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The Impact Of A Culturally Tailored Telehealth Education Programme On Glycemic Control And Self-Care Behaviours In Jordanian Adults With Type 2 Diabetes: A Randomised Controlled Trial

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Abstract

BACKGROUND: The prevalence of type 2 diabetes mellitus (T2DM) in Jordan is a significant public health challenge, with glycemic control frequently remaining suboptimal.

AIMS: To assess the impact of a culturally tailored telehealth education programme on glycemic control and self-care behaviours in Jordanian adults with T2DM.

METHODS: We conducted a two-arm, parallel-group, randomised controlled trial in outpatient diabetes clinics in Amman, Jordan. A total of 104 adults with uncontrolled T2DM (HbA1c 7.5-11%) were randomised (1:1) to either a 6-month intervention or standard care (control). The low-burden intervention consisted of educational content via WhatsApp broadcasts and personalised telephonic coaching for goal-setting. The primary outcome was the change in HbA1c whereas secondary included self-care behaviours, medication adherence, diabetes knowledge, and diabetes fatalism, as well as patient satisfaction with the intervention.

RESULTS AND CONCLUSIONS: A total of 92 of 104 randomised participants (88%) completed the 6-month follow-up. The intervention group demonstrated a more pronounced mean reduction in HbA1c compared to the control group (-1.1% ± 1.1% vs. -0.2% ± 1.2%; adjusted mean difference -0.9%, 95% CI -1.3 to -0.5; $P < 0.001$). This clinical improvement coincided with marked improvements in psychosocial and behavioural measures. Culturally grounded fatalistic beliefs were significantly reduced in the intervention group ($P < 0.001$), and diabetes knowledge scores increased substantially ($P < 0.001$). The proportion of participants with low medication adherence decreased from 64% to 20% in the intervention group, compared to a minimal change in the control group (68% to 62%) ($P < 0.001$). Self-care activities, particularly for general diet and blood glucose monitoring, also improved markedly (both $P < 0.001$). A culturally tailored telehealth education programme was successful in improving glycemic control and key psychosocial and behavioural outcomes among Jordanian adults with T2DM.

Keywords: Telehealth; Type 2 Diabetes; Jordan; Glycemic Control; Culturally Tailored Intervention; Self-Management Education.

1. Introduction

The prevalence of type 2 diabetes mellitus (T2DM) in Jordan represents a significant challenge, with estimates suggesting that over 20% of the adult population will be affected by 2050 [1]. A significant challenge in diabetes management is achieving and maintaining optimal glycemic control. Recent cross-sectional data from Jordan indicate that poor glycemic control (HbA1c > 7%) affects more than half of patients with T2DM, a problem linked to unsatisfactory self-care behaviours and low medication adherence [2, 3]. This highlights a critical need for effective educational interventions that are both accessible and culturally resonant.

Diabetes self-management education (DSME) is fundamental to effective diabetes care, yet traditional in-person programmes face significant barriers, including transportation costs, time constraints, and limited availability of trained educators [4]. In response, telehealth has emerged as a vital tool to overcome these barriers, becoming a lifeline for managing chronic conditions, particularly since the COVID-19 pandemic [5]. A robust body of evidence from numerous systematic reviews and meta-analyses show that telehealth interventions can lead to clinically significant reductions in HbA1c [6-9]. These technologies are especially valuable for reaching rural or underserved populations [10].

Furthermore, the effectiveness of DSME is greatly enhanced when it is culturally tailored, that is, adapted to the specific language, dietary habits, religious practices, and social norms of the target population. Culturally sensitive programmes for Arabic-speaking populations in Lebanon and Denmark have demonstrated success in improving self-care and metabolic outcomes [11, 12]. While investigations in other Middle Eastern nations have shown the feasibility and acceptability of WhatsApp-based DSME [13, 14], there remains a lack of rigorous data from RCTs evaluating a comprehensive, culturally tailored telehealth programme specifically designed for the Jordanian context.

The present study aimed to assess the impact of a culturally tailored telehealth education programme on glycemic control and self-care behaviours among Jordanian adults with T2DM. We hypothesised that participants in the intervention group would demonstrate a greater reduction in HbA1c and greater improvements in self-care behaviours, diabetes knowledge, medication adherence, and diabetes fatalism, and report high satisfaction with the intervention, in comparison to individuals receiving usual care.

2. Materials and Methods

2.1. Study Design and Setting

This study was a two-arm, parallel-group, randomised controlled trial designed in accordance with the Consolidated Standards of Reporting Trials (CONSORT) 2010 guidelines. The trial was conducted in three outpatient endocrinology clinics of large academically-affiliated medical centre in Amman, Jordan. Participant recruitment occurred during January 2025, and each individual was followed for a 6-month period, with final data collection concluding in July 2025.

2.2. Participants and Recruitment

Eligible participants were adults aged 18 years or older with a clinical diagnosis of Type 2 Diabetes Mellitus (T2DM) for at least one year. Inclusion criteria required a baseline HbA1c between 7.5% and 11.0%, ownership of a smartphone with the WhatsApp application, and the ability to read Arabic. Exclusion criteria were type 1 diabetes, pregnancy or lactation, severe diabetes-related complications (e.g., end-stage renal disease), or a cognitive impairment that would preclude meaningful participation.

2.3. Randomisation and Blinding

Following written informed consent, participants were randomised in a 1:1 ratio to either the intervention or control group. A computer-generated block randomisation sequence, stratified by clinic site, was utilised to ensure balanced allocation. Of the 104 participants randomised, 52 were allocated to the intervention group and 52 to the control group. The allocation sequence was concealed from the recruitment team using sequentially numbered, sealed, opaque envelopes. Due to the behavioural nature of the intervention, blinding of participants and the diabetes educator was not feasible; however, outcome assessors and the data analyst were blinded to group assignment.

2.4. Sample Size Calculation
The sample size was powered for the primary outcome of change in HbA1c at 6 months. A minimum of 36 participants per group was required to achieve 80% power at a two-sided alpha of 0.05. This calculation was based on detecting a clinically significant between-group difference of 0.8% [15], with an estimated standard deviation (SD) of 1.2% derived from local data on Jordanian adults with T2DM [16]. The study successfully exceeded this target by randomising 104 participants, ensuring the final analysis was adequately powered.

2.5. Interventions
The intervention was a 6-month, multi-component programme grounded in Social Cognitive Theory [17], with the goal of enhancing self-efficacy through education and personalised goal-setting. The cultural adaptation of the intervention was a multi-step process. A panel that included a certified diabetes educator, a nutritionist, and patient representatives co-developed the educational content.

Intervention Group: Participants in the intervention arm received a culturally tailored telehealth programme delivered entirely in Arabic, which supplemented their standard medical care. The programme was designed to be low-burden and flexible, consisting of:

- WhatsApp Broadcasts: The content covered core DSME topics (e.g., diet, exercise, medication management, self-monitoring, and problem-solving).
- Individual Teleconsultations: Each participant had three scheduled 5-minute phone calls with a certified diabetes educator (at the study's start, and at 3 and 6 months).

Control Group: Participants in the control group continued to receive standard care from their endocrinologists and the clinic, which typically included routine clinic visits every 3-6 months. They were not exposed to any components of the telehealth programme from the study team.

2.6. Data Collection
Collected data at baseline included demographics (age, gender, education, income) and clinical data (diabetes duration, comorbidities, and medications). Weight and height were measured in the clinic to calculate Body Mass Index (BMI). HbA1c was measured at a central laboratory using a standardised assay at baseline and 6 months. Other patient-reported outcomes, categorised into behavioural and psychosocial domains, were also collected at two time points (baseline and the 6-month follow-up) using previously validated Arabic versions of the instruments

- Behavioural Outcomes:
    - Diabetes Self-Care: Assessed using the Summary of Diabetes Self-Care Activities (SDSCA) questionnaire, which measures the frequency of engagement in the key domains of General Diet, Exercise, Self-Monitoring of Blood Glucose (SMBG), and Foot Care [18, 19].
    - Medication Adherence: Assessed using the 8-item Morisky Medication Adherence Scale (MMAS-8) [20].
- Psychosocial Outcomes:

- Diabetes Knowledge: Evaluated using the 14-item general test from the Revised Michigan Diabetes Knowledge Test (DKT) to assess changes in participants' understanding of core diabetes management concepts [21].
- Diabetes Fatalism: The Diabetes Fatalism Scale (DFS), a 12-item scale, was used to measure changes in culturally grounded beliefs related to despair and hopelessness regarding diabetes [22].

Patient Satisfaction was assessed at the 6-month follow-up in the intervention group using a validated custom-developed 6-item questionnaire. Participants rated their agreement with statements about the programme's usefulness, cultural relevance, and ease of use on a 5-point Likert scale.

2.7. Statistical Analysis

Statistical analysis was performed using SPSS Version 28.0 on an intention-to-treat basis. A two-sided P-value < 0.05 was considered significant for all analyses. Baseline characteristics were summarised using frequencies (%) for categorical variables and means (SD) for continuous variables. Inferential analysis for the primary outcome, change in HbA1c, utilised an analysis of covariance (ANCOVA) to compare 6-month values between groups while covarying for baseline HbA1c. This model was also used for other continuous secondary outcomes. Categorical outcomes were compared using chi-square tests. Prior to modeling, the assumption of normality for all continuous variables was confirmed using the Shapiro-Wilk test.

2.8. Ethical Considerations

The study protocol was approved by the Institutional Review Board at the University of Petra (S/12/12/2024). All participants provided written informed consent before the initiation of any study-related procedures.

3. Results

3.1. Participant Flow and Baseline Characteristics

A total of 159 individuals were assessed for eligibility. Of these, 55 were excluded (48 did not meet inclusion criteria and 7 declined to participate), leaving 104 participants who provided informed consent and were randomised. Among the 48 excluded for not meeting inclusion criteria, the most common reasons were having an HbA1c outside the 7.5-11% range (n=31) and not owning a smartphone (n=10). Fifty-two participants were allocated to the telehealth intervention group and 52 were allocated to the standard care control group. During the 6-month study, 7 participants (13.5%) from the intervention group and 5 (9.6%) from the control group were lost to follow-up. The final sample included in the analysis consisted of 45 participants in the intervention group and 47 participants in the control group (Figure 1).

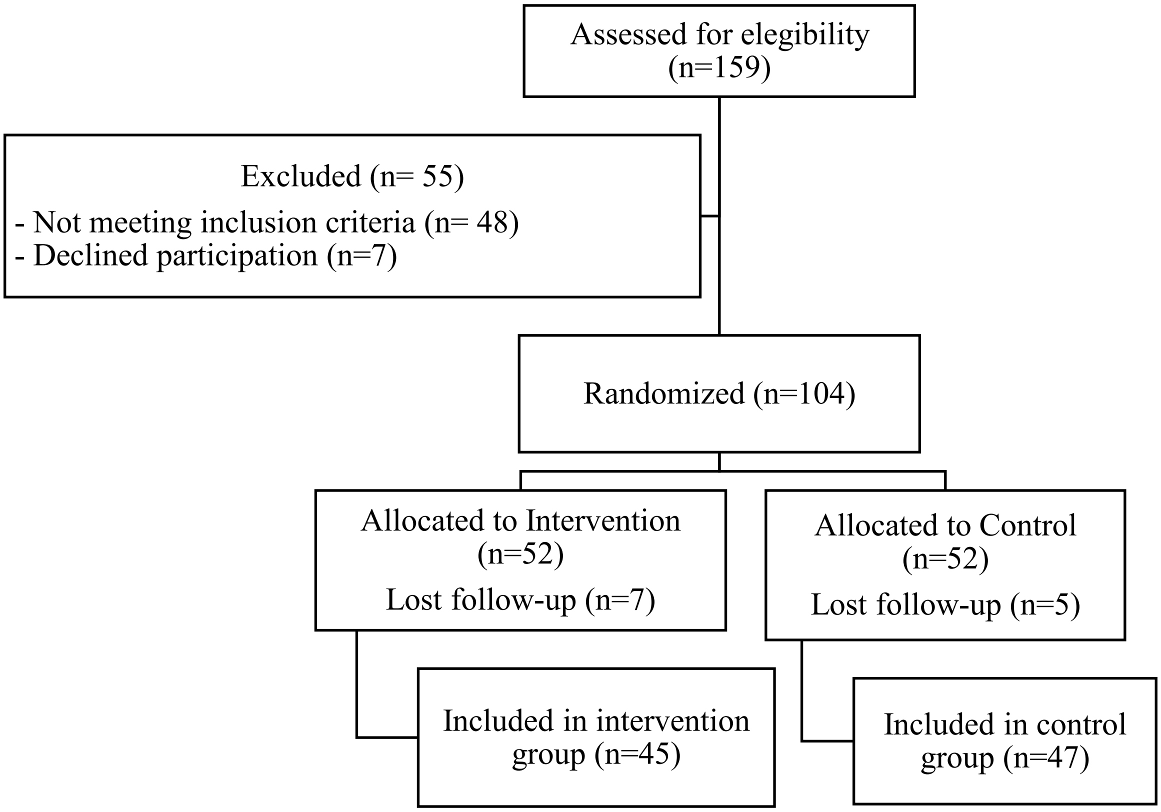

Figure 1 CONSORT flow diagram of the trial.

The mean age of the cohort was 56.4 years, with a mean diabetes duration of 9.1 years. There were no statistically significant differences between the intervention and control groups for any measured baseline variable, confirming that randomisation was successful (Table 1).

Table 1: Baseline Demographic and Clinical Characteristics of Study Participants (n=92)

Characteristic		**Intervention (n=45)**	**Control (n=47)**	**P-value**
Age, years, mean (SD)		55.9 (10.2)	56.9 (9.8)	0.64
Female, n (%)		25 (55.6)	24 (51.1)	0.69
Education (Secondary or less), n (%)		28 (62.2)	31 (66.0)	0.67
Monthly Household Income ($), n (%)	< 500	20 (44.4)	22 (46.8)	0.88
	500 – 1000	16 (35.6)	17 (36.2)	
	> 1000	9 (20.0)	8 (17.0)	
Diabetes Duration, years, mean (SD)		9.3 (4.5)	8.9 (4.8)	0.71
BMI, kg/m ^{2}, mean (SD)		31.5 (4.1)	32.1 (4.5)	0.51
Hypertension, n (%)		33 (73.3)	35 (74.5)	0.90
Dyslipidemia, n (%)		28 (62.2)	30 (63.8)	0.88
On oral antidiabetic agents only, n (%)		24 (53.3)	23 (48.9)	0.69
On insulin therapy (with or without oral agents), n (%)		21 (46.7)	24 (51.1)	0.69

Abbreviations: SD, Standard Deviation; BMI, Body Mass Index
P-values are from t-tests for continuous variables and chi-square tests for categorical variables.

3.2. Glycemic Control, Behavioural, and Psychosocial Outcomes

At the 6-month follow-up, the telehealth intervention resulted in a substantial and clinically relevant improvement in glycemic control (Table 2). The mean HbA1c in the intervention group decreased by 1.1%, a reduction that was statistically significant compared to the minimal 0.2% decrease in the control group (adjusted mean difference -0.9%; P < 0.001).

This clinical improvement was supported by significant enhancements in key psychosocial domains that are known barriers to self-management. The intervention successfully increased participants' diabetes knowledge, resulting in an adjusted mean difference of +2.8 points on the Diabetes Knowledge Test (P < 0.001). Notably, the culturally tailored programme was highly effective in reducing fatalistic beliefs, demonstrating an adjusted mean difference of -1.6 points on the Diabetes Fatalism Scale (P < 0.001). Regarding self-care behaviours, the programme was highly effective at improving adherence to a General Diet (+1.8 days/week; P < 0.001) and Self-Monitoring of Blood Glucose (SMBG) (+2.5 days/week; P < 0.001). In contrast, while a positive trend was observed for physical activity, the increase of +0.6 days/week in Exercise did not reach statistical significance compared to the control group (P = 0.08). The intervention did not have a significant impact on Foot Care practices (P = 0.35), which remained a challenge for both groups.

These psychosocial gains translated into tangible behavioural changes. Medication adherence improved substantially, with the proportion of participants with low adherence significantly lower in the intervention group (20.0%) compared to the control group (61.7%) (P < 0.001).

Table 2: Outcomes at Baseline and 6 Months (n=92)

Outcome		Group	Baseline Mean (SD)	6-Month Mean (SD)	Adjusted Mean Difference (95% CI)	P-value
HbA1c (%)		Intervention	9.2 (0.9)	8.1 (1.1)	-0.9 (-1.3 to -0.5)	<0.001*
		Control	9.1 (1.0)	8.9 (1.2)		
SDSCA Subscales (days/week)	General Diet	Intervention	2.5 (1.4)	4.5 (1.5)	+1.8 (1.2 to 2.4)	<0.001*
		Control	2.6 (1.5)	2.8 (1.6)		
	Exercise	Intervention	1.8 (1.6)	2.6 (1.8)	+0.6 (-0.1 to 1.3)	0.08
		Control	1.6 (1.5)	1.8 (1.7)		
	SMBG	Intervention	2.1 (2.0)	4.9 (2.2)	+2.5 (1.7 to 3.3)	<0.001*
		Control	2.0 (1.9)	2.3 (2.1)		
	Foot Care	Intervention	3.5 (2.2)	3.9 (2.3)	+0.2 (-0.4 to 0.8)	0.35
		Control	3.6 (2.3)	3.8 (2.4)		
DKT (14-point score)		Intervention	8.2 (2.1)	11.5 (1.9)	+2.8 (2.1 to 3.5)	<0.001*
		Control	8.0 (2.3)	8.5 (2.4)		
DFS (10-point scale)		Intervention	6.8 (1.5)	4.9 (1.6)	-1.6 (-2.2 to -1.0)	<0.001*

		Control	7.0 (1.4)	6.7 (1.5)		
Medication Adherence	Low Medication Adherence (MMAS-8 <6), n (%)	Intervention	29 (64.4)	9 (20.0)	OR: 0.16 (0.06 to 0.45)	<0.001*
		Control	32 (68.1)	29 (61.7)	Reference Group	

Abbreviations: DKT, Diabetes Knowledge Test; DFS, Diabetes Fatalism Scale; HbA1c, Glycated Hemoglobin; MMAS-8, Morisky Medication Adherence Scale-8 item; OR, Odds Ratio; SD, Standard Deviation; SDSCA, Summary of Diabetes Self-Care Activities; SMBG, Self-Monitoring of Blood Glucose. Adjusted Mean Difference is the between-group difference from ANCOVA models, adjusted for baseline values. A negative value for HbA1c and DFS indicates improvement. * Represents significant values at $p<0.05$. Odds Ratio and p-value for categorical outcome derived from Chi-square test.

3.3. Patient Satisfaction with the Telehealth Intervention

Satisfaction with the 6-month telehealth programme was assessed in the 45 participants who completed the intervention. Overall satisfaction was very high, demonstrating the programme's strong acceptability (**Table 3**). Nearly all participants (96%) agreed or strongly agreed that the WhatsApp messages helped them better manage their diabetes, and 98% would recommend the programme to others.

Table 3: Patient Satisfaction with the Telehealth Intervention at 6 Months (n=45)

Questionnaire Item	Agree or Strongly Agree, n (%)	Neutral, n (%)	Disagree or Strongly Disagree, n (%)
Overall, I am satisfied with the telehealth programme.	43 (95.6)	2 (4.4)	0 (0.0)
I would recommend this programme to others with diabetes.	44 (97.8)	1 (2.2)	0 (0.0)
The weekly WhatsApp messages were easy to understand.	45 (100.0)	0 (0.0)	0 (0.0)
The messages helped me manage my diabetes day-to-day.	43 (95.6)	2 (4.4)	0 (0.0)
The 5-minute phone calls were helpful.	41 (91.1)	3 (6.7)	1 (2.2)
The information was relevant to my culture and lifestyle.	43 (95.6)	2 (4.4)	0 (0.0)

4. Discussion

In this randomised controlled trial, our culturally tailored telehealth programme demonstrated a significant and clinically meaningful improvement in glycemic control among Jordanian adults with T2DM. The 0.9% greater reduction in HbA1c in the intervention group compared to standard care was a robust finding that contributed important evidence to the global literature on diabetes management. This effect size compares favourably with outcomes reported in large-scale meta-analyses of telehealth interventions, which typically found mean HbA1c reductions between 0.4% and 0.6% [6-8]. Furthermore, the magnitude of this effect aligned with the higher end of improvements seen in telehealth trials conducted during the COVID-19 pandemic [9, 14]. The success of this intervention underscores that a structured programme is crucial; telemedicine alone may be insufficient, especially for patients with complex comorbidities, a point highlighted in a recent systematic review focusing on rural populations [10]. Therefore, the strong results of our trial suggested that the combination of remote delivery with deep cultural tailoring was a particularly potent strategy for improving diabetes outcomes.

A notable strength of this investigation was its capacity to elucidate the mechanisms driving these clinical improvements. The intervention's success appeared to be associated with a cascade of positive changes, starting with knowledge and psychosocial barriers. Our programme produced a substantial increase in diabetes knowledge, a critical first step, as poor knowledge is a known barrier to effective self-management [23], and behavioural research has established that it is a prerequisite for effective self-care behaviours [11, 13]. More importantly, our intervention successfully reduced diabetes fatalism, a culturally grounded belief system associated with poor glycemic control that is widespread in the region [11, 24]. This represents a crucial point of distinction from prior regional research, where a pilot study in Lebanon found that fatalism did not change, suggesting it was a non-modifiable trait [11]. This outcome brings into question the notion that empowering telehealth approach can indeed modify these deep-seated psychosocial barriers. It must be noted, however, that a formal mediation analysis, which was beyond the scope of this trial, would be required to statistically confirm this causal pathway. This aligns with the core principles of DSME, which aim to empower patients to take an active role in their health by improving self-efficacy through mastery and vicarious experiences [4, 25].

This newfound empowerment translated directly into tangible behavioural change. We observed significant improvements in medication adherence, a critical achievement given that poor adherence is a primary contributor to suboptimal glycemic control in Jordan [3]. Furthermore, our intervention had a strong impact on specific self-care activities, particularly in Self-Monitoring of Blood Glucose (SMBG) and adherence to a General Diet. This is noteworthy, as prior cross-sectional studies in Jordan identified these as major areas of weakness [2]. However, consistent with other regional studies, improving exercise frequency remained a challenge [11]. The lack of a significant effect on exercise suggests that more complex, habit-driven behaviours may require interventions that go beyond remote education, a limitation also seen in text-messaging programmes focused solely on physical activity [26] and even in broader, randomised behavioural lifestyle intervention trials conducted in the United Arab Emirates [27].

The use of WhatsApp as the primary delivery platform proved to be a feasible, acceptable, and effective method. This aligns perfectly with findings from recent RCTs in Saudi [13] and the United Arab Emirates [14], which also found WhatsApp-based DSME to be highly successful. Furthermore, the versatility of this platform for health education is notable; another recent randomised controlled trial demonstrated its effectiveness for delivering clinical case scenarios to community pharmacists to optimise care for the elderly [28]. The high patient satisfaction observed in our study further supported the use of such platforms, which have become central to healthcare delivery since the COVID-19 pandemic [5, 9, 29]. Our findings also demonstrated that a structured, collaborative telehealth programme can effectively complement or replace some in-person visits, a conclusion supported by a systematic review focused on rural communities [10].

This study had several strengths, most notably its randomised controlled design, which provided strong evidence of causality and moved beyond the limitations of the quasi-experimental [11, 30] and cross-sectional studies [3] that have characterised much of the prior research in the region. However, several limitations must be acknowledged. One primary limitation was that the study was conducted in a single urban centre, and its findings may not be generalisable to rural populations, who often face unique challenges, such as restricted internet access and lower technological literacy. Furthermore, recruitment was limited to smartphone users, potentially creating a selection bias and raising concerns about the digital divide. Second, our reliance on self-reported measures for behavioural outcomes was subject to potential recall and social desirability bias. Third, the increased attention and contact given to the intervention group compared to the standard care group introduced a potential for attention bias (the Hawthorne effect), which may have contributed to the observed improvements independently of the intervention's specific content. Additionally, the slightly higher attrition rate in the intervention group (13.5% vs 9.6%), though not statistically significant, may have reflected a greater perceived burden of participation compared to standard care. Finally, the 6-month follow-up period, while sufficient to demonstrate clinical efficacy, did not provide evidence on the long-term sustainability of these improvements, a known challenge for telehealth programs where benefits may not be sustained beyond six months.

5. Conclusion

In conclusion, this culturally tailored telehealth education programme was significantly more effective than standard care, leading to clinically meaningful improvements in glycemic control, as well as in diabetes knowledge, medication adherence, and key self-care practices, while also reducing diabetes fatalism among Jordanian adults with T2DM. This model offered a powerful, acceptable, scalable, and patient-centered strategy to enhance diabetes care. Healthcare systems in Jordan and similar cultural settings across the Middle East should consider integrating such structured telehealth programmes into standard diabetes management protocols to combat this escalating public health issue.

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References

1. Awad SF, Huangfu P, Dargham SR, Ajlouni K, Batieha A, Khader YS, et al. Characterizing the type 2 diabetes mellitus epidemic in Jordan up to 2050. Sci Rep. 2020;10(1):21001.
2. Almomani MH, AL-Tawalbeh S. Glycemic Control and Its Relationship with Diabetes Self-Care behaviours Among Patients with Type 2 Diabetes in Northern Jordan: A Cross-Sectional Study. Patient Prefer Adherence. 2022;16:449-65.
3. Al-Qerem W, Jarab A, Eberhardt J, Alkaee SM, Alsabaa ZH, Alasmari F, et al. Health Literacy and Medication Adherence Among Patients with Type 2 Diabetes in Jordan: A Cross-Sectional Study. Patient Prefer Adherence. 2024;18:2019-2026.
4. American Diabetes Association. Standards of Care in Diabetes—2025. Diabetes Care. 2025;48(Suppl 1).
5. Vigili de Kreutzenberg S. Telemedicine for the Clinical Management of Diabetes; Implications and Considerations After COVID-19 Experience. High Blood Press Cardiovasc Prev. 2022;29:319-326.
6. Faruque LI, Wiebe N, Ehteshami-Afshar A, Liu Y, Dianati-Maleki N, Hemmelgarn BR, et al. Effect of telemedicine on glycated hemoglobin in diabetes: a systematic review and meta-analysis of randomized trials. CMAJ. 2017;189:E341-64.
7. Zhang A, Wang J, Wan X, Zhang Z, Zhao S, Guo Z, et al. A Meta-Analysis of the Effectiveness of Telemedicine in Glycemic Management among Patients with Type 2 Diabetes in Primary Care. Int J Environ Res Public Health. 2022;19:4173.
8. Getie A, Amlak BT, Ayenew T, Gedfew M. Assessing the impact of telehealth on blood glucose management among patients with diabetes: a systematic review and meta-analysis of randomized controlled trials. BMC Health Serv Res. 2025;25:285.
9. Chiaranai C, Chularee S, Saokaew S, Bhatarasakoon P, Umnuaypornlert A, Chaomuang N, et al. Effectiveness of telehealth on the glycemic control of patients with type 2 diabetes mellitus during the COVID-19 pandemic: A systematic review and meta-analysis of randomised controlled trials. Int J Nurs Stud Adv. 2024;6:100169.
10. AlQassab O, Kanthajan T, Pandey M, Francis AJ, Sreenivasan C, Parikh A, et al. Evaluating the Impact of Telemedicine on Diabetes Management in Rural Communities: A Systematic Review. Cureus. 2024;16(7).

11. Sukkarieh-Haraty O, Egede LE, Khazen G, Abi Kharma J, Farran N, Bassil M. Results from the first culturally tailored, multidisciplinary diabetes education in Lebanese adults with type 2 diabetes: effects on self-care and metabolic outcomes. BMC Res Notes. 2022;15:39.
12. Bjerre N, Christensen L, Hoeiberg C, Ottosson C, Jensen MK, Kildsig N, et al. Effectiveness of a Person-Centered and Culturally Sensitive Course of Treatment in Arabic-, Turkish-, and Urdu-Speaking Individuals With Type 2 Diabetes (the ACCT2 Study): Protocol for a Pragmatic Randomized Controlled Trial. JMIR Res Protoc. 2025;14:e67319.
13. Yaagoob E, Lee R, Stubbs M, Shuaib F, Johar R, Chan S. WhatsApp-based intervention for people with type 2 diabetes: A randomized controlled trial. Nurs Health Sci. 2024;26:e13117.
14. Al Omar M, Hasan S, Palaian S, Mahameed S. The impact of a self-management educational programme coordinated through WhatsApp on diabetes control. Pharmacy Practice. 2020;18(2):1841.
15. Jarab AS, Alqudah SG, Mukattash TL, Shattat G, Al-Qirim T. Randomized Controlled Trial of Clinical Pharmacy Management of Patients with Type 2 Diabetes in an Outpatient Diabetes Clinic in Jordan. J Manag Care Pharm. 2012;18(7):516-26.
16. Nimer RM, Alfaqih MA, Shehabat ER, Mujammami M, Abdel Rahman AM. Label-free quantitative proteomics analysis for type 2 diabetes mellitus early diagnostic marker discovery using data-independent acquisition mass spectrometry (DIA-MS). Sci Rep. 2023;13:20880.
17. Bandura A. Self-efficacy: The exercise of control. New York: W.H. Freeman; 1997.
18. Alshehri B. Validation of the Arabic Version of the Summary of Diabetes Self-Care Activities Scale Among Type 2 Diabetes Patients in Saudi Arabia. Cureus. 2024;16(10):e71813.
19. Toobert DJ, Hampson SE, Glasgow RE. The summary of diabetes self-care activities measure: results from 7 studies and a revised scale. Diabetes Care. 2000;23(7):943-50.
20. Ashur ST, Shamsuddin K, Shah SA, Bosseri S, Morisky DE. Reliability and known-group validity of the Arabic version of the 8-item Morisky Medication Adherence Scale among type 2 diabetes mellitus patients. EMHJ. 2015;21(10):722-728.
21. Alhaiti AH, Alotaibi AR, Jones LK, DaCosta C, Lenon GB. Psychometric Evaluation of the Revised Michigan Diabetes Knowledge Test (V.2016) in Arabic: Translation and Validation. J Diabetes Res. 2016:9643714.
22. Sukkarieh-Haraty O, Egede LE, Abi Kharma J, Bassil M. Psychometric properties of the Arabic version of the 12-item diabetes fatalism scale. PLoS ONE. 2018;13(1):e0190719.
23. Al-Maskari F, El-Sadig M, Al-Kaabi JM, Afandi B, Nagelkerke N, Yeatts KB. Knowledge, attitude and practices of diabetic patients in the United Arab Emirates. PLoS ONE. 2013;8(1):e52857.
24. Bassil M, Sukkarieh-Haraty O, Abi Kharma J, Egede LE. Predictors of diabetes fatalism among Arabs: cross-sectional study of Lebanese adults with type 2 diabetes. J Relig Health. 2018;57(3):858-68.
25. Powers MA, Bardsley J, Cypress M, Duker P, Funnell MM, Hess Fischl A, 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. Diabetes Care. 2015;38(7):1372-82.
26. Blake H, Alsahli MJ, Chaplin WJ, Konstantinidis ST. The ActiveText@T2D text messaging behavioural intervention to increase physical activity in adults with type 2 diabetes: A prospective single-arm feasibility trial. PLOS Digit Health. 2025;4(7):e0000953.
27. Abdi S, Sadiya A, Ali S, Varghese S, Abusnana S. Behavioural Lifestyle Intervention Study (BLIS) in patients with type 2 diabetes in the United Arab Emirates: a randomized controlled trial. BMC Nutr. 2015;1(1):1–9.
28. Mohamed Ibrahim O, Al Mazrouei N, Elnour AA, Ibrahim R, Abdel-Qader DH, Hamid RME, et al. Randomized controlled trial parallel-group on optimizing community pharmacist's care for the elderly: The influence of WhatsApp-Email delivered clinical case scenarios. PloS one. 2024;19(10):e0308448.
29. Huang M, Wang M, Wu B. Telehealth Education via WeChat Improves the Quality of Life of Parents of Children with Type-1 Diabetes Mellitus. Appl Clin Inform. 2022;13:263-269.

30. Alsahli M, Abd-alrazaq A, Fathy DM, Abdelmohsen SA, Gushgari OA, Ghazy HK, et al. Effectiveness of Patients' Education and Telenursing Follow-Ups on Self-Care Practices of Patients With Diabetes Mellitus: Cross-Sectional and Quasi-Experimental Study. JMIR Nurs. 2025;8:e67339.