care diabetes management model, to provide remote services to patients. During the COVID-19 outbreak, management of type 2 diabetes was different than prior to the outbreak in terms of factors controlling blood sugar in patients in China. The number of online communications, rather than the number of online blood glucose monitoring tests, was associated with the improvement of HbA1c in type 2 diabetes patients during the pandemic. The higher level of online self-management support significantly improved the levels of HbA1c and BMI in these patients.

**Declarations**

All clinical investigations detail in manuscripts submitted to the ENDOCRINOLOG are conducted in accordance with the Declaration of Helsinki and the study has been approved by the appropriate institutional human research committee. At the same time, all authors declare no conflict of interest.

**References**

1. Li Ang, Zhang Junqing, Guo Xiaohui, et al. Stage management efficiency and medication alteration analysis in a shared care clinic of diabetes. Chin J Diabetes Mellitus. 2018,10(7):471-475. DOI: 10.3760/cma.j.issn.1674-5809.2018.07.007
2. Shi Q, Zhang X, Jiang F, et al. Clinical Characteristics and Risk Factors for Mortality of COVID-19 Patients With Diabetes in Wuhan, China: A Two-Center, Retrospective Study. Diabetes Care. 2020;43(7):1382-1391. doi:10.2337/dc20-0598
3. Bornstein SR, Rubino F, Khunti K, et al. Practical recommendations for the management of diabetes in patients with COVID-19. Lancet Diabetes Endocrinol. 2020;8(6):546-550. doi:10.1016/S2213-8587(20)30152-2
4. Stoian AP, Banerjee Y, Rizvi AA, Rizzo M. Diabetes and the COVID-19 Pandemic: How Insights from Recent Experience Might Guide Future Management. Metab Syndr Relat Disord. 2020;18(4):173-175.
5. Yang JK, Feng Y, Yuan MY, et al. Plasma glucose levels and diabetes are independent predictors for mortality and morbidity in patients with SARS. Diabet Med. 2006;23(6):623-628. doi:10.1111/j.1464-5491.2006.01861.x
6. Zhou J, Tan J. Diabetes patients with COVID-19 need better blood glucose management in Wuhan, China. Metabolism. 2020;107:154216. doi:10.1016/j.metabol.2020.154216
7. Katulanda P, Dissanayake HA, Ranathunga I, et al. Prevention and management of COVID-19 among patients with diabetes: an appraisal of the literature. Diabetologia. 2020;63(8):1440-1452. doi:10.1007/s00125-020-05164-x
8. Hartmann-Boyce J, Morris E, Goyder C, et al. Diabetes and COVID-19: Risks, Management, and Learnings From Other National Disasters. Diabetes Care. 2020;43(8):1695-1703. doi:10.2337/dc20-1192
9. Gupta S, Tang C, Higgs P. Social isolation during Covid-19: Boon or bane to diabetes management. Diabetes Metab Syndr. 2020;14(4):567-568. doi:10.1016/j.dsx.2020.04.046
10. Peric S, Stulnig TM. Diabetes and COVID-19: Disease-Management-People. Wien Klin Wochenschr. 2020;132(13-14):356-361. doi:10.1007/s00508-020-01672-3
11. Gupta R, Hussain A, Misra A. Diabetes and COVID-19: evidence, current status and unanswered research questions. Eur J Clin Nutr. 2020;74(6):864-870. doi:10.1038/s41430-020-0652-1
12. Jeong IK, Yoon KH, Lee MK. Diabetes and COVID-19: Global and regional perspectives [published online ahead of print, 2020 Jul 3]. Diabetes Res Clin Pract. 2020;166:108303. doi:10.1016/j.diabres.2020.108303
13. Hartmann-Boyce J, Morris E, Goyder C, et al. Diabetes and COVID-19: Risks, Management, and Learnings From Other National Disasters. Diabetes Care. 2020;43(8):1695-1703. doi:10.2337/dc20-1192
14. Kitsiou S, Paré G, Jaana M, Gerber B. Effectiveness of mHealth interventions for patients with diabetes: An overview of systematic reviews. PLoS One. 2017;12(3):e0173160. Published 2017 Mar 1. doi:10.1371/journal.pone.0173160
15. Guo XH, Yuan L, Lou QQ, et al. A nationwide survey of diabetes education, self-management and glycemic control in patients with type 2 diabetes in China. Chin Med J (Engl). 2012;125(23):4175–4180.
16. Powers MA, Bardsley J, Cypress M, et al. Diabetes Self-management Education and Support in Type 2 Diabetes: A Joint Position Statement of the American Diabetes Association, the American Association of Diabetes Educators, and the Academy of Nutrition and Dietetics. Clin Diabetes. 2016;34(2):70-80. doi:10.2337/diaclin.34.2.70