Impact of a multidisciplinary intensive education program on type 2 diabetes mellitus patients' glycemic control and cardiovascular risk factors

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ABSTRACT

الأهداف: تقييم أثر برنامج التعليم المكثف متعدد التخصصات على نتائج مرضى السكري من النوع الثاني.

الطريقة: تم استخدام دراسة استعادية لتقييم تأثير برنامج التعليم المكثف متعدد التخصصات على نتائج مرضى السكري من النوع الثاني للفترة من 1 مايو 2016 إلى 31 مايو 2017. تم تجميع البيانات من العيادة التعليمية لمرضى السكري بالمدينة الطبية بجامعة الملك سعود، حيث يتم إحالة المرضى من العيادات الخارجية إلى العيادة التعليمية لمرض السكري لشرح برنامج التعليم المكثف متعدد التخصصات. لمعرفة تأثير البرنامج على نتائج المرضى، تم تقييم معدلات السكر في الدم، ضغط الدم، الوزن، والدهون خلال 3 و6 و12 شهراً من شرح البرنامج للمرضى.

النتائج: اشتملت الدراسة على بيانات 174 مريضا يعانون من مرض السكري من النوع الثاني. أشارت النتائج إلى وجود تحسن في معدل نسبة السكر في الدم حيث انخفضت مستويات السكر التراكمي وسكر الدم لدى المرضى بشكل كبير بعد 3 أشهر و6 أشهر و12 شهراً مقارنة بالنتائج الأولية. علاوة على ذلك، تم ملاحظة تحسن ضغط الدم من خلال البرنامج؛ كما لوحظ وجود تحسن في متوسط ضغط الدم الانقباضي والانبساطي مقارنة بالنتائج الأولية بعد 12 شهراً من تطبيق البرنامج. بالإضافة إلى ذلك، وجدت الدراسة فروق في مستويات الكوليسترول الكلي والبروتين الدهني منخفض الكثافة بعد 6 أشهر من اتباع البرنامج.

الخاتمة: يؤدي تطبيق برنامج التعليم المكثف متعدد التخصصات في مرضى السكري من النوع الثاني إلى تحسين النتائج السريرية للمرضى وتأخير المضاعفات على المدى الطويل.

Objectives: To evaluate the impact of a multidisciplinary intensive education program (MIEP) on type 2 diabetes mellitus (T2DM) patients' outcomes.

Methods: A retrospective study was used to evaluate the impact of MIEP on T2DM patients' outcomes for between May 2016 and May 2017. Data were collected from the diabetes education clinic in King Saud University Medical City (KSUMC), Riyadh, Saudi Arabia where patients were referred from diabetes outpatient clinics to the diabetes education clinic to receive MIEP. In terms of measuring the clinical outcomes of the T2DM patients, glycemic control, blood pressure, weight, and lipid profiles were assessed before MIEP at 3, 6, and 12 months.

Results: A total of 174 patients with T2DM fulfilled study inclusion criteria. The results indicate improved glycemic control where patients' HbA1c and blood sugar levels were significantly reduced 3, 6, and 12 months after MIEP compared to the baseline ($p<0.005$). Moreover, blood pressure improved after education; a significant improvement was observed in the mean systolic blood pressure (SBP) from baseline to 12 months ($p=0.036$), and in the mean diastolic blood pressure (DBP) after 12 months ($p=0.016$). Additionally, the study found significant differences in total cholesterol and low-density lipoprotein (LDL) cholesterol 6 months after the intervention ($p=0.014$, $p=0.02$, respectively).

Conclusion: Implementing an MIEP for T2DM patients can improve their clinical outcomes, which consequently may delay the disease's long-term complications.

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In the past few decades, there was a notable improvement in the Saudi population socioeconomic status which was also associated with adoption of the unhealthy dietary patterns and sedentary lifestyle. These have made diabetes mellitus (DM) and obesity to become the leading chronic diseases in Saudi Arabia. A recently published report by the World Health Organization (WHO) showed that there are almost 7 million individuals with diabetes and more than 3 million with pre-diabetes.[1,2] This has made Saudi Arabia rank as the second highest rate of DM in the Middle East.[1,2] Changing lifestyle through performing physical exercises, following a healthy diet, and using appropriate medications, if necessary, are considered the core steps in DM glycemic control and decreasing the cardiovascular complications risk.[3] Single-physician approaches, irregular clinic visits, poor adherence to medication, and lack of patient education and support remain priority challenges toward improving complex glycemic control.[4,5] Multidisciplinary team is a broad term used to describe all members of a healthcare team, professional and non-professional, who work dynamically together to assess, plan, and evaluate patient care through interdependent collaboration, open communication, and shared decision-making.[6] This approach seems especially suited to the administration of diabetes care, including preventing its complications, as synchronized cooperation among medical service experts empowers helpful critical thinking and basic leadership that results in synergistic advantages to patient care.[7,8] Multidisciplinary management of diabetes within education programs has been recommended as an essential tool for improving patient outcomes with the best results manifested in clinical outcomes.[8] Such diabetes education programs have been shown to be more effective when used by multidisciplinary teams with a complete plan for care.[9] Several studies, systematic reviews, and meta-analyses have aimed to confirm evidence that performing a self-management intervention using a multidisciplinary educational program (MEP) or behavioral strategies stimulates among adults the individual's performance of diabetes self-care in terms of things such as checking blood glucose, consuming fewer calories, being more physically active, and practicing medical care.[8,10-14] These studies show significant improvements in glycemic control, blood pressure, and lipid profile following multidisciplinary educational interventions in patients' diabetes self-management. In the literature, several works demonstrate the importance of an interdisciplinary team, incorporating at least a clinical pharmacist and a primary care physician, in improving diabetic patients' clinical outcomes and decreasing long-term complications.[15-17]

In Saudi Arabia, an interventional study was conducted to investigate the impact of a multidisciplinary care program on patients with uncontrolled typer 2 DM (T2DM). The healthcare providers included a senior family physician, a clinical pharmacist, a nurse, a specialist, a dietician, a diabetic educator, a health educator, and a social worker. In this study, 41 participants (17 males [41.5%] and 24 females [58.5%]), enrolled in the multidisciplinary care program. Clinical outcome measurements included glycated hemoglobin (HbA1c), blood pressure, lipid profile, and weight.[4] The findings of this study were that HbA1c and total cholesterol significantly improved after 6 months ($p<0.001$, $p=0.029$). Due to the short duration of the study, measurements were taken only at 6 months after the intervention. Additionally, the effectiveness of the program was tested on a small sample size; therefore, it would not be appropriate to generalize the findings to other settings, and a large study was recommended to confirm these findings. For this reason, we conducted this study to investigate the impact of a multidisciplinary care program on HbA1c, lipid profile, and blood pressure among patients with uncontrolled T2DM.

Methods. A retrospective cohort study was carried out at King Saud University Medical City (KSUMC), a tertiary teaching hospital in Riyadh, Saudi Arabia, between May 2016 and May 2017, to determine the impact of a multidisciplinary intensive education program (MIEP) on diabetic patients' glycemic control and cardiovascular risk factors.

Multidisciplinary intensive education program. Due to the increasing number of patients with uncontrolled diabetes, the primary care clinic (PCC) staff initiated a MIEP on April 2014 in order to devote more attention to this high-risk population. As a program, MIEP reflects the basic requirements of T2DM which include medications, nutrition, self-monitoring, and self-management as well as ensuring that diabetes standards of care are met. The program was designed to address the regular and recurring needs of patients with prolonged poor glycemic control and/or co-morbidities and visiting KSUMC. An MIEP allows patients to

manage their diabetes in order to improve their glycemic control. Patients are eligible for referral if they meet at least one of the following criteria: i) having a persistent HbA1c ≥8.5%; ii) receiving an insulin dose to bring HbA1c to the recommended level but it is still higher than recommended; iii) being uncontrolled on oral antihyperglycemic medications, in need of being shifted to insulin and requiring close monitoring for control; iv) refusing to start insulin therapy after counseling by the physician and the diabetes educator.

The healthcare professionals working in the diabetic education clinic include a consultant family medicine physician, a senior registrar family medicine physician, a nurse (responsible for monitoring patients' vitals, referrals, and appointment scheduling), a clinical pharmacist, a health educator, and a dietician. The patient initially sees the family medicine physician, who conducts a physical evaluation including a foot examination and a review of the patient's laboratory results and/or home blood glucose readings, then adjusts the patient's medication regimen. The patient is referred to the health educator and/or dietician for instructions and education regarding lifestyle modifications at the discretion of the physician.

The nurse then schedules the second appointment, with the clinical pharmacist. The clinical pharmacist contacts the patient prior to the appointment to remind them of it, to request them to complete their laboratory tests, at least 3 days of blood glucose readings, and to ask them to bring in all of their prescription, non-prescription, and alternative medications for reconciliation at the appointment. During the appointment, the clinical pharmacist provides medication reconciliation and education, including insulin and/or liraglutide administration instructions. After the appointment, the clinical pharmacist provides a telephone follow-up service during which the patient, taking insulin and/or liraglutide, provides their home blood glucose readings. The clinical pharmacist makes adjustments to the patient's insulin and/or liraglutide regimen as necessary at least twice weekly and continues to follow up with the patient until their blood glucose readings are controlled.

The health educator then provides personal education, instructions, support and follow-up for the patient about diabetes self-management, the diabetes disease process, monitoring, diabetes complications and risk reduction, physical activity, and psychosocial adjustment. These activities are based on the clinical practice improvement (CPI) approach to ensure the best outcomes for the education program.

As a member of the team, the dietician will provide the patient with nutritional information on the role of food in diabetes management including dietary instructions and serving sizes, nutritional information on prevention and treatment of hypoglycemia, and general recommendations on food habits for diabetic patients. Enrollment into the MIEP is conducted via physician referral from the PCC using the Diabetes Clinic Patient Referral Form. Currently, there are 307 participants, 196 males (63.6%) and 111 females (36.4%), enrolled in the MIEP, of whom 174 (56%) participated in the study. Patients were enrolled if they had an HbA1c test performed within 3 months after MIEP and had follow-up data for at least 3 months. Patients were excluded if there were insufficient data and/or an incomplete medical history.

The main clinical outcomes measured included HbA1c, fasting blood sugar, blood pressure (BP), lipid profile, and weight. Lipid profile included total cholesterol, low-density lipoprotein (LDL), high-density lipoprotein (HDL) cholesterol, and triglycerides (TG), given in mmol/L. All these clinical outcomes were measured at baseline before MIEP and at 3-, 6- and 12-month intervals after MIEP.

Ethical approval was obtained from the institutional review board, KSUMC, Riyadh, Saudi Arabia (Research Project No. E-16-1903).

Statistical analysis. Descriptive statistics were calculated and results were presented in the form of numbers, percentages, medians, means, and standard deviations (SDs). The Wilcoxon signed-rank test was used to analyze the variations and significance of patients' clinical outcomes at baseline and after enrolling in MIEP. Further, p-values of less than 0.05 were considered statistically significant. All statistical analysis was performed using IBM SPSS® Statistics for Windows, Version 24.0 (Armonk, New York, IBM Corporation).

Results. The mean age of the subjects was 52.9±14.2. More than half of the total number of subjects were male 79 (55.7%) while 77 (44.3%) were female. The mean duration of diabetes was 21.3±15.3 years.

Table 1 summarizes the mean HbA1c, which was 10.5±1.6 at baseline, 9.9±1.78 at 3 months, 9.9±1.86 at 6 months, and 9.9±1.7 at 12 months. The mean HbA1c was significantly improved after 3 months (p=0.001), 6 months (p=0.003), and 12 months following MIEP (p=0.04).

Table 2 shows the means and SDs of fasting blood sugar (FBS). The mean FBS was 12.8 mmol/L±3.83 at baseline, 12.1 mmol/L±5.01 at 3 months, 11.6±4.35 at 6 months, and 10.9 mmol/L±3.84 at 12 months. There was a statistically significant decrease in FBS after

Table 1 - Mean and median comparisons for HbA1c at baseline and at 3, 6 and 12 months.

HbA1c	Mean (median) mmol/L	Mean (median) %	± SD	*P*-value*
Baseline	14.1 (14.4)	10.5 (10.7)	1.67	0.001
3 months	13.2 (13.2)	9.9 (9.9)	1.78	
6 months	13.2 (13.2)	9.9 (9.9)	1.86	0.003
12 months	13.2 (13.2)	9.9 (9.9)	1.70	0.04

*Wilcoxon signed-rank test fasting blood sugar, HbA1c - glycated hemoglobin

Table 2 - Mean and median comparisons for fasting blood sugar (FBS) at baseline and at 3, 6 and 12 months.

FBS	Mean (median) mmol/L	± SD	*P*-value*
Baseline	12.8 (12.7)	3.83	0.17
3 months	12.1 (12.0)	5.01	
Baseline	12.8 (12.5)	3.83	0.001
6 months	11.6 (10.9)	4.35	
Baseline	12.8 (12.5)	3.83	<0.001
12 months	10.9 (9.9)	3.84	

*Wilcoxon signed-rank test blood pressure

Table 3 - Changes in systolic blood pressure (SBP) and diastolic blood pressure (DBP) before and after MIEP intervention.

Blood pressure	Mean (median) (mm Hg)	± SD	*P*-value*
Systolic blood pressure			
Baseline	134.5 (133)	17.19	0.304
3 months	132.8 (134)	15.26	
6 months	132.3 (132)	15.61	0.141
12 months	130 (130)	13.37	0.036
Diastolic blood pressure			
Baseline	71.8 (71)	9.41	0.921
3 months	71.7 (71)	9.72	
6 months	70.6 (70)	10.13	0.278
12 months	69 (69)	9.01	0.012

*Wilcoxon signed-rank test lipid profile

Table 4 - Mean and median comparisons for lipid profile levels at baseline and at 3, 6 and 12 months.

	Mean (median) (mmol/L)	± SD	*P*-value*
Total cholesterol			
Baseline	4.6 (4.4)	1.31	0.435
3 months	4.5 (4.1)	1.10	
6 months	4.2 (4.1)	1.02	0.014
12 months	4.3 (4.1)	2.20	0.101
LDL cholesterol			
Baseline	2.6 (2.5)	0.97	0.884
3 months	2.6 (2.5)	0.88	
6 months	2.3 (2.3)	0.81	0.02
12 months	2.5 (2.5)	0.87	0.176
HDL cholesterol			
Baseline	1.1 (1.0)	0.57	0.833
3 months	1.1 (0.98)	0.57	
6 months	1.1 (098)	0.59	0.528
12 months	1.2 (1.0)	0.75	0.744
Triglycerides			
Baseline	1.8 (1.5)	1.19	0.088
3 months	1.7 (1.5)	1.23	
6 months	1.7 (1.5)	0.89	0.682
12 months	1.9 (1.7)	1.02	0.122

LDL - low density lipoprotein, HDL - high density lipoprotein, TG - triglycerides, *Wilcoxon signed-rank test

Table 5 - Mean and median comparisons for weight at baseline and at 3, 6 and 12 months.

Weight	Mean (median) (Kg)	± SD	*P*-value*
Baseline	84.4 (82.0)	18.07	0.393
3 months	83.0 (82.0)	19.01	
Baseline	84.4 (82.0)	18.07	0.752
6 months	84.5 (82.7)	17.85	
Baseline	84.5 (82.0)	15.40	0.986
12 months	83.2 (82.0)	16.10	

*Wilcoxon signed-rank test

6 and 12 months following MIEP (*p*=0.001, *p*<0.001, respectively).

Table 3 shows changes in systolic blood pressure (SBP) and diastolic blood pressure (DBP). Both SBP and DBP were significantly reduced (*p*=0.036, *p*=0.012).

Table 4 shows the means and SDs of the lipid profile, including total cholesterol levels, LDL cholesterol, HDL cholesterol, and TG. There were significant differences in total cholesterol 6 months after the intervention (*p*=0.014). In addition, this study found a significant improvement in LDL cholesterol 3 months after the intervention (*p*=0.02).

There were no statistically significant differences (**Table 5**) in the means of weight from baseline to 3, 6, and 12 months after MIEP (*p*=0.393, *p*=0752, *p*=0.986).

Discussion. The aim of this study was to determine the effect of an MIEP on the clinical outcomes of patients with T2DM. An MIEP is a multi-structural intervention where these interrelations are taken into account; it is meant to help patients to better incorporate diabetes into their lives. Besides, an intense multidisciplinary approach by physicians, nurses, pharmacists, and dieticians is the best intercession to lower the risk of serious detrimental sequelae. The results

from this study suggest the value of a multidisciplinary instructive approach in improving outcomes in terms of better control of HbA1c, decreased risk of diabetes complications, and decreased cardiovascular risk factors.[4,8]

The mean baseline FBS level, 12.9 mmol/L, was higher than recommended,[18] although FBS levels steadily reduced over the subsequent visits: 12.1 mmol/L at 3 months, 11.6 mmol/L at 6 months, and 10.7 mmol/L at 12 months after MIEP. The reduction in FBS from the baseline to the 6- and 12-month levels was significant (both p=0.001).

The mean baseline HbA1c was 10.5 mmol/L. This, too, significantly decreased over the subsequent visits: 9.9 mmol/L (0.7%) at 3 months, 9.9 mmol/L (0.5%) at 6 months, and 9.9 mmol/L (0.6%) at 12 months after MIEP. This statistically significant reduction in HbA1c from the baseline value might result in considerable reductions in cardiovascular morbidity and morbidity and mortalities if maintained properly. Although stemming from a study utilizing an alternate multidisciplinary approach and study design, these results support the findings of previous studies that reported an improvement in glycemic control.[12,19-21] In this study, the mean HbA1c was significantly improved more than in some previous studies. A 2006 study conducted by Keers et al reported a decrease in HbA1c of 0.43% at 3 months after MIEP and 0.32% at 12 months.[8] Another retrospective study that aimed to assess the effects of multidisciplinary care plans on outcomes for patients with T2DM found an absolute reduction in HbA1c of 0.38%.[21] Further, an interventional study carried out in Saudi Arabia to explore the impact of a multidisciplinary care program on patients with T2DM reported an absolute reduction in HbA1c level of 1.9%. The study did have a small sample size (n=41) and assessed the impact of the program only in relation to short-term effects.[4] It is important, however, as significant improvements in HbA1c reduce the risk of cardiovascular complications and mortality among patients with T2DM.[22] Hypertension is one of the major vascular complications of diabetes.[23] Several studies have revealed that lowering blood pressure to <140/80 mmHg would lower the incidence of hypertension, coronary heart disease, and stroke.[24,25] This study revealed that most patients (48.8%) had hypertension, and that their baseline blood pressure was a little higher than is recommended (130/80 mmHg)[18] and continued to be 3, 6, and 12 months after the MIEP intervention by healthcare providers. This study reported the baseline blood pressure of the subjects to be 134.2/71.7 mmHg, which reduced to <132.9/71.7 mmHg after engaging in the MIEP. However, there were no significant reductions

of blood pressure due to MEIP (p>0.05). This result is similar to those of previous studies that evaluated multidisciplinary care programs; however, previous studies failed to produce statistically significant BP reductions.[4,12,26] According to the American Diabetes Association (ADA), fasting lipid profiles should be investigated at the time of diagnosis during the initial medical evaluation, and then monitored every 5 years for those patients without atherosclerotic cardiovascular disease (ASCVD) risk factors.[18] Hyperlipidemia coexists with T2DM and is associated with the development of cardiovascular diseases such as coronary artery disease and stroke.[18] Despite decreases in the lipid levels after MIEP, the impact of these changes was not significant. This finding is comparable to the results of previous research that reported no significant differences in lipid profile levels of patients participating in an integrated care program.[4,12,21] Only total cholesterol levels significantly decreased 6 months after the MIEP intervention compared to the baseline (p=0.014). However, HDL cholesterol (1.1 mmol/L) was lower than the recommended level before MIEP and improved in subsequent visits. This was in contrast to a study by Al Asmary et al[4] that reported that HDL cholesterol did not improve following an integrated care program.

Obesity and excessive weight have been associated with an increased risk of diabetes and cardiovascular diseases.[18] Weight reduction programs may delay the progress of T2DM in high-risk populations and may improve glycemic control in those who have been diagnosed with T2DM.[27] In this study, the mean baseline weight, 84.4 kg, reduced in the subsequent visits: 82.9 kg at 3 months and 83.1 kg at 12 months; however, this reduction was not significant (p>0.05). This result is in agreement with the results of similar multidisciplinary care program studies, which failed to produce significant reductions in weight.[4,21]

Study limitations. There is a limitation in the design of this retrospective cohort study: it lacked a control group to compare its results with the intervention arm of the study. Use of a control group would make it possible to avoid biased results. Furthermore, the study inclusion criteria tend to recruit patients who are complaint with follow-up, which would lead to a bias due to the effect of compliance rather than the intervention. Additionally, the results from this study reflect a single center practice which might differ from other institutions for different reasons such as composition of the multidisciplinary team, program structure, and access to the team. Moreover, the study assessed the impact of MIEP over a year-long period; a longer study period with prospective design should be considered to assess the impact of this program on

glycemic control, cardiovascular risk factors as well as long-term T2DM complications.

In conclusion, this study reported that implementing an MIEP for patients with uncontrolled T2DM is associated with significant improvements in glycemic control and lipid profile, and with better control of blood pressure and weight. Future studies should include a control group in order to confirm these results.

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